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The Use of Low Rank Fuels

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—The low rank fuels form a very important part of Canada's fuel resources, and this paper is designed to indicate possible and probable means of using them. They consist of fuels of high moisture or ash content, such as lignites, wood waste and peat, which cannot be transported economically to a great distance from their source. The methods of utilizing them are divided into four classes, namely, internal combustion, grate or stoker firing, burning in a state of suspension, and conversion into forms of higher fuel value.

The Rupa pulverized fuel engine and Holzwarth turbine are examples of internal combustion methods which are applicable to such fuels. The principles of grate and furnace design for wood and peat burning are discussed briefly, and the combustion of lignites by hand firing and by the use of sprinkler, chain grate and underfeed stokers, respectively, is discussed in detail. Some European systems which may be applicable to Canadian fuels are also described. The peculiar problems incidental to the burning of low rank fuels in the pulverized form are also described, together with some recent innovations which are of possible importance in this connection. A brief survey follows of low temperature carbonization and briquetting processes, with particular reference to the northern Ontario lignite deposits, but as many of the problems involved are primarily those of chemical engineering, no attempt has been made to cover this field exhaustively. The results obtained on a gas producer suitable for use with low grade fuels, and a brief consideration of the possibilities of liquefaction, conclude the paper.

The general aim is to discuss and to give results on processes that have passed the experimental stage, but in some cases exceptions have been made where important applications are probable in the future.

Introduction

The Canadian fuel question has already been discussed in considerable detail by The Engineering Institute of Canada.(1) In the present paper, the authors desire to direct attention to those fuels having low calorific values, which are available in considerable quantities and form an important potential source of heat.

The sub-bituminous coals and lignites of Canada are estimated at over a billion short tons and comprise 77 per cent of the fuel resources of the Dominion. The output of lignite alone, in 1930, amounted to 3,453,127 tons.(2)

The area of the Canadian peat bogs is estimated at 37,000 square miles, forming a fuel reserve of nearly 35,000 million tons. Much of this is in the neighbourhood of the western coal deposits, where it is of comparatively little consequence at present, but some 114 million tons, in and near the acute fuel area, represent a source of fuel that is favourably situated with respect to present centres of population and transportation facilities.

Other fuels are produced as by-products from various industries, particularly those relating to the use of timber.

It is estimated that the waste produced per 1,000 board feet of lumber is about one-half unit or 100 cubic feet, sufficient to generate 4,000 pounds of steam from and at 212 degrees F. The amount of bark removed is approximately 10 to 20 per cent of the volume of wood handled. An auto truck body plant found that 25 per cent of its purchases of cut lumber ultimately went to the boiler room as fuel, and chair factories report that about 30 per cent of their timber is consumed in the same way.(3) It is further estimated that a paper plant using 100 cords of wood a day would have 22½ tons of moist bark to dispose of, and if this is burned, after deducting the cost of pressing, the saving as compared with coal at $7.00 per ton, would amount to $5,500 per annum.(4)

The development of these natural resources must depend on the relative economies of importing fuel from other countries and of using efficiently the fuels that are available in the Dominion. In this connection, there are two opposing factors. The first is the necessity of conserving our natural resources, which are irreplaceable, and the second is that of utilizing these to the full, so that production may proceed on an economical basis. There is an element of truth in both of these arguments. The former is obvious, as greater scarcity involves increased cost, but so also does a low load factor. In any case, efficient working reduces running expenses and a consideration of the best conditions under which our low grade fuel resources may be utilized, is probably worth while. An adequate treatment of this subject would require a book, and therefore detailed consideration will only be given by the authors to those phases which appear to them to be of immediate interest. It has been their general aim to report only on processes that have already passed the experimental stage, but exceptions have been made in some cases, where experiments have so far progressed that practical application can be expected in the near future, or when the nature of the work is such that its later application will be of considerable importance.

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(1) The Fuel Problem in Canada, L. R. Thomson, Feb. 1926.
(2) Canadian Chemistry and Metallurgy, Dec. 1931.
(3) "The Utilization of Waste Wood for Steam Generation," A. R. Smith, "Combustion," Oct. 1930.
(4) "Pulpwood Bark for Fuel," Rue and Gleason, 1924.

Definition

Low rank fuels may be classified according to their source. They are either obtained from the earth, by mining or cutting (e.g. lignite or peat), or are by-products from some industry and have to be disposed of.

In either case, the cost of transportation and handling is the limiting factor which decides the radius over which the fuel can be used. With all solid fuels, this radius is a function of the quantities of ash or moisture, or both, that have to be excavated, transported, handled and removed.

The term "low rank," therefore, is a relative one, signifying a fuel that cannot be transported economically to a considerable distance from the place where it is produced, on account of its large content of moisture or ash, or both.

It is evident, therefore, that a low rank fuel must be used locally for the production of heat or power, and then either the products of combustion, or the power generated, may be distributed over a wider area, in the event that suitable markets can be found for them.

The question of economy includes on the one hand, the desirability of developing the natural resources of the Dominion and of replacing competitive imports, and on the other, the necessity of avoiding the accumulation of waste products.

Moisture

The water present in a low rank fuel, as received, may vary from 20 to 80 per cent, or more, of the total weight. For every class of fuel, a curve may be drawn showing at what percentage of moisture[5] the heat required to evaporate this water becomes equal to the heat available from the combustible matter present. This represents the theoretical limit, beyond which the material has no heat value at all, but the practical limit is reached before that point.

The effects of water are to reduce the temperature of combustion and to increase the losses due to the exhaust gases. This reduction of temperature is due not only to the heat absorbed in evaporating the water present in the fuel, but also to the dilution of the oxygen required for combustion, which delays contact between the molecules of combustible and oxygen and retards the process. If the fuel is burned in deep beds, the wet fuel also tends to pack and to obstruct the draught.

It follows, therefore, that the water present in the fuel must be reduced to a minimum either by mechanical action, by the use of waste heat, or by a combination of these two methods, so that the fuel may be used to the best advantage. It does not follow, however, that the objective is the maximum elimination of moisture, as the cost of complete drying is usually greater than the benefits derived. Beyond a certain point, the increase of efficiency due to the continued reduction of moisture content is very slow and the cost curve rises rapidly. There is, therefore, with each fuel, an economic optimum value for the moisture content and this is not necessarily the minimum value obtainable.

The greatest difficulty met with in the commercial handling of peat is due to the fact that most bogs contain about 90 per cent of moisture, most of which cannot be removed by mechanical action. Pressures up to two tons per square inch only succeed in eliminating about 20 per cent of the water, leaving 70 per cent, or more, still in the fuel.[6] The low thermal conductivity of peat makes it suitable for use as an insulating material, but renders artificial drying impracticable, unless a very large supply of waste heat from other sources is available for the purpose. The cost of such operations on a low rank fuel is usually prohibitive.

The standard requirement for peat to be used for combustion purposes is about 30 per cent of moisture content, and this must, therefore, be reached by some process of air drying, the possibilities of which are detailed in the final report of the Peat Committee. So far, in spite of the somewhat favourable report of the Committee, no commercial developments have taken place in Canada, but such may become feasible and necessary as alternative fuels become scarcer and more expensive.

Waste fuels, such as bark or wood waste, are also subject to similar conditions. The dry barking process, used by approximately 40 per cent of the companies reporting,[7] produced a moisture content of 35 to 55 per cent, and the wet process, used by the others, gave 60 to 85 per cent. It is possible, by pressing, to reduce the latter to 50-65 per cent[8] and, at the former figure, the bark may be burned alone or mixed with fuels of a higher grade. The average calorific value, in this state, is about 3,000 B.t.u. per pound. Obviously, it is preferable, however, to reduce the moisture further by the use of waste gases from the furnace.

An analysis of the situation by Ahara,[9] shows that there is little gain in boiler efficiency when the moisture content is reduced below 40 per cent.

Wood waste from lumber mills (50 per cent moisture or less) will burn satisfactorily without the use of coal, and is extensively used as fuel in the west, but that produced by the wet barking process requires the addition of high grade fuel. Dry wood waste, from furniture or similar plants, may be burned in the same way as coal and the furnace walls must then be cooled, to avoid trouble with refractory linings.

The cost of drying wet bark to a low moisture percentage is great, on account of the complicated and expensive apparatus required for high thermal efficiency. Also, the flue gas obtained from the wood refuse alone is insufficient to dry the raw fuel completely, on account of the large quantity of moisture already present, and therefore a self-contained drying unit is very difficult to design and operate successfully. On the other hand, in cases where very wet refuse is produced, the power available from this source alone is generally insufficient for the requirements of the plant, and for this reason, coal or oil fired boilers must also be installed, the gases from which may be used for drying the wood refuse. Under these conditions, a high thermal efficiency is not necessary in the dryer and a simpler and cheaper unit may be employed.

The flue gas temperature used should be less than 500 degrees F. and the design should be such as to avoid packing and bridging.

Lignites should not be dried below the percentage of moisture corresponding to a condition of equilibrium with the moisture content of the air, otherwise water will be re-absorbed with a generation of heat which may be sufficient to produce spontaneous combustion. This limit is usually from 16 to 18 per cent of moisture. Drying at the mine, under controlled humidity conditions, will possibly reduce freight and handling charges by about 20 per cent.

It is possible to reduce the moisture content of lignites from 35 per cent to 15 per cent by using waste gases, but generally at the risk of promoting disintegration. This phenomenon has been studied in Austria by Professor

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(6) Cochrane, "Finding and Stopping Waste in Modern Boiler Rooms," p. 75.

(6) Final Report of Peat Committee, 1925.

(7) "Utilization of Pulpwood Bark for Fuel," Rue and Gleason, 1924.

(8) Generally 60 to 62 per cent.

(9) Pulp and Paper Magazine, Nov. 27, 1930.

Fleissner,[10] who attributes it to the shrinkage that takes place when these coals are dried. The outside layer dries rapidly and shrinks, before the core loses its moisture, so that the outer shell peels off and crumbles. This process removes layer after layer in succession, until the whole mass is crumbled.

This method of drying, from the outside inward, is usually carried out in inclined revolving drums, the coal being fed in at the top and gradually working down. Most processes of this kind have the air moving in the opposite direction to the fuel, but with lignites the air and fuel generally move in the same direction. This avoids having the partly dried fuel exposed to the high temperature of the gases entering the apparatus. When the gases and fuel enter together, the rapid evolution of water in the high temperature zone helps to prevent oxidation of the fuel. The lignite also leaves the dryer at a comparatively low temperature and is not so liable to ignite when it enters the atmosphere. This is a very real danger, as the porosity of the dried lignite makes it very liable to ignite spontaneously. For this reason, the dried fuel must be loaded as cold as possible.

The disintegration referred to above, may be overcome by steam heating. Dr. Fleissner claims that with this method the drying takes place evenly through the mass of the lumps and that a denser and more stable product is produced. The coal is heated in an enclosed iron vessel, by steam at a pressure of 120 to 150 pounds per square inch, for a period of one and a half to two hours. Then air, either warm or cool, is passed over the coal for sixty to ninety minutes, after which the dried coal is removed. Tests have shown that the moisture content is reduced to about 16 per cent by this means. The consumption of steam is six pounds per pound of water removed, and the final volume of the coal is about 80 per cent of the initial volume. Exposure tests for three hundred and twelve days indicated a considerable improvement in the weathering properties of the dried fuel, as compared with that produced by gas drying from the exterior. The future of this process will be watched with interest.

Ash

In some low rank fuels (e.g. wood waste), the percentage of ash is small, but others may contain up to 20 per cent on the dry basis. This non-combustible matter reduces the calorific value of the fuel, lowers the efficiency of combustion and entails additional expense for ash disposal. The insulating properties of ash make a greater draught necessary, and therefore greater leakage losses are liable to occur when the percentage of ash is high. The labour and cost of keeping an even flow of air through the fire also increase with the ash content. Polakov[11] gives a curve indicating that the steaming capacity of coal decreases parabolically with increase of ash, and W. L. Abbott states that 20 per cent ash appears to be the upper economical limit for steam producing coal. On the other hand, Kreisinger and the United States Bureau of Mines say that fuel with 40 per cent of ash can be burned under proper conditions. It is evident that the upper limit depends upon local conditions, the capacity and loading of the plant, and on facilities for the continuous and automatic disposal of large quantities of refuse.

The removal of ash from coal, by washing, is limited by the amount of fixed ash present (usually 2-3 per cent), but usually, the free ash is not entirely removed, the reduction varying from 20 to 50 per cent of the original ash content. The fusing point of the ash and its tendency to accumulate as clinker are also important factors.

[10] "Fuel in Science and Practice," Vol. X, Sept., p. 385; also Ind. and Eng. Chemistry, Dec. 1930.

[11] "The Economical Use of Fuel," Trans. A.S.M.E., 1918.

The ash in Canadian peat varies from 1.3 to 27 per cent of the weight of the dry fuel, but twenty-eight out of eighty-seven analyses made by the Peat Committee had ash contents of 10 per cent, or less. High percentage of ash may be the deciding factor in connection with the commercial utilization of peat, as the ash displaces an equal volume of combustible matter, and when the peat is carbonized, the percentage of ash in the charcoal will be from two and a half to three and a half times as high as that in the peat from which it is produced. When peat is burned in a furnace, the resulting ash is finely divided and does not form clinkers.

Possible Methods of Burning Low Rank Fuels

The objectives may be divided roughly into heat and power production. The former may consist of the generation of steam for heating buildings or for process work, or, alternatively, the production of gas or oil, either with or without by-product recovery. The latter may involve internal combustion, in which either the solid fuel itself, or the gas or oil produced from it, is burned in an engine cylinder. The most general case, however, is the production of steam.

Thus, processes used for heat production may be classed with those employed for power generation, as there is no essential difference in the methods used.

The following is an analysis of the various principles involved:—

(1) Burning the pulverized fuel in an engine cylinder.

(2) Burning the fuel on a grate or stoker, either alone, or in combination with higher rank fuels.

(3) Spraying the finely divided fuel into a boiler furnace.

(4) Conversion of the fuel, prior to combustion, into a more convenient or valuable form, either by gasification, liquefaction, carbonization or briquetting.

The possibilities of utilizing the various low rank fuels by these processes will be discussed in the following pages. It is obvious, however, that a general comparison only can be attempted.

1. *The Direct Generation of Power by Means of Internal Combustion Engines.*

(A) *The Rupa Pulverized Fuel Engine.*

When Dr. Rudolf Diesel started work on his "economical heat engine" he experimented for a time with solid fuels, which idea had been conceived by MacCallum in 1891. It was found, however, during the early stages of the development of the so-called constant pressure engine, that liquid fuels were easier to use, and so work on the pulverized coal engine was abandoned. One of Diesel's associates, Dipl.-Ing. Rudolf Pawlikowski, however, resumed these experiments later. Five years elapsed before the converted oil engine, which was used for these trials, produced its first ignition on pulverized coal. Since 1916, Mr. Pawlikowski has continued this work and has converted a number of oil engines to the use of solid fuel. The development was slow, as he had to work without any outside financial help and thus was often handicapped by the lack of money, so that the results obtained are the more creditable. Some of these converted engines have been operating successfully for a number of years, and are approaching a reliability equivalent to that of the oil engine.

Pawlikowski's engine is known as the "Rupa," and in appearance, size and weight, is very similar to the Diesel engine. In fact, the latter can be converted to the Pawlikowski process by making a few changes, provided that the engine fulfils certain requirements.

There is, however, a very essential difference between the Rupa and the Diesel engines. Whereas in the latter,

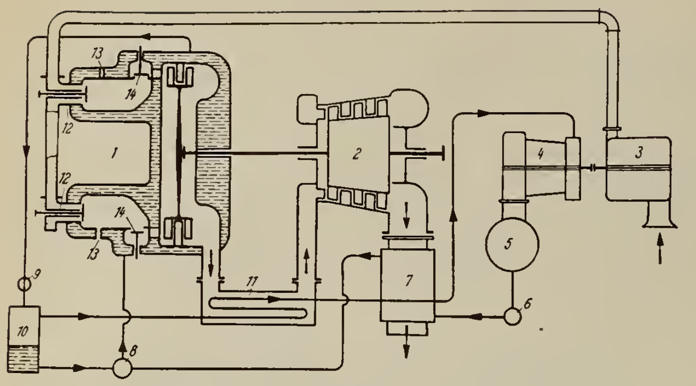

Fig. 1—Holzwarth Internal Combustion Turbine.

1. High pressure stage of gas turbine.
2. Low pressure stage of gas turbine.
3. Turbo-compressor for combustion air.
4. Steam turbine driving turbo-compressor.
5. Condenser.
6. Condensate pump.
7. Preheater heated by exhaust gases.
8. Feed water and circulating pump.
9. Reducing valve.
10. Steam separator.
11. Superheater heated by gases from high pressure stage.
12. Fuel and air inlet valves.
13. Ignition equipment.
14. Nozzle valves.

the fuel is injected into the combustion space at, or near, the end of the compression stroke, the solid fuel of the former is measured into the pre-combustion chamber during the suction stroke. This chamber is continuously connected to the cylinder, but a special design of throat prevents the fuel from entering the cylinder until the combustion temperature is reached, or in other words, until the proper injection time. This arrangement is probably the reason for Pawlikowski's success. It appears that all the other inventors who tried to develop a pulverized fuel engine, adhered to the injection principles of the oil engine and, therefore, could not overcome the difficulties of injecting and measuring the solid fuel in the short time available. In the Rupa engine, the time available for measuring and injecting the fuel is from ten to fifteen times as long as that in an engine of the dead centre injection type.

Complete descriptions of the Rupa principle can be found in "Engineering" ([12]) and in the Proceedings of the Second International Conference on Bituminous Coal,([13]) and, therefore, we shall refer only to the developments which have taken place since that time.

Over five hundred types of pre-combustion chamber have been tried on fuels of the most diversified nature. All kinds of coal, from bituminous coal to semi-lignites, peat, coke, sawdust, charcoal, flour, rice and other vegetable matter of different origin, including ground olives, have proved to be usable fuels in this engine. The power output, with fuels which contain no appreciable oxygen content, is the same as that obtained with fuel oil. The heat consumption is always in the neighbourhood of 7,900 B.t.u. per B.h.p. hour. Fuels containing a high percentage of oxygen, as for instance, lignites, give the best results on this type of engine, as they permit an extremely high specific power output to be obtained, without supercharging. The oxygen contained in the fuel gives the same result as the oxygen contained in supercharging air, without the disadvantage of additional nitrogen. Normal four stroke cycle Rupa engines, operating on lignites, give a brake mean effective pressure of 160 pounds per square inch, roughly 60 per cent more than can be obtained with oil or other fuels having no oxygen content. The indicated thermal efficiency of the Rupa engine is as good as that obtained in a high compression oil engine, but the mechanical efficiency is about 10 per cent lower. This is not a serious disadvantage, as the fuel used is extremely cheap, the main feature being that combustion is complete, as is shown by the high indicated efficiency and by the fact that the exhaust gases contain practically no combustible matter. The exhaust of the first Rupa engine, which is located close to a brick wall, has not yet blackened this wall after more than nine thousand hours of operation.

Fuels which are poor in volatile matter and are, therefore, slow burning, require for their combustion, the addition of a small amount of fuel oil, to be injected into the pre-combustion chamber simultaneously with the pulverized coal. Thus, the fuel oil pumps are not operating against high compression pressures, as they are in the ordinary oil engine. The regulation of the Rupa engines, on all fuels, is as good as that of a Diesel engine. They are usually built in such a fashion that they can use any fuel. They are equipped with solid injection high pressure oil pumps for operation on oil only, with a low pressure oil pump for fuels lacking volatile matter, and with an injection air compressor for pulverized fuel of too high a moisture content for airless injection. If the fuel to be used is known from the beginning, the engine will, of course, only need one part of the above-mentioned equipment. To be suitable for airless injection in the Rupa engine, any fuel has to be dry enough not to cake in the pre-combustion chamber or conveyor. This can easily be determined by pressing it by hand into a ball and putting the ball down gently. If it immediately collapses into the form of a loose cone, it is suitable for airless injection.

Rupa engines have been built as single-acting four stroke cycle engines in sizes up to 220 B.h.p. per cylinder. These run at 166 r.p.m., but as some smaller Rupa engines have successfully operated speeds as high as 500 r.p.m. it may be anticipated that, if required, a higher speed can be obtained with the larger units. Rupa engines have about the same dimensions as Diesel engines of the same power and speed, but their price will be about 10 per cent more. For engine-generator units of about 500 to 1,000 kw. a cost of about $145.00 per kw. output, including duty, can be expected. The first commercially built units are said to be ready for delivery about June 1932.

(B) *The Holzwarth Gas Turbine.*

After successful tests with a 500 kw. machine, the further development of Holzwarth turbines has been taken over by Brown-Boveri and a new 2,000 kw. unit is under construction. Whereas the 500 kw. machine gave an efficiency of 23 per cent, the builders expect to attain 30 per cent on the new and larger units. So far, the Holzwarth turbine has operated on oil only, but as it is expected that tests with pulverized fuel will soon yield positive results, this type of engine is being mentioned in this paper.

The new turbines([14]) have undergone a number of changes in principle from the original designs. (See Fig. 1.) Expansion is now being completed in two steps, and the combustion gases are cooled before they enter the high pressure runner. The combustion chambers and high pressure housing are placed in a cooling jacket in which the pressure is sufficiently high to prevent evaporation. The water leaving this jacket passes through a reducing valve, where it evaporates, and then through a superheater placed inside the gas duct between the high and low pressure stages. The superheated steam then passes to the turbo compressor, which supplies the combustion air. The two

([12]) Sept. 28th, 1928, p. 408.
([13]) Pittsburgh, Vol. I, 1928.

([14]) Second World Power Conference, Vol. V (Prof. P. Langer).

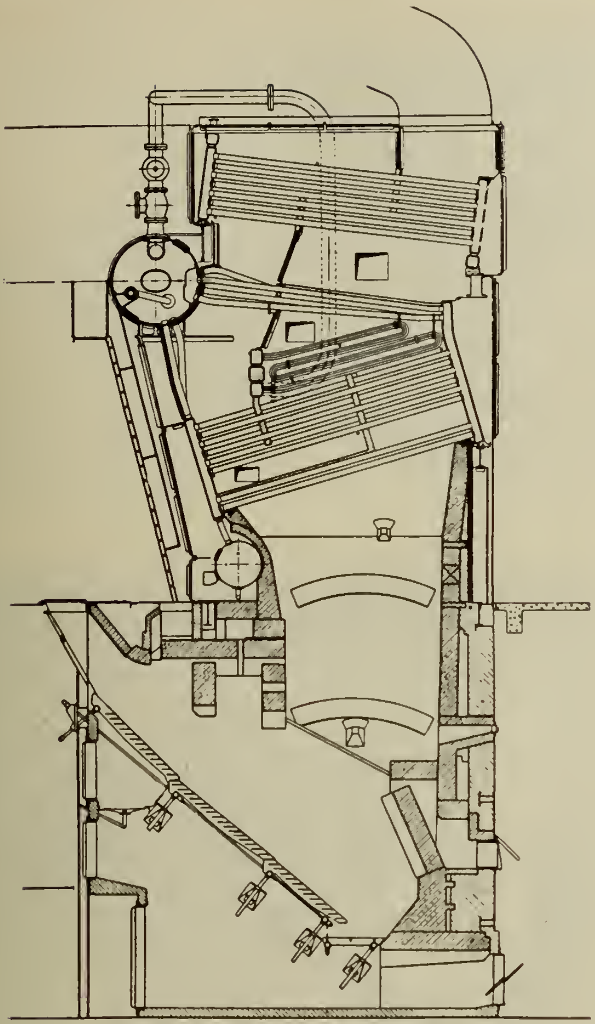

Fig. 2—Stromberg's Furnace for Wood Burning.

gas turbine stages are bolted to the generator shaft, whereas the present turbo compressor is installed independently. It is possible that, later on, the compressor turbine also will be bolted to the generator shaft if more steam energy should be available, depending upon the amount of heat extracted by the cooling water from the combustion gases. This machine can conceivably pass through all stages from a gas turbine, with cooling-water heat recovery, to a steam turbine plant with exhaust gas turbine.

From the knowledge already obtained, it is expected that the floor space required by the complete turbine unit will be approximately the same as that for a steam turbine plant with the same output, in which case the space required by the boilers and auxiliaries of the turbine plant would be saved. The price of a complete Holzwarth unit is said to be about 85 per cent of that of a complete steam turbine plant (including boilers) of equal output. For the immediate future, at least, the Rupa engine will be of greater interest to the practical Canadian engineer than the Holzwarth gas turbine, as the former has already left the experimental stage and has proved its ability to operate on the low rank fuels which are available in this country.

2. *Burning the Fuel on a Grate or Stoker.*

(A) *Wood Refuse.*

This fuel has a heating value, when dry, of 8,500 to 9,500 B.t.u. per pound, and contains from 1 to 3 per cent of ash.

Apart from the influence of moisture in reducing the combustion temperature, difficulties are experienced in connection with the correct supply and distribution of air, particularly when the fuel is bulky in proportion to its weight and contains a high percentage of volatile matter. Blowholes are liable to form in the fire and light particles of fuel may be carried unburned to the stack. Wood contains from 30 to 40 per cent of volatile matter and this must be burned entirely before the gases are chilled by contact with the boiler heating surface. For wet hogged wood,[15] from 2 to 5 cubic feet of furnace volume should be provided per boiler horse power. The furnace unit must be arranged with refractory linings and arches, so that heat is radiated on to the fuel, producing high temperatures locally and shielding the fire from the cooling effect of the boiler tubes. These arches must also be arranged to produce the most efficient mixing of fuel and air.

When logs are transported overland and carry accumulations of foreign matter with them, hard slag is liable to form, and for this reason provision must be made for easy cleaning of grates and combustion chambers; apart from this, there is little tendency for slag to form from Canadian timbers. The air-cooled wall has greatly increased the life of the refractories where dry wood is used, and in other cases the water-cooled wall has been employed successfully.[16]

Flat or inclined grates, usually enclosed by some form of Dutch oven, are commonly used with these fuels. The wood collects in piles and burns mostly on the surface, so that air should be admitted above the grate in sufficient quantity to complete the combustion of the volatile matter. The fuel bed should not be disturbed any more than is absolutely necessary, though pushers are sometimes advisable where inclined grates are used.[17] Uniform size of fuel is important for all feeding devices and the supply must be in proportion to the load, as the steam demand bears very little or no relation to the amount of refuse produced. Where coal or oil fired boilers are used in addition to those burning wood waste, the fluctuations of load are usually taken on the former, and in that case the wood is burned as it is delivered. The feeder should provide a seal between the storage bin and the furnace to

[15] For power consumed in hogging, see "Combustion," Oct. 1930, p. 22.

[16] A.S.M.E., Fuels and Steam Power, C. S. Gladden, Jan.-April, 1931.

[17] A.S.M.E., Wood Industries, Hafft, Oct. 1930.

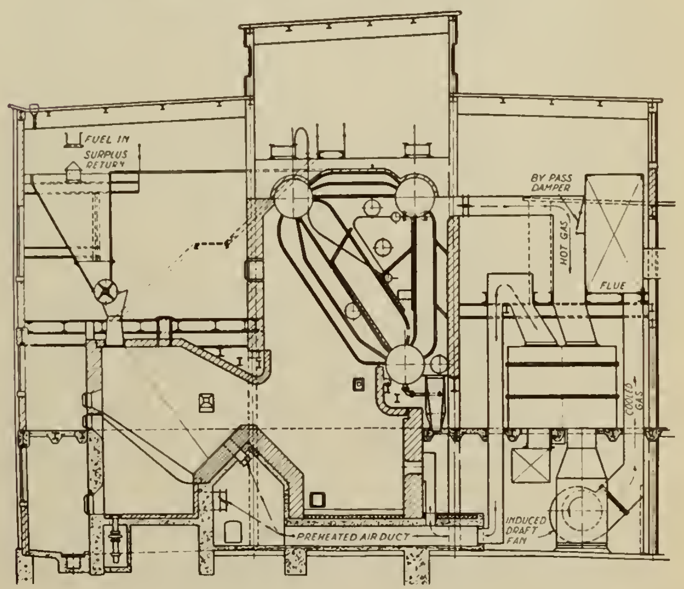

Fig. 3—Wood Burning Furnace with Preheated Air.

prevent fires.[18] In some cases, oil or natural gas is used in the same furnace as a standby fuel.

The wood burns at a high rate, 200 pounds per square foot of grate per hour being common, and although the fuel bed is deep, it has a much lower reserve capacity than a coal fire, as eight cubic feet of wood are about equal to one cubic foot of coal in steaming capacity.[19] Either straight or bent tube boilers are suitable.

Wood is burned sometimes in underfeed stokers, but in practically every case it is fed on to a bed of coal, the latter fuel alone being admitted through the stoker. Forced draught is almost invariably used, and high air velocities are necessary through the secondary nozzles. An installation of the Lake St. John Paper Company has a stoker in a Dutch oven and auxiliary grates for burning wood under a 250 h.p. B. & W. boiler. Preheated air is supplied at 380 to 440 degrees F. and ratings up to 325 per cent are obtained on refuse containing 50 per cent water. The maintenance cost is said to be negligible and the furnace is cleaned once a week.

Strömberg[20] states that wood with 50 to 60 per cent moisture can be burned efficiently, but only if the combustion equipment is specially designed for that fuel. In his furnace (shown in Fig. 2), natural draught is used, so that large air passages are necessary, and the fuel is fed automatically on to an inclined grate at an angle of nearly 45 degrees. A 535-h.p. boiler is described, which works on sawdust and wood chips, having a moisture content of 54 to 57 per cent, and a net heating value of about 3,000 B.t.u. per pound. Tests made at 87, 166 and 242 per cent rating gave overall efficiencies of 83.3, 84.7 and 82.3 per cent, respectively. The CO_2 content of the flue gases varied from 17.5 to 15.7 per cent, and at the highest rating 222,000 B.t.u. were liberated per square foot of grate area per hour.

The use of preheated air in wood-burning furnaces (see Fig. 3) gives increased steaming capacity and greater efficiency. Colby[21] gives examples of boilers operating up to 250 per cent rating with air preheated to 400 degrees F., and efficiencies as high as those obtained with coal firing are quoted by various writers.

(B) *Lignite.*

Most of the Canadian lignites are found in the west, though smaller deposits occur in Manitoba and Ontario.

The moisture content of western coals increases generally with the distance of the deposits eastward from the Alberta-British Columbia boundary, and this forms a convenient method of classification. Representative analyses of the various grades of lignite are given in the following table:—

Class	A 10-22 per cent of moisture	B 22-26 per cent of moisture	C 26-30 per cent of moisture	D Over 30 per cent of moisture
Moisture, per cent....	17	25	28	34
Ash "	10	7	6	7
Volatiles "	28	28	29	27
Fixed Carbon "	45	40	37	32
Sulphur "	0.4	0.3	0.4	0.4
Calorific value B.t.u. per pound.......	9,500	8,700	8,300	7,100
Examples...........	Drumheller Pembina	Edmonton Cardiff	Tofield Camrose	Souris Estevan

These are all non-coking. Different classes have different burning characteristics and, therefore, should not be mixed in the hopper or used at the same time.

Class "A" is tough in structure[22] and will stand considerable handling without appreciable breakage. Some varieties have a tendency to heat when stored, but generally no particular precautions are necessary. Drumheller coals have been stored to a depth of 15 feet without trouble. As a rule, they do not deteriorate materially when stored exposed to the weather. The smaller sizes are difficult to ignite, form clinkers and present difficulty in keeping the fire alight when forced draught is used, also much unburned coal finds its way into the ashes. Lumps exposed to the fire tend to disintegrate, plugging the grate or being blown away, thus producing bare spots on the grate. They also tend to cover the remaining lumps and prevent them from burning. A thin fuel bed is necessary, as a thick fire tends to go out, owing to the prevalence of an endothermic reaction which reduces the CO_2 to CO. For this reason the layer of ash at the discharge end of the stoker becomes very thin, so that, unless the air is properly distributed, large losses occur due to the presence of excess air, particularly

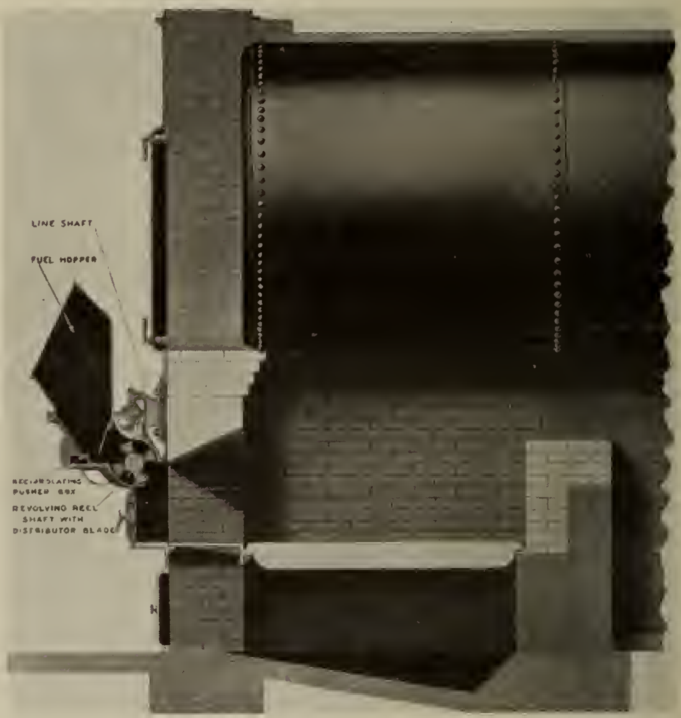

Fig. 4—Sprinkler Stoker for Lignites.

at low ratings. These factors (which apply also to other classes), combined with the low calorific value, make large grate areas necessary for such coals.

Class "B" coals are tough in structure and can be stored successfully, but deteriorate to a greater extent than Class "A," when stored. Only the top of the fuel pile is affected, however. The general burning characteristics are similar to those of the previous class, but the clinkering is more serious and can only be avoided by working at comparatively low furnace temperatures.

Class "C" has storing characteristics similar to those of Class "B" and the ash has a lower fusing temperature, but does not form bad clinkers. It is free burning, ignites readily and produces good results in a boiler furnace.

The coals in Class "D" are tough structurally but crumble when exposed. They are more difficult to burn than any of the others, forced draught being necessary with the smaller sizes. Under these conditions they ignite readily, burn with a long flame, do not produce serious clinkers and give relatively high furnace temperatures.

(18) See "Economical Use of Fuel," A.S.M.E. 1918, p. 353.
(19) Technical Association Papers of the Pulp and Paper Industry, Series VIII, "Burning of Wood Refuse," Beers.
(20) Second World Power Conference, Vol. VII, p. 256.
(21) Trans. A.S.M.E., Fuels and Steam Power, 1931, p. 27.
(22) See also Investigation of Fuels and Fuel Testing, Dept. of Mines, 1924, pp. 20-44.

Fig. 5—Pyramid Grate for Winnipeg.

Generally, the clinkering characteristics of lignites do not appear to have the same relationship to the fusing point of the ash as in the case of bituminous coals. Possibly the high moisture content of the fuel has some influence in this connection. The question of clinkering is important in such cases, where thin fires and low furnace temperatures are usual. The fusing temperature of the ash in western lignites varies from 1,900 to 2,400 degrees F.

Long flaming coals of this type require relatively high furnace settings, and this factor, together with the use of special non-sifting grates, marks the principal changes necessary in furnace designs where lignites are burned. As in the case of wet wood, furnace temperatures must be increased by the use of arches and by the avoidance of water cooling, either in the walls or by radiation from the surface of the boiler proper. With mechanical feeding, the length of the arch is reduced to the minimum necessary to maintain proper temperatures at the front of the furnace, to speed up drying and distillation and to give an intimate mixture of air and unconsumed volatile matter. The maximum throat area must be allowed to avoid the accumulation of slag on the tubes, and it should be arranged to give turbulent rather than streamline flow. The presence of moisture facilitates a uniform rate of distillation of the volatile matter and promotes the formation of water gas, which is readily burned without the formation of smoke. The carbon remaining after this distillation process is of a relatively porous character, and its large ratio of surface to volume makes high combustion rates possible. Natural and induced draught are usually not suited to the burning of lignites on account of the high resistance of the fuel bed.

Fig. 6—Detail of Pyramid Grate.

The following optimum conditions are laid down by R. L. Sutherland([23]) for burning lignites:—

(1) A minimum amount of free oxygen at the surface of the fuel bed, the best thickness of which varies with the age of the fuel and its size.

(2) A uniform flow of air in proportion to the load.

(3) Minimum disturbance of fuel bed.

(4) Horizontal, or nearly horizontal, non-sifting grates.

(5) Forced draught with or without preheat.

The methods of feeding these fuels may be summarized as follows:—

(1) *Hand firing*, with natural draught, is usually not economical, as large sizes of coal are required (between two and six inches) and considerable skill is necessary on the part of the fireman. Forced draught, with over-fire draughts of about .02 inch water gauge, automatically regulated to suit the load, has been used successfully in combination with non-sifting grates. The alternate method of firing is employed, the fuel bed being three to four inches thick, with Souris coal. The low first cost of this type of equipment, combined with the use of cheap fuel, creates a considerable market in spite of its relatively low efficiency (55 to 58 per cent).

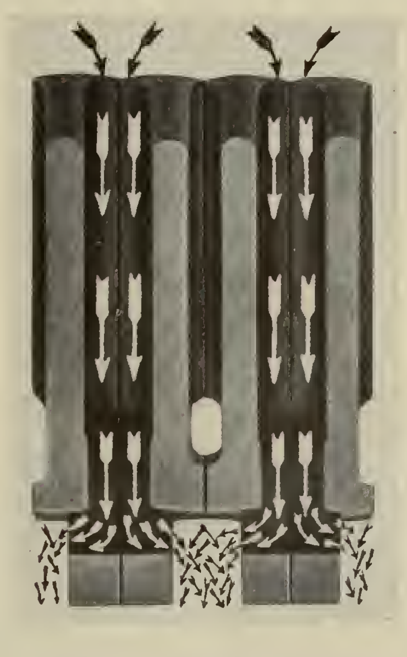

Fig 7—Detail of Hulson Grate.

(2) *Sprinkler stokers* (see Fig. 4) avoid the necessity of opening the furnace doors when firing, but the grates still have to be cleaned by dumping or shaking. In some cases, the grates are made in sections which can be dumped separately, so that a continuous fire may be maintained. If the sizing is uniform, the coal will be distributed evenly over the grate and the fire kept at its best thickness. The pressure in the ashpit varies from 0.2 inch of water for a clean fire, to one inch for a dirty fire. Fuel burning rates up to 60 pounds per square foot per hour have been obtained on Edmonton slack coal containing 25 per cent of moisture. In tests made at the Parliament buildings power plant, Edmonton, 55 pounds of slack were burned per square foot of pyramid grate per hour, producing a boiler rating of 160 per cent, with an overall efficiency of 65 per cent. A rating of 200 per cent has been obtained from North Dakota lignite (similar to Saskatchewan lignite). The average efficiency of the boilers at the University of North Dakota, for the first four months of 1931, was 68.6 per cent, corresponding to an equivalent evaporation of 4.95 pounds of

([23]) "Heat and Power"—Special Lignite issue, p. 10.

water per pound of lignite of 7,000 B.t.u. per pound. A test at Humboldt (Saskatchewan) gave an efficiency of 73.87 per cent on Drumheller coal of 9,697 B.t.u. per pound as fired. The sprinklers are operated by engines or variable speed motors and the spread or throw of the coal is varied by altering the speed of the driving mechanism.

Precaution is taken to ensure safety from breakage due to foreign matter entering the distributor, and a coal agitator is also provided to prevent arching in the hopper. The size of coal best suited to this type of stoker is from one-half inch to two inches. Dumping grates should be used where the ash content is high, the fusing temperature low, or where a continuous heavy load has to be carried.

Generally, sprinkler stokers have low initial and maintenance costs and are suitable for moderate sized plants or those having a low annual load factor. They are not limited to small sizes, however, as a large unit has recently been installed for the Northern Public Service Corporation at Winnipeg (Fig. 5). This consists of one boiler rated at 877 h.p. to be run continuously at 250 per cent rating on Saskatchewan lignite and at a maximum of 300 per cent. This plant is the largest yet constructed, the grate being 12 feet 6 inches long and 16 feet wide. The plant has recently been put into operation and eventually three more units of the same size are to be added.

One peculiar feature, in connection with the combustion of lignites, is the high percentage of CO_2 (16 to 17 per cent) that can be obtained without producing CO. This is probably due to the combination of low furnace temperatures and large moisture content of the gases.

Non-sifting grates, upon which the success of these installations depends, are those having indirect or winding passages for the air, thus enabling low velocities and air pressures to be used without losing fuel. The "pyramid" type consists of a series of caps covering large vertical holes.

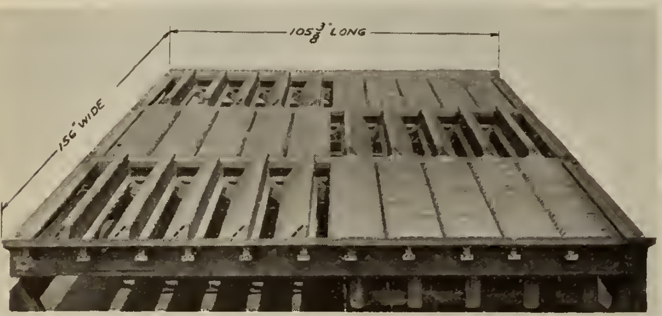

Fig. 8—Hulson Grate, Showing Dumping Sections.

The air is distributed by means of four horizontal openings in the sides of each cap. (Shown in Fig. 6.) This construction gives an effective air space of about 30 per cent of the grate area, and has proved very satisfactory in service. Dumping bars, operating two or more sections separately, provide openings sufficiently large for ordinary clinkers to pass into the ash pit and, for that reason, these grates are generally used in industrial work, as shown in Fig. 5. Souris coal has been burned on these grates up to a maximum of 90 pounds per square foot per hour.

The "Hulson" grate is made suitable for both shaking and dumping and is suitable for low combustion rates, or for lignites with relatively high fusing temperatures. It consists of a number of loose "fingers" (see Fig. 7) arranged to provide alternate vertical and horizontal passages for the air. These grates have been used with fuel consumptions of North Dakota lignite up to 71 pounds per square foot per hour, using natural draught (Fig. 8).

(3) *Travelling Grates.* With these grates, the necessity of maintaining a thin fuel bed over the whole of the area makes the use of natural draught very uneconomical.

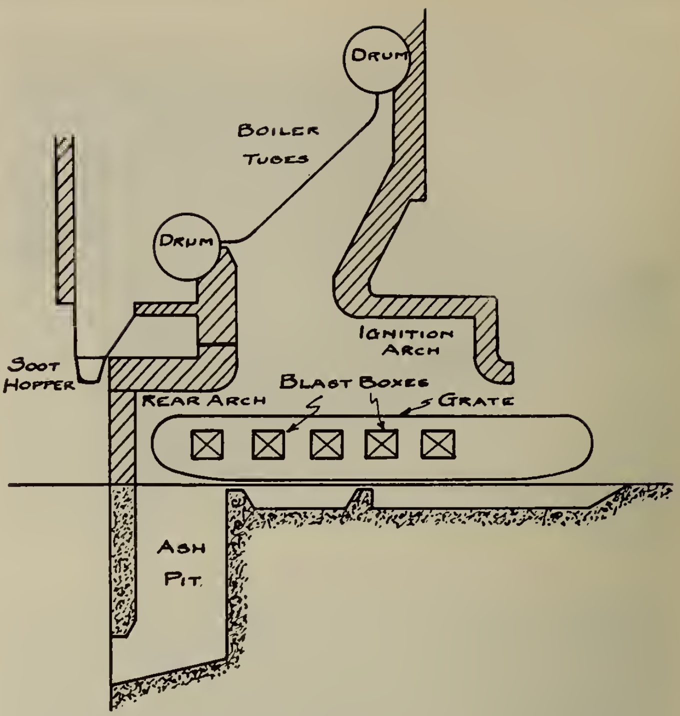

Fig. 9—Arrangement of Setting for Forced Draught Chain Grate.

Large volumes of excess air enter at the rear of the grate, giving low CO_2 readings, and the maximum rate of combustion is ordinarily about 20 pounds per square foot per hour. This may be increased by the use of special arches to about twice that figure, but in most cases the better air distribution obtained by the use of sectionally controlled forced draught, combined with the use of non-sifting grates, has given much more satisfactory results.[24]

The arches are usually arranged in such a way as to provide a secondary combustion chamber above them, so that the rich gases from the front of the grate can be thoroughly mixed with the lean gases from the back, before they are cooled by contact with the boiler surface. (See Fig. 9.) In this case, the initial thickness of fire must be greater than that required to produce the maximum CO_2 at the surface, and this requires from eight to twelve inches of fire, depending on the length of grate and the load requirements.

[24] Combustion rates quoted for Harrington stokers are:—
Alberta lignite (Edmonton) 50 pounds per square foot per hour (continuously).
Alberta lignite (Edmonton) 60 pounds per square foot per hour (2 hour peaks).
Saskatchewan lignite (Souris) 70 to 80 pounds per square foot per hour (continuously).
Saskatchewan lignite (Souris) 90 pounds per square foot per hour (2 hour peaks).

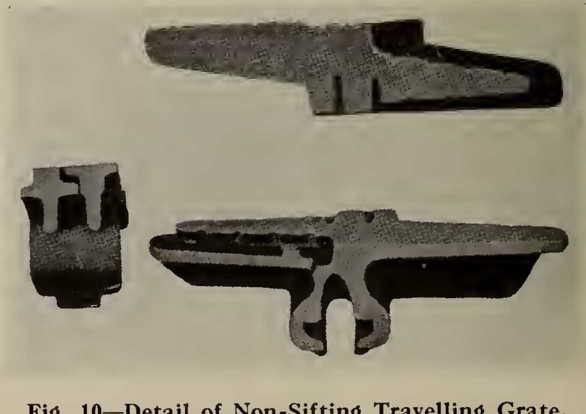

Fig. 10—Detail of Non-Sifting Travelling Grate.

The resistance of the fuel bed varies considerably and therefore dampers must be provided to regulate the air supply to the various boxes under the grate. Preheated air must be used at high ratings to dry the coal, and at the steam plant of the Otter Tail Power Company, North Dakota lignite is used to produce steam at 300 per cent rating for several hours at a time, with an air temperature of nearly 400 degrees F. Tests made on Saskatchewan lignite indicate that air preheated to 375-400 degrees F. will give approximately 35 to 40 per cent more capacity than can be obtained with air at 70 degrees F. A committee appointed to visit this and other North Dakota plants using lignite, reported that all of the ten stations visited had clear and clean stacks. On account of the tendency to disintegrate, non-sifting grates must be used. The kind of grate used for this purpose is illustrated by Fig. 10. The first section of the grate acts as a dryer, the middle as a gas producer and the end usually has an excessive supply of air. This type of stoker appears to be the best for Saskatchewan lignite, the only disadvantage being its relatively high cost, which necessitates substantial economies in running expenses to offset the capital cost.

The furnace volumes used in these installations correspond to a heat liberation of 40,000 to 50,000 B.t.u. per cubic foot per hour for continuous running, and up to 60,000 for peak loads. The principal criterion, however, is the length of flame travel available before the gases reach the surface of the boiler. For this reason, high boiler settings are necessary to avoid excessive quantities of unburned hydrocarbons in the flue gases.

(4) *Underfeed Stokers.* Many western coals can be burned on underfeed stokers. Some, however, (e.g. Canmore and Brazeau) pulverize in the retorts and stop or break the coal pushers. The fuel bed, with these coals, must be kept at a uniform thickness of about eight inches above the tuyeres, so that an air pressure below the fire of not more than one and a half inches water gauge may be used. Also, on account of the low calorific value of lignite, the feeding mechanism must run about twice as fast as that for bituminous coals. The maximum rate of burning is from 60 to 70 pounds per square foot per hour. Both single and multiple retort stokers have been used, with some trouble, however, from clinker formation. One of the difficulties met with, is the tendency of "green" coal to pass down the centre of the retort without igniting, and this has been overcome by special arrangements for raising and spreading this fuel over the end of the fire; this method also reduces the amount of excess air near the end of the retort. The proper distribution of air is extremely important, as in the travelling grate. By adjusting the air supply in one installation, the average CO_2 readings in the boiler flue were increased from 6 per cent to 12 per cent with a corresponding increase of efficiency and less trouble with clinkers. The maintenance cost of underfeed stokers, using lignite, is low on account of the high moisture content and low furnace temperature, and no trouble is experienced with burning or growth in the grate. In all cases the grates should be arranged horizontally, or nearly so, to avoid "avalanching" on to the dump plates, with a consequent high percentage of combustible in the ash. A deep retort gives the minimum disturbance of fuel bed and so promotes successful working.

A test made at Winnipeg in April 1931, showed that Saskatchewan lignite (Souris), containing 33 per cent moisture, and having a calorific value of 7,215 B.t.u. per pound, could be burned in Jones Underfeed Multiple Retort Stokers over a range of 15 to 245 per cent of normal rating. For this purpose, the stoker was modified by blanking off tuyeres at the front of the stoker, supplying air through perforated dead plates and substituting Hulson shaking and dumping grates for the original dump plates. The size of fuel varied from three inches to dust, the larger sizes being the more satisfactory.

As a general rule, however, only the higher grades of lignite (e.g. some Alberta coals) can be handled satisfactorily on underfeed stokers.

The Martin or Reverse-flow stoker[25] is designed to handle fuels of high moisture or ash content (up to 50 per cent), or fuels difficult to burn for other reasons. It is shown in Fig. 11. Coal with 15 per cent moisture and 34.6 per cent ash was used on this stoker by Pradel,[26] with a heat liberation of 550,000 B.t.u. per square foot of grate. The overall efficiency obtained on a 320-h.p. boiler was 74.1 per cent.

Soot from smoke boxes of locomotives has an ash content of about 16 per cent and is difficult to burn. It has been handled on this stoker, however, mixed with bituminous nut coal, with a heat liberation of 720,000 B.t.u. per square foot per hour.

(C) *Peat.*

The calorific value of dry peat varies from 7,000 to 9,700 B.t.u. per pound, but as usually found, only 10 per cent of the material excavated is solid matter, the rest being water. Attempts to remove this water by mechanical action showed that, after this operation, the amount of moisture present was still 75 per cent,[27] so that some method of further reducing this quantity, by drying, to about 30 per cent, must be found. The details of the methods investigated are given fully in the final report of the Peat Committee in 1925 and will not be repeated here, but the Committee came to the conclusion that the only methods or processes which can be economically employed for the manufacture of peat fuel are those employing air drying. Once this has been done economically, the peat fuel obtained in Ontario and Quebec is suitable for domestic and industrial purposes, but, owing to the cost of transportation, the present limit of distribution is approximately 100 miles from the peat bog.

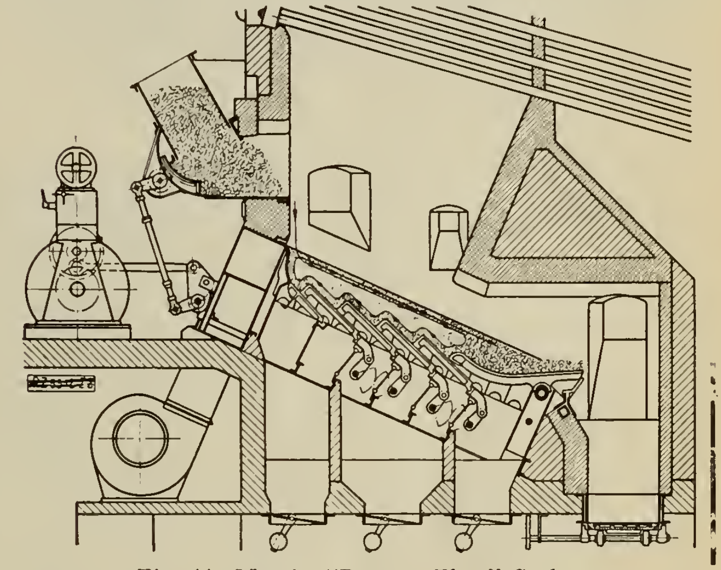

Fig. 11—Martin "Reverse Flow" Stoker.

The characteristics of peat that favour its use on grates are[28]:—

(1) Fuel burns with a long flame on account of its high percentage of volatiles.
(2) Can be burned almost smokelessly.
(3) Is low in ash and non-clinkering.
(4) Is free from sulphur.

[25] Z.V.D.I., Vol. 75/1.
[26] Die Feuerung, 1929.
[27] Haanel, Can. Inst. of Mining and Metallurgy, 1923.
[28] Final Report of Peat Committee (1925), p. 200.

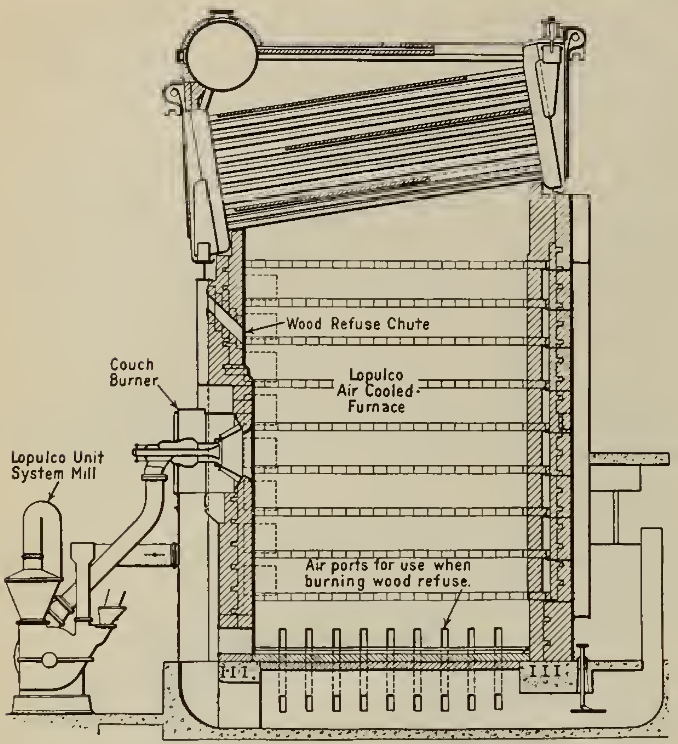

Fig. 12—Furnace for Burning Wood Waste in Suspension.

Furnaces of the Dutch oven type, with stepped grates, are generally used with alternate firing, as in the case of lignites.

A method of burning peat containing 40 per cent of moisture on a stepped grate, with natural draught and without air preheating, is described by Kirsch.[29] The drying shaft, or hopper, is controlled by a vertical slide and is built integral with the furnace. When the slide is raised, drying is facilitated by direct radiation from the fire. At the end of the incline, the fuel falls on to a short chain grate, where combustion is completed. Three boilers of about 430 h.p. each have been put into operation at the Wladimir power station (Russia), and a combustion rate of 66 pounds per square foot has been maintained, giving a boiler rating of 260 per cent and an efficiency exceeding 75 per cent. The peat contains 8 per cent of ash and has a net heating value of 4,750 B.t.u. per pound.

(3) *Burning Fuels in Suspension.*

(A) *Wood Waste.*

The conditions necessary for burning wood waste in suspension are similar to those involved in the combustion of pulverized coal. The fuel must be in a uniform finely divided state, and a high boiler setting is required, so that it may be consumed practically completely before reaching the floor. Thus, large furnace volumes of 7.5 cubic feet, or more, per boiler horse power must be provided, and this demands a building of appropriate size. Such conditions can usually only be fulfilled economically, in installations of comparatively large capacity. Difficulties have been experienced with dry wood, in connection with the maintenance of refractory walls, and air cooled, or water cooled furnaces have been installed to avoid such troubles. The storage hopper must have vertical, or nearly vertical, sides to avoid arching and interruption of supply, and the feed screws must be driven by a variable speed transmission, controlled by the steam pressure. The furnace feed should be so arranged, that the fuel is delivered in the form of a fine spray.[30] The cost of preparation is an offset to the economical use of fuel in this form, and in the case of shredded bark the power required for this purpose is frequently excessive.

In some instances, a part of the wood fed into the furnace is burned in suspension, while the remainder is consumed when it reaches the grate,[31] and the design of the furnace will naturally depend on the amounts of fuel to be consumed in these two ways. (See Fig. 12.) Pulverized coal, or oil, are generally employed when an auxiliary supply of fuel is required. In furnaces of this type, care must be taken to distribute the air so that stratification shall be avoided and turbulence promoted, without carrying fuel away from the furnace in an unburned or partly consumed condition.[32] Air cooled furnaces are used, with heat liberations up to 15,000 B.t.u. per cubic foot per hour, and water cooled furnaces up to 20,000 B.t.u. per cubic foot per hour. From 2 to 2½ cubic feet of furnace volume are usually provided per horse power actually developed.

A new furnace for this purpose has been used in Russia by Professor L. K. Ramzin.[33] This has a U-shaped flame, travelling first downward, so that the larger particles are discharged on to a grate, and then upward to the boiler tubes. A constant fuel level is maintained on the grate by regulating the air supply beneath it. Sawdust, containing 60 and 40 per cent moisture respectively, has been burned in this manner. The following results were obtained:—

Moisture per cent	60	40
B.t.u. per cubic foot furnace volume per hour	18,000	21,500
Auxiliary fuel	15 per cent oil	none
Excess air per cent	28	43
Furnace efficiency, per cent	58.7	88.5

(B) *Lignite*

Pulverized coal has been used in the cement industry since 1895, and its subsequent application in metallurgical processes and steam power plants has been one of continued success. The fuels generally used, however, are relatively low in moisture and ash content. The troubles experienced with lignite in this connection are due, firstly, to the difficulty of drying the fuel effectively without losing some of the volatile combustible matter, and at the same time incurring serious fire hazard. Also, the cost of pulverization is increased relatively, in view of the large quantity of material which has to be handled and ground for a given supply of heat, and because the cost of pulverization per pound of material is high. Either the central storage system or the unit system can be used successfully. Most of the lignites also, tend to fracture in flakes, and in air separation mills these are carried over to the furnace with resulting incomplete combustion. The standard types of furnace bottom that have proved successful on low fusion ash bituminous coals, have also been used satisfactorily with western lignites (Fig. 13).

Lethbridge coals containing 10 to 15 per cent moisture and 20 to 25 per cent ash, having a fusing temperature of about 2,100 degrees F., have been burned for one to two years in a furnace having a water screen at the bottom. No signs of slagging in the furnace bottom have been observed with this installation.

Texas lignite has been burned by the San Antonio Public Service Company in the pulverized form for seven and a half hours, with a combustion efficiency of 81.8 per cent at a boiler rating of 360 per cent.[34] The Northern Pacific Railway have also burned pulverized Texas lignite in an experimental locomotive. Calorific values as low as

(29) Z.V.D.I., Vol. 74/2, 1930.
(30) A.S.M.E. Transactions, Wood Industries Section, Oct. 1930.
(31) A.S.M.E. Transactions, Fuels and Steam Power, Jan-Apr. 1931, p. 21.
(32) "Power House," Oct. 1931.
(33) Second World Power Conference, Vol. VII.
(34) See "Power," July 2nd, 1929.

7,500 B.t.u. per pound have been used successfully in heavy main line traffic.(35)

(C) *Peat.*

The same remarks apply, in a general way, to the combustion of peat in the pulverized form.(36) There appears to be no particular difficulty in burning the fuel, once it is in the furnace, the main question being that of the economy of transporting, crushing and conveying the large quantities of incombustible material associated with the fuel proper and of handling the waste matter from the furnace.

Ramzin(37) describes a milling cutter process for obtaining peat, already broken up into a suitable size for burning in suspension, and in a relatively dry state. The peat is shaved in thin layers from the surface of the bog, and 40 to 50 per cent of it is less than .02 inch in mean diameter, while 55 to 65 per cent is less than .04 inch. It is left to dry on the bog, and if this is overdone, the peat is liable to be blown about, so that its moisture content, when removed, should be kept at about 45 per cent.

(35) See also Tasker, Canadian Chemistry and Metallurgy, Dec. 1931, p. 313.

(36) See Haanel C.I.M.M. 1923, p. 14. Attempts to produce powdered peat for locomotive fuel in Sweden failed on account of the high cost of processing.

(37) Loc. cit.

Tests on a 180-h.p. B. & W. boiler gave a heat liberation of 22,000 B.t.u. per cubic foot of furnace volume per hour. It is claimed that the cost of reclaiming peat by this method, is about one-half that of the best of the systems previously employed, and that the power required to feed each ton of fuel is 6 kw.h., as compared with 20 kw.h. for pulverized fuel. Steady combustion has been maintained with 50 per cent moisture, so that auxiliary drying is unnecessary. Ramzin states that, with fuels having high volatile content, the fineness of division required for complete combustion decreases considerably, so that comparatively coarse particles may be used, but that these require aeration before leaving the burner. The fuel is therefore delivered to the suction inlet of the feed fan.

4. *Low Temperature Carbonization, Gas Production and Liquefaction.*

(A) *Carbonization.*

The complex nature of fuels containing large percentages of volatile matter, has directed considerable attention to the possibility of analyzing them into their component parts, with the subsequent use of each component to the best advantage. It is probable that as solid fuels become scarcer and more expensive, this method of handling them will become a necessity, and therefore the

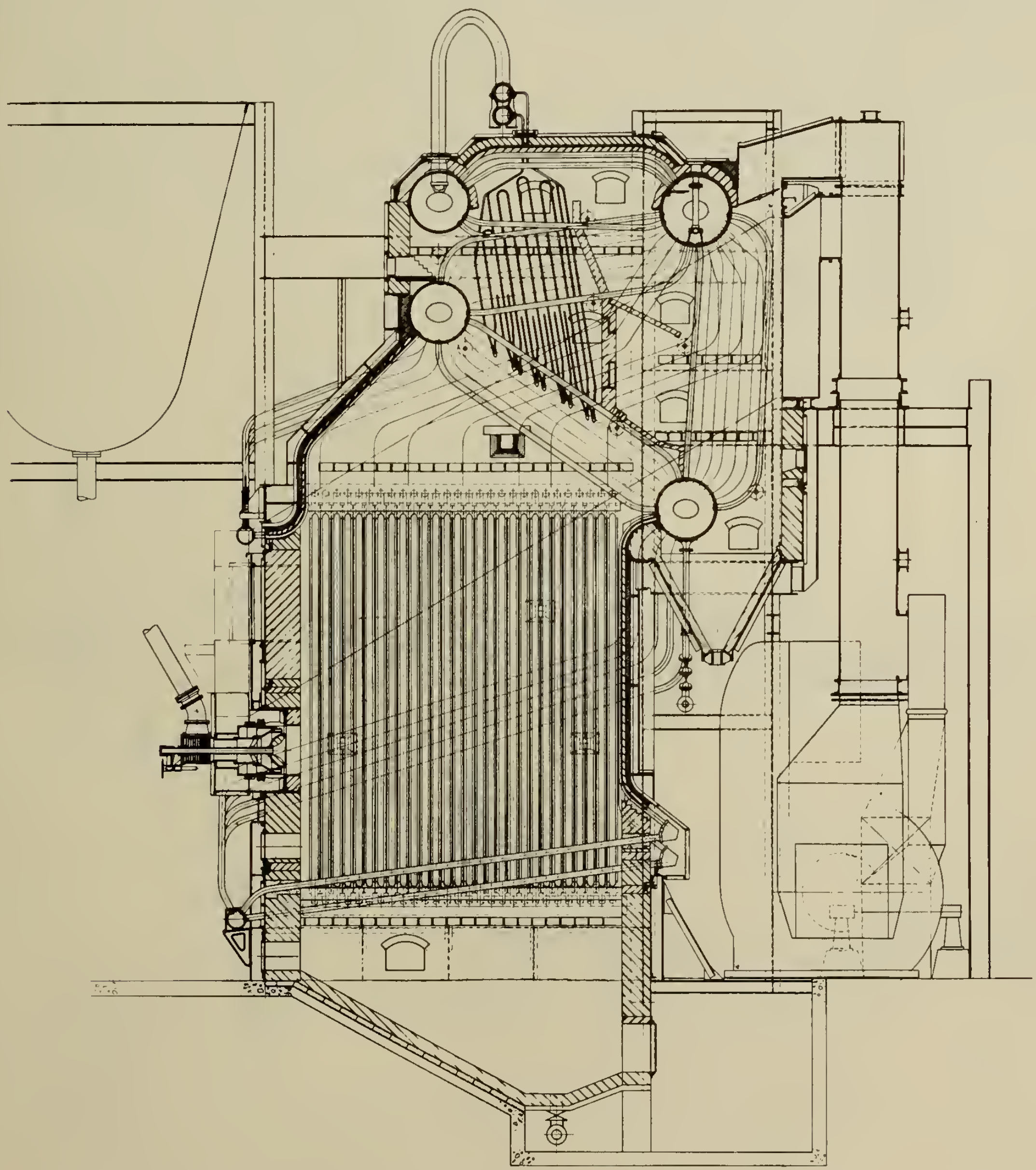

Fig. 13—Furnace with Water Screen for Burning Low Fusion Ash Coals in Suspension.

time and money spent upon such processes will have been advantageously expended in the long run. The present possibilities, however, are invariably controlled by economic considerations, and as such processes depend for their success very largely on the sale of by-products, it is necessary to repeat that "the value of by-products is what the consumer can afford, or is willing to pay, and not the value placed upon them by the producer."[38]

The past history of low temperature carbonization processes in America, provides numerous examples of financial failure, largely due to the application of this law. The only country where a considerable measure of success may be said to have been obtained is Germany, [39]and in that country the process has been largely devoted to the treatment of brown coal or lignite. It is understood, however, that at present, low temperature carbonization is almost at a standstill and no further development is expected until a commercial use for semi-coke can be found.[40]

On the other hand, Rosenthal[41] reports on the successful development of the first Harprecht plant for carbonizing lignites (Fig. 14), the resulting fuel to be used in the existing pulverized fuel equipment of locomotives. The experimental plant was built in 1925, and a new plant to carbonize 1,000 tons a day is now under construction. The raw lignite, containing 50 to 52 per cent moisture, is broken up in a hammer mill and is then passed through a drying drum, where the moisture is reduced to 12 per cent. The fuel is then carbonized on moving cars which are propelled in the opposite direction to the flow of gases. Re-circulating and regenerating apparatus is provided to give the maximum thermal efficiency, and a gas producer gives an auxiliary supply of heat for starting and running. The new plant will require twenty-seven men and will cover an area of 70,000 square feet. The total cost of the plant, including equipment for water, spirit and tar extraction, is expected to be $1,200 per ton of dry coal daily throughout.

(38) Hall, Engineering Journal, Aug. 1928.

(39) Trans. A.S.M.E. May-Aug. 1929, Fuels and Steam Power.

(40) "Economic Conditions in Germany to July, 1930," Dept. of Overseas Trade.

(41) Z.V.D.I., 1930, Vol. 74/2.

In Canada, a report was made on the Carbonizing and Briquetting of Lignites in Saskatchewan[42] in 1917, and the subject was further studied by the Lignite Utilization Board from 1918 onwards. A plant was operated at Bienfait, Sask., from September 1921 to January 1923, and was run intermittently until December 1923, after which it was shut down.[43]

Apart from the Ford plant at Walkerville, Ontario, which ran from 1924 to 1926, and was then dismantled, low temperature carbonization tests have been made only on the laboratory scale by the Fuel Research Laboratories of the Department of Mines.

Dick[44] gives the heating value of carbonized briquettes from coals similar to Saskatchewan lignite, as 11,500 to 12,000 B.t.u. per pound, but these must be made from low ash coals. The ash from the briquettes is very flocculent and bulky, and if present in large quantities prejudices buyers against the fuel.[45] This "char" should contain at least 5 per cent of volatile matter for ease of ignition, and not more than 15 per cent for smokeless combustion.

Its physical characteristics vary with the raw coals used, with the rate of heating, final temperature obtained, and the physical conditions under which the fuel is treated during the carbonization period. In most cases, the "char" produced from lignite requires treatment before it can be used as a domestic fuel, but sometimes it is used industrially

(42) Commission of Conservation of Canada, W. J. Dick.

(43) See "Second Progress Report of Dominion Fuel Board", 1928, p. 51.

(44) Loc. cit.

(45) Tasker, "The Low Temperature Carbonization of Solid Fuels," Fuel Symposium, McGill University, Nov. 1931.

Fig. 14 (Details)

- (a) Wet coal hopper.
- (b) Mill.
- (c) Conveyors.
- (d) Pulverized coal hopper.
- (e) Dryer.
- (f) Cyclone.
- (g) Screw conveyor.
- (h) Bucket conveyor.
- (i) Entrance gate lock for coal conveying cars.
- (k_1) Carbonizing zone in oven containing moving cars.
- (k_2) Cooling zone in oven.
- (l) Exit gate lock.
- (m_1, m_2) Car transporter.
- (n_1, n_2) Coolers.
- (o) Tar extractor.
- (p_1, p_2) Tar storage.
- (q) Gas producer.
- (r) Regenerator.
- (s) Coal car.

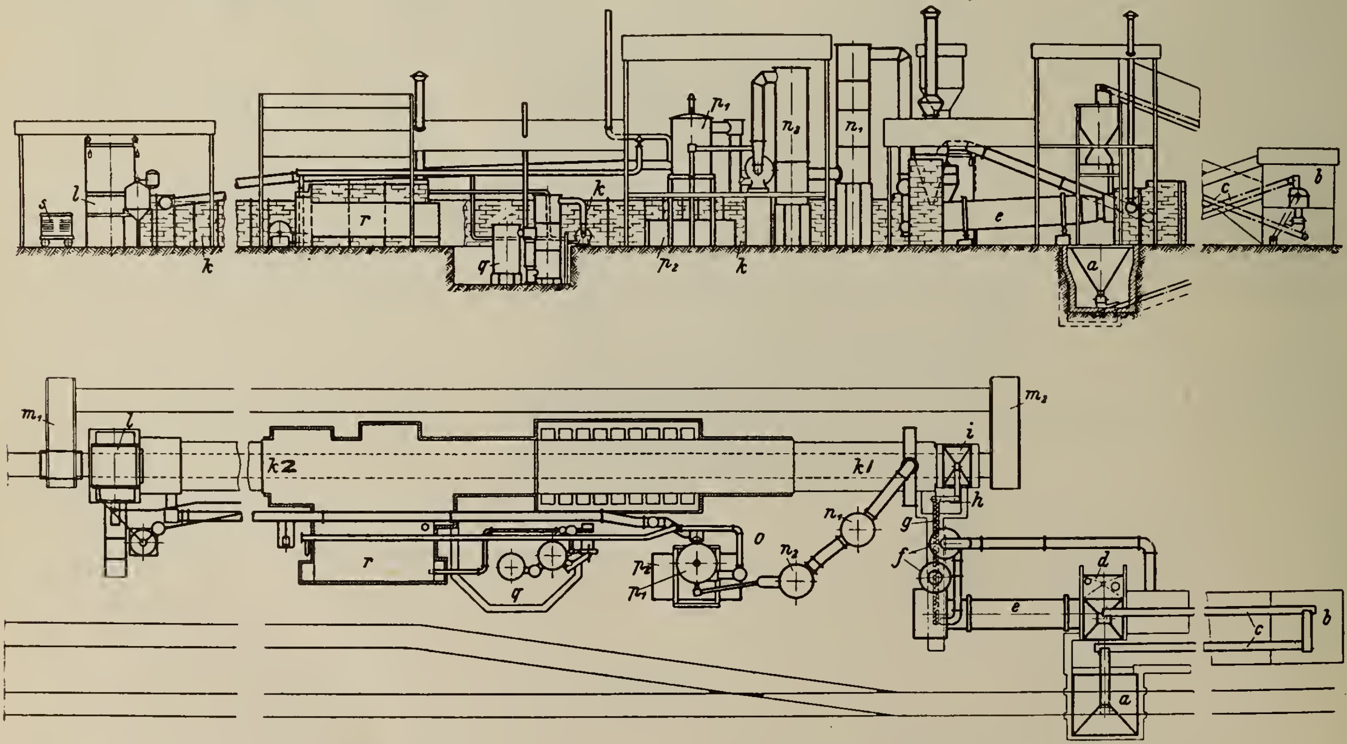

Fig. 14—Harprecht Plant for Low Temperature Carbonization of Lignites.

without such treatment. It may also be burned advantageously, in the pulverized form.

Examples worked out by Dr. C. H. Lander for the Second World Power Conference show that the revenue derived, under different conditions, from the sale of this semi-coke or char is from 60 to 66 per cent of the total income from the process. It is evident, therefore, that the first consideration must be a good and reliable market for the solid fuel.[46]

The tar oils, at present, have value only as fuels and are saleable at 5 to 7 cents per gallon, and the crude spirit is of similar value, the two together accounting for about 15 to 17 per cent of the total revenue, the remainder being supplied by the sale of gas. The commercial liquor obtained is not only valueless but is a liability. It cannot be sold in competition with synthetic ammonia, on account of its higher price, and must be treated in some way before it can run off into sewers or streams.[47] The value of the gas depends upon its application. If employed to heat the retort, its value is equivalent to that of the fuel displaced by it, and if sold for distribution, its value is equivalent to that of the gas already being distributed in the same way. Thus, the price obtainable for these by-products is determined almost entirely by outside conditions, and so far, these have been such as to make the low temperature carbonization process uneconomical in Canada.[48]

The considerations apply with particular force to the application of lignites found in northern Ontario (estimated to amount to about 100 million tons) which occur in two seams, of which the second or lower, is by far the better. The fuel consists of three separate varieties:—

(1) A woody material occurring in lumps, which can probably be used directly, after drying by the Fleissner or other process.

(2) A peaty constituent which may possibly be used after carbonization.

(3) An earthy material, high in ash, which may be used after dry briquetting.

All of these have about 50 per cent of moisture as obtained, and their uses are not definitely known at present. The Ontario Research Foundation is now investigating the matter, and some of the fuel has been sent to Germany, where it will be tested in plants that have already given satisfactory results with German lignites. It is probable that the initial market will be domestic rather than industrial, as the fuel is best suited to this kind of application and the economic radius of distribution is likely to be 300 miles, or less, from the source of supply.

The results of briquetting tests on the lignites of northern Ontario are given in the Investigations of Fuels and Fuel Testing of the Department of Mines (1928), as follows:—

"The tests carried out on the sample of lignite from northern Ontario, indicated that the fuel may be considered as slightly inferior to the lignite mined in Saskatchewan, which is being treated commercially for the production of a domestic briquette. Carbonization tests show that the lignite, when treated at low temperatures, produces a char which is sufficiently hard to briquette satisfactorily. The yields of by-products are low, but sufficient gas is obtained to effect carbonization. The briquettes produced in a laboratory plunger press, with approximately 9 per cent of asphalt binder, may be considered as of satisfactory quality commercially. From the yield of char, it may be estimated that 2½ tons of the lignite will be required for one ton of briquettes."

[46] See also "Lurgi" Process of Lehigh (N.D.) Briquetting Co., Max Toltz, Trans. A.S.M.E., Fuels and Steam Power, May-Aug. 1930.

[47] Tasker, loc. cit.

[48] See Landt, Engineering Journal, Feb. 1926. For prices obtainable in U.S.A., see "Coal Pretreatment," Wisner, Trans. A.S.M.E. F.S.P., May-Aug., 1930.

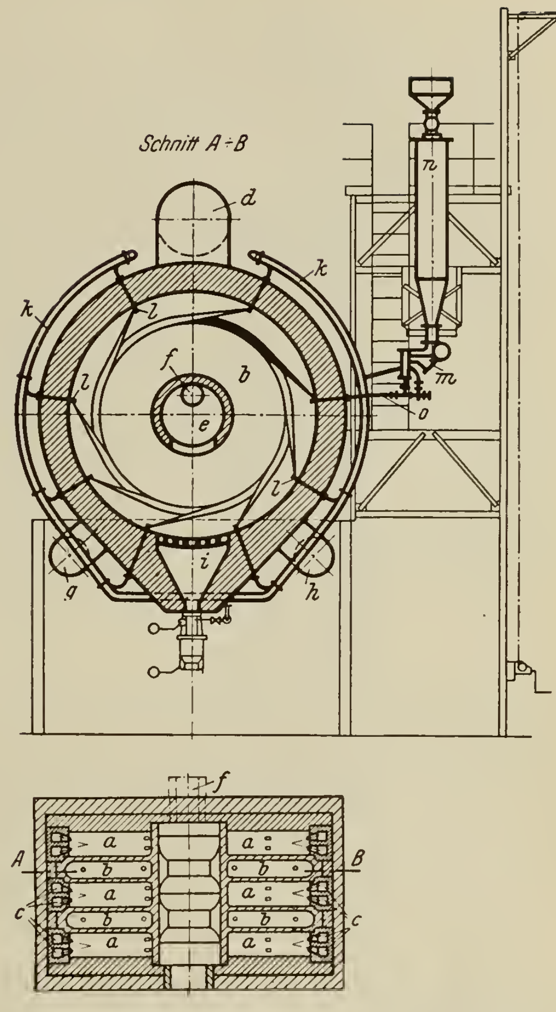

Fig. 15—Heller Process for Generating Water Gas From Pulverized Lignite.

(*a*) Combustion chambers.
(*b*) Retorts.
(*c*) Air and combustion gas passages.
(*d*) Exhaust gases.
(*e*) Water gas pipe.
(*f*) Water gas outlet.
(*g* and *h*) Air and combustion gas pipes.
(*i*) Ashpit.
(*k*) Steam pipes.
(*l*) Steam nozzles.
(*m*) Regulator for coal injection.
(*n*) Coal hopper.
(*o*) Pulverized fuel nozzle.
Schnitt *AB* = Section *AB*

Similar considerations also apply to the carbonization of peat. Haanel[49] states that the moisture content must be reduced by artificial drying, to at least 10 per cent, to permit carbonizing to be conducted efficiently. A binder must then be used and the mixture briquetted in a press. Six costly operations are required to produce briquettes having a calorific value of 12,000 B.t.u. per pound, and for every ton of carbonized material, 30 tons of raw peat must be excavated, transported and dried. The initial capital investment, therefore, is great and the overhead charges are high.

Although low temperature distillation of wood waste has been tried, it has not been successful commercially, only the best grades of timber being suitable for such processes.

It follows, generally, that for some years at least, low temperature carbonization is an unlikely solution of Canada's fuel problem. The ultimate solution, however, is very likely to be along those lines.

In Germany, great strides have been made recently in perfecting low temperature carbonization of lignites, in

[49] Trans. Can. Inst. Mining and Metallurgy, 1923.

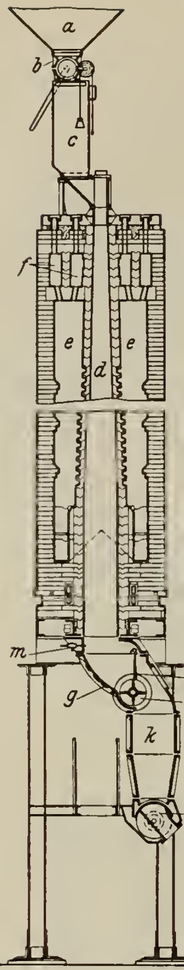

Fig. 16—Lignite Town-Gas Producer.

(a) Coal hopper.
(b) Hopper valve.
(c) Coal reserve.
(d) Retort.
(e) Combustion chambers for heating retorts.
(f) Air and gas passages.
(g) Supporting elbow.
(h) Rotary discharge valve.
(i) Coke outlet.
(k) Cooling chamber.
(l) Safety flap.
(m) Steam valve.

spite of the fact that this industry, at the present time, is badly handicapped by low oil prices. Paraffin prices are so low that most of the tar produced by low temperature carbonization had to be converted into burner oil by hydrogenation.

For these reasons, interest was diverted to the production of water-gas and town gas from lignite and semi-coke.

Several systems for the generation of water gas have been developed, amongst which the Heller process(50) (Fig. 15), using pulverized lignite, is probably the most interesting. The gas generator consists of a horizontal cylinder, which is divided by vertical walls into disc-shaped receptacles. Each alternate receptacle is used as a retort and the others as combustion chambers, which provide the heat for the water gas reaction. Gas and air, entering through jets, are burned in the heating chambers. The pulverized material is injected into the retorts by superheated steam, in a radial direction, and is kept in suspension in a circular path by a series of superheated steam jets. The gas produced, together with the ashes formed, leaves the retorts through a centrally located pipe and is then cleaned. The heat cycle is worked out very carefully and a very high thermal efficiency is obtained by means of heat exchangers and regenerators. Actual figures are not published as yet, but it is understood that the performance obtained is very satisfactory.

(50) Z.V.D.I., Vol. 75/2, p. 913.

For years, attempts have been made to find efficient means for generating town gas from lignites, but this was only achieved after the increasing coke oven gas supply in lignite districts, forced the lignite, and particularly the lignite briquette industry, to tackle the problem seriously. It was found that briquettes were suitable for gasification and that they formed a coke which was suitable for retort heating by means of water gas generation. Thus, it was found possible to convert lignite into town gas, without incurring the difficulty of by-product disposal.(51)

The Brown-coal Gas Company (Braunkohlen Gesellschaft, Berlin) erected a lignite gas plant (Fig. 16) in the city gas works of Kessel, which produced such good results that, after a short period of operation, the installation was doubled. It is reported that the gas obtained is practically equivalent to that generated from gas coal, after the carbon dioxide contained in this gas is washed out by a solution of caustic soda. The CO_2 is caused by the high oxygen content of the younger lignites. A. Thau states definitely that the problem of town gas generation from lignites is solved.

(B) *Producer Gas Generation.*

Producer gas plants have not undergone many radical changes during the last few years. Most of the changes made have been more in the nature of improvements in design and efficiency, than in the development of new systems. This is probably due to the fact that a number of fuels, which previously could only be used in gas producers, are now usable by other processes, such as direct combustion, carbonization or liquefaction. There is, however, one new gas producer on the market, for which high claims are made regarding its ability to use successfully some materials which have been considered as waste. The Whitfield(52) gas producer has the appearance of an old-fashioned, horizontal grate, updraught, single-zone producer, but has a special grate with a closely controlled air supply. The method of air control is both restrictive and distributive, having specially regulated inlets to air pockets in the grate, and a distributive control incorporated in the top flanges of the fire bars.

It is claimed that this arrangement results in the elimination of the chimney effect of the fuel bed and the

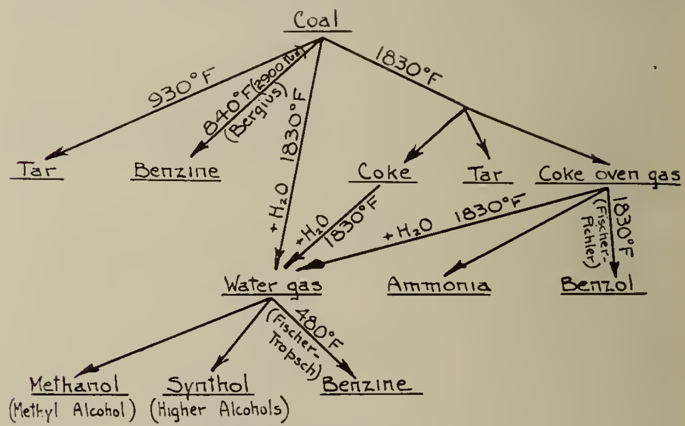

Fig. 17—Products Obtained from the Liquefaction of Coal by Different Processes.

breaking through of the fire. It also maintains the combustion zone close to the grate and distributes it evenly over the whole grate area. The producer can, therefore, be operated with an unusually thin fuel bed in cases where this is necessary or advisable. This practice also results in low

(51) A. Thau, Z.V.D.I., July, 1931.
(52) According to information received from Whitfield Gas Producers, Ltd., London, England.

outlet temperatures of the gases, so that the loss in sensible heat is greatly reduced.

Whitfield gas producers are in continuous operation on fuels of rather unusual kinds. Some use the vegetable waste from jam factories, consisting of orange peelings, etc., having a moisture content of over 70 per cent. The gas produced has a heating value of about 112 B.t.u. per cubic foot. Operating on peat of 68.5 per cent moisture content, the gas ranges from 125 to 134 B.t.u. per cubic foot at 30 inches of mercury and 60 degrees F., and a similar gas is generated when operating on refuse bark of 52.6 per cent moisture.

This producer gives remarkable results when operating on household refuse, which is previously freed from dust, metal and glass by picking and screening. The gas obtained has the following analyses: CO_2, 7.3 to 8.1: $C_n H_m$, 0 to 1.1; CO, 21.6 to 22.2; O_2, 1.5 to 1.3; H_2, 5.1 to 4.4; CH_4, 3.1 to 2.2 per cent. With city garbage of average quality, containing 60 to 70 per cent of combustible matter, about 400 to 450 h.p. hours of gas engine output can be generated from one ton of raw garbage, or about 650 h.p. hours per ton of cleaned refuse. Considering that only about 95 h.p. hours are generated when incinerators and boilers are used, it can be seen that a reliable garbage gas producer gives an entirely new aspect to the question of city refuse disposal. Figuring on a possible generation of 280 kw.h. per ton of refuse, representing a value of about $2.00, it is evident that to use such refuse as filling material is a rather costly method of disposal, besides being highly insanitary. Furthermore, passing the producer gases through an engine and converting them into exhaust gases, makes them far less objectionable than incinerator gases.

(C) *Liquefaction, Hydrogenation and Related Processes.*

Space does not allow these processes to be discussed in detail, but they have to be considered at least briefly, as they will probably soon become of importance in industries using carbonaceous materials. In Germany, where liquefaction processes have been largely developed, progress has recently been retarded by rich oil strikes, as in the case of by-product coking plants. It is not believed that their scientific development was retarded, but there is little doubt that had these oil strikes not been made, with a consequent lowering of crude oil prices, more and larger liquefaction plants would now be in use.

The original Bergius EVAG process, which was developed for gas coal, and also the further researches of Imperial Chemicals Limited, and of the Fuel Research Station, will not be of so great an interest to Canada as the Bergius I.G. process for lignite. Unfortunately, hardly any reports are available on the latest developments of this process, and we have, therefore, to use data given by Dr. Bergius, a few years ago. In 1925, one ton of coal gave about half a ton of liquid fuels, consisting of about 295 pounds motor spirit, 395 pounds Diesel oil, 116 pounds lubricating oil and 180 pounds furnace oil. To produce this amount of oil, a further input of 1.8 tons of coal for power and heat generation was required, so that actually 18 per cent of the weight of coal was converted into marketable liquid form. In addition to these, about 460 pounds of gas and 450 pounds of coke were produced. In November 1927, according to H. Bruckmann, the oil output per ton of coal was already increased to between 1,250 and 1,400 pounds. (See also results on Alberta Lignite, Eleventh Annual Report of the Research Council of Alberta.)

The following figures, based on the experience of Imperial Chemicals, Limited,([53]) may be of interest, as they give an idea of the costs involved in a liquefaction plant. The overall cost of motor spirit produced would be 14 cents per gallon, when manufactured in a plant with an annual spirit output of 220,000 tons. The plant cost is estimated to be about thirty-eight million dollars. These figures are based on the normal exchange rate of $4.86 per pound.

([53]) "Engineering," Oct. 9, 1931.

The Bergius process, which does not use catalysts, could not vary the percentages of different hydrocarbons in the products, so that the relative percentages of different grades of oils were fixed. The Fischer-Tropsch and I.G. catalyst processes (Fig. 17) have overcome this difficulty and can, to a large extent, vary the proportions of different oils in the final product.

The high temperatures and pressures required in continuous processes of this kind have necessitated the application of the highest degree of engineering and metallurgical skill, so that they are not merely chemical achievements. One factor, about which little is known at present, is the life of the equipment, and this is of great importance from the financial standpoint, on account of the high initial capital cost of the equipment. This knowledge can only be obtained in course of time, by experience.

Conclusion

The elimination of waste is one of the most important functions of the engineer, and in the combustion field, it involves the use of local fuels to the best advantage. When combustion apparatus is installed, and after installation it appears that the apparatus is only suitable for fuels transported from a distance, the waste by neglect of natural resources is obvious. Only where it is commercially unsound to use local sources of energy, is the transportation of fuels from outside defensible. Frequently, this difficulty is due to the scale of operations, or to lack of co-ordination. Central heating plants, for instance, can use successfully much poorer fuels than is possible with small isolated units, and their potentialities as yet have hardly been touched.([54])

Many other sources of power and heat generation are in course of development at the present time. The Suess turbine enables the energy of running water to be used, and tidal powers are being investigated and harnessed. The temperature differences at various ocean depths are being utilized; the heat of the sun gives about 3,000 B.t.u. per square foot per minute in these latitudes, and Russia is using wind turbines of 35 kw. and is constructing units up to 100 kw. capacity. It is not anticipated that all of these sources of energy will prove to be of importance in Canada, but they are mentioned to indicate that new fields are continually being explored. With the co-ordination of hydro-electric and fuel plants, the possibilities are by no means exhausted and some of the above may yet be employed as parts of a general power scheme.

If and when this super power system eventuates, low rank fuels are likely to play a still more important part than they do at present.

The thanks of the authors are due to the Riley Engineering Company and the Combustion Engineering Company, for information concerning the various boiler and furnace plants installed by them; also to Messrs. B. F. Haanel, M.E.I.C., R. C. Wiren, A.M.E.I.C., W. T. Brickenden, A.M.E.I.C., and C. Tasker, who have freely supplied facts and figures relating to different aspects of the low rank fuel problem.

([54]) Notwithstanding the fact that several such installations exist in Winnipeg and the west, and a scheme is projected for the down town area of Toronto.

Ice Thrust in Connection with Hydro-Electric Plant Design

With Special Reference to the Plant at Island Falls on the Churchill River

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SUMMARY.—The investigation described was intended to ascertain the pressure exerted by ice in expanding as its temperature rises, the information being desired for the purpose of estimating the allowance to be made for the possible pressure exerted by an ice sheet on the crest of a dam.

Previous experiments have demonstrated the flow or yielding of ice, but did not afford means of estimating the pressure actually exerted by an ice sheet. In the experiments now discussed a cube of ice was allowed to rise gradually in temperature while held in a testing machine, the thrust exerted against the loading blocks being due to the combined effect of the expansion and flow of the ice. The results indicate that in many cases allowances heretofore made for ice pressure on the crest of a dam have been excessively large. As a result of the investigation, an ice pressure of 10,000 pounds per linear foot was used in the design of the dams at Island Falls.

A general description of the hydro-electric power development at Island Falls on the Churchill river in Saskatchewan was published in The Engineering Journal for June, 1931, the author being M. H. Marshall, M.E.I.C. It is therefore not necessary to cover that ground again, but in order to make clear the problems which confronted the designers, it will be best to restate a few facts which had a decided bearing upon the design of the dams.

The plant is located in Saskatchewan, 15 miles west of the Manitoba boundary, at approximately 56 degrees north latitude, and is 70 miles from the nearest railroad which is at Flin Flon. The lowest temperature experienced during its construction was −50 degrees F., but there is little doubt that the thermometer occasionally drops considerably below that point. This indicates an ice sheet of more than three feet, and possibly four feet, in thickness above the dams, and the pressure resulting from the expanding ice, when the temperature is rising during the late winter and early spring, becomes a very important factor in determining the cross section of the dam.

While it was desired to design a dam with ample factors of safety, the long rail haul to Flin Flon and the transportation for 70 miles overland from that point, made cement very expensive and prohibited the adoption of a dam section heavier than necessary.

The practice of engineers in allowing for ice pressure in the design of dams has been so varied as to establish no rule, and to indicate little knowledge on the subject. A great many dams have been designed with no specific allowance for ice thrust, while for others, built in climates where the ice could not attain a thickness of more than half that to be expected on the Churchill river, an allowance of 40,000 pounds to 50,000 pounds per linear foot of dam has been made.

The concrete dams constructed for the Island Falls development support a head which varies from a few feet to 70 feet and the average head on the longest dam is about 21 feet. The importance of assuming a proper value for the ice pressure against dams of these heights is shown in the following table, which gives the pressures and moments per linear foot.

Much has been written regarding the overturning moment due to upward pressure of water under dams which, on all assumptions, is less than the moment due to the pressure of the water against the upstream face, yet the allowance for ice pressure has been more or less a guess of the individual engineer.

The table shows that even for a dam 70 feet high, an ice pressure of 50,000 pounds per linear foot produces an overturning moment almost equal to that of the water pressure on the upstream face, and for a dam 21 feet high, the same pressure will produce an overturning moment almost ten times as great as that of the water on the upstream face.

When one considers the number of low dams which have stood for years, though designed with no specific allowance for ice pressure, the only logical conclusion is that pressures of 50,000 pounds per linear foot, or of anything like that magnitude, do not exist. This conclusion, and the desire to obtain at least an approximate idea of the magnitude of the pressure which might be expected against the dams at Island Falls, led to an experimental investigation. The procedure followed, and the conclusions reached, are described below.

General Statement—Nature of Problem

The determination of the thrust exerted when the expansion of ice is resisted involves the consideration of many factors. A series of tests on the behaviour of cubes of ice when loaded at different rates was made by one of the authors during 1926 for the Board of Engineers of the St. Lawrence Waterways Project, and the results are given in an appendix to the report of the Board.* These tests demonstrated clearly the "flow" or yielding of ice at different rates of loading, and under sustained loads of different intensities. The amount of yielding at a given temperature, corresponding to a given increment of load, increases as the time interval between the increments is lengthened. There is also progressive yielding under sustained load, the yielding in any given period being greater as the intensity of the load is greater. These characteristics occur at all temperatures, but in varying degree at different temperatures, the general tendency being for the "flow" corresponding to any given condition

*Report of Joint Board of Engineers on St. Lawrence Waterways Project, Ottawa, November, 1926, p. 406, Appendix E, "Ice Formation on the St. Lawrence and Other Rivers."

"*A*" Head of Water on Dam	"*B*" Water Pressure Against Up-Stream Face of Dam	"*C*" Moment of "*B*" about Base of Dam	"*D*" Assumed Ice-Pressure	"*E*" Moment of "*D*" about Base of Dam	Percentage which "*E*" is of "*C*"
70 feet	153,125 pounds	3,572,900 ft.-lbs.	50,000 pounds	3,400,000 ft.-lbs.	95 per cent.
70 "	153,125 "	3,572,900 "	10,000 "	680,000 "	19 " "
21 "	13,781 "	96,500 "	50,000 "	950,000 "	984 " "
21 "	13,781 "	96,500 "	10,000 "	190,000 "	197 " "

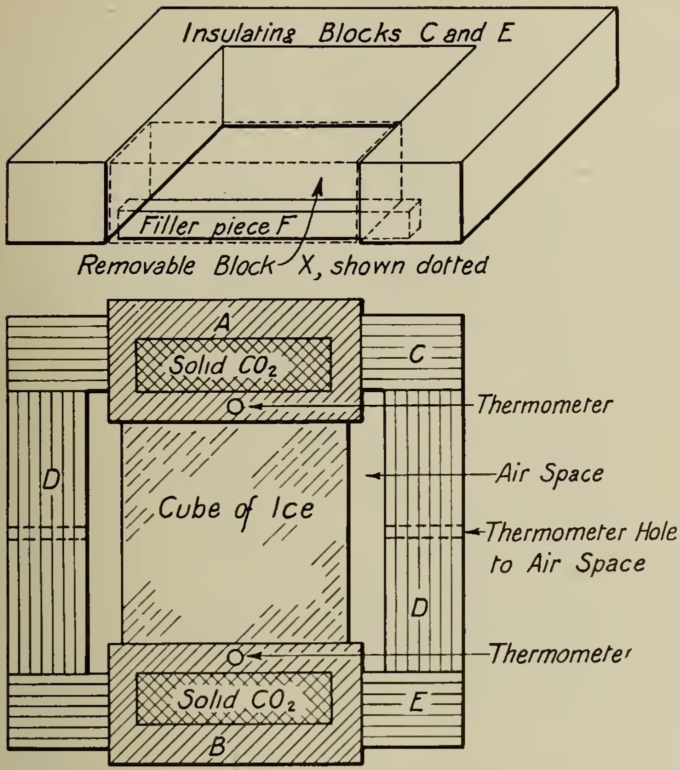


Fig. 1—Method of Insulating Specimens.

of loading to increase as the temperature rises. This means that ice is plastic, and that values of the modulus of elasticity E, computed from the load deformation curves, will decrease progressively as the length of the time interval between given load increments increases, or as the duration of a sustained load is increased.

In order to estimate the pressure against a structure such as a dam when it resists the expansion of ice, one must consider the strain in the ice cover due to rising temperature, and multiply this by the appropriate value of the modulus of elasticity, E, of the ice, the dam being assumed to be a rigid resistant structure. As noted above, the strain corresponding to any given stress intensity depends on the time element.

The problem is complicated further by the fact that the coefficient of expansion of ice is variable, and increases as the temperature rises. Thus the strain which is resisted by the dam depends not only on the time rate of increase of the temperature of the ice, but on the temperature at which the increase occurs, while the property which ice possesses of "flowing," as outlined in the preceding paragraph, is a factor which governs the value of E to be used in translating strains into pressures. Two opposing factors are, therefore, at work, the expansion of the ice tending to create thrust, and the thrust in turn tending to cause the ice to "flow" with consequent relief of the pressure due primarily to expansion. A general examination of the strains corresponding to a rise of temperature of about 5 degrees F. per hour, based on the expansion coefficient of ice at different temperatures, showed that the strains were much greater than those which were found for the longest intervals of loading increments in the St. Lawrence Waterways tests, and it therefore followed that the probable value of E to be used in estimating thrust was much lower than the lowest value found from those tests. The appropriate value of E could be estimated, only very roughly, by extended prolongation of curves based on values found for the time intervals of the St. Lawrence Waterways tests. It was therefore decided to supplement these tests by experiments in which the rate of increase of temperature of a block of ice could be controlled while it was placed in a testing machine, so as to exert a thrust which could be measured by balancing the lever in the usual way. It is believed that such data, supplemented by temperature measurements made under natural conditions to determine the distribution of temperature through a thick cover of ice when atmospheric temperature changes, will enable a rational estimate to be made of the pressure exerted by ice against a structure.

Preparation of Specimens for Test

Fig. 1 shows the method of insulating specimens for measurement of the thrust due to the expansion of a cube of ice as the temperature is raised gradually. A large block of river ice supplied by the City Ice Company of Montreal was placed in one of the rooms of the cold storage warehouse of the Harbour Commission of Montreal. From this, 3-inch cubes were cut for testing, and marked so that in the tests the pressures would act normally to the length of the crystals as under natural conditions. The specimens were stored in a room at about 5 degrees F. to 10 degrees F. and were prepared in this room for testing. The test cube was placed between two cast iron loading blocks A and B, planed on both faces. The blocks were warmed very slightly above the temperature of the room and passed over the faces of the cubes, thus melting the ice and forming a uniform bearing. The thin film of water thus formed froze quickly, and gave good contact with the blocks. The bearing faces of the blocks measured 3¼ inches by 3¼ inches. Each block was provided with a rectangular opening running clear through it, in which was placed a piece of solid CO_2, known commercially as dry ice. The whole was then enclosed in an insulating box of paper fibre board one inch thick, made in three pieces C, D and E. The middle section D was arranged to provide an air space of one-half inch all round the cube. The two end pieces C and E fitted against, and made contact with, the faces of the cast iron blocks. The pieces C and E were cut as shown, so that portions X, fitting against the opening in each cast iron block, could be withdrawn to control the supply of dry ice in the interior space of the loading blocks. Small pieces of insulating board F were fixed to the parts C and E to close the gaps which would otherwise have existed between one face of D and the corresponding faces of the cast iron blocks A and B when the pieces X were removed. A dead

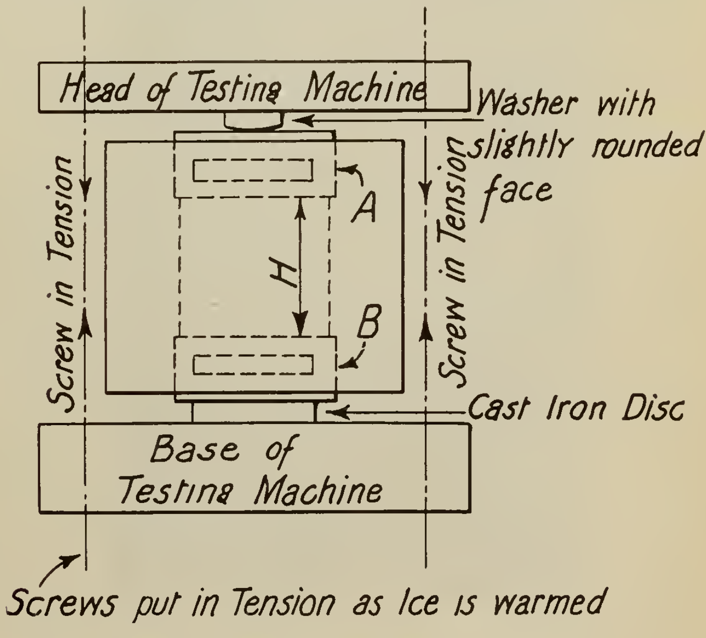


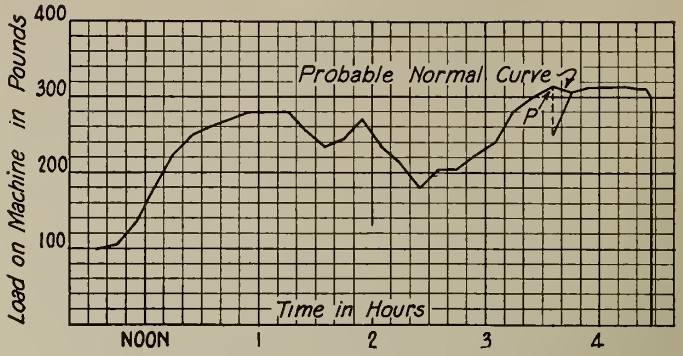
Fig. 2—General Arrangement for Testing.

air space was thus maintained round the test cube at all times. Holes were drilled as far as the middle of the cast iron blocks, for the insertion of thermometers through holes, bored to match, in one face of the part *D* of the insulating box. Holes were also bored in faces of *D* normal to that just mentioned, so that two thermometers could be inserted at the elevation of the centre of the cube, in the air space surrounding it.

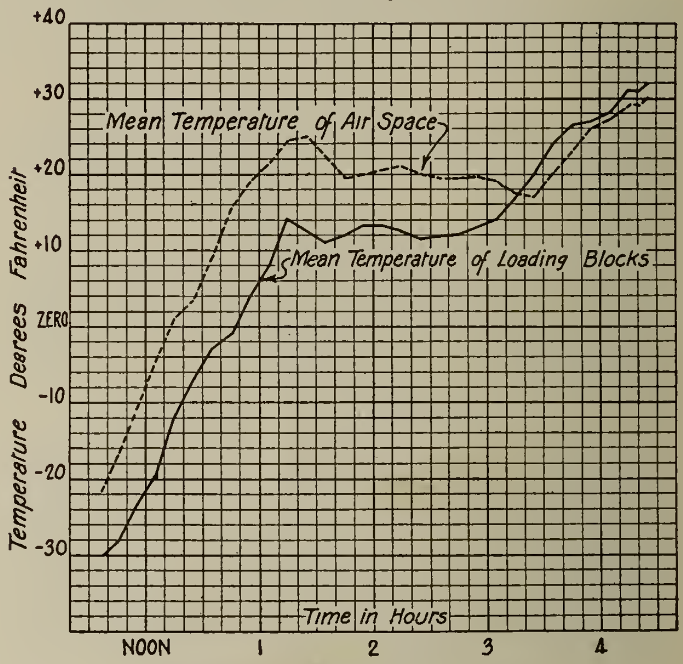
The box containing the test cube was then placed in a larger insulating box of one-inch paper fibre board, inside which pieces of dry ice were placed before the cover was screwed down. The above process was completed in the cold room, and the box was taken immediately to the laboratory, the specimen being kept thoroughly chilled during transportation. The box was then unpacked and the specimen set in the testing machine as described below.

Method of Testing

A small Olsen testing machine of 10,000 pounds capacity was used. (See Fig. 2.) The base of the machine was chilled by placing dry ice upon it, and the test specimen enclosed in the insulating box shown in Fig. 1 was set on it as shown, a slightly rounded small cast iron washer being provided on the upper loading block *A*, as the loading faces of the blocks would not be exactly parallel. The lower block *B* rested on a cast iron disc to raise it above the base of the machine, and thus permit the placing of dry ice round the base. Initially a small clearance was left between the washer and the upper head of the machine. Slabs of dry ice were placed against the outer and upper faces of the insulating box, in the holes in the cast iron blocks, and around the base of the testing machine, to chill the specimen and the air surrounding it. Temperatures were read by four thermometers, two in the cast iron blocks, and two in the air space. By manipulation of the dry ice the temperature could be lowered gradually to about −30 degrees F., all four thermometers reading the same within two or three degrees, with the best regulation attained. This cooling process occupied from one and a half to two hours as a rule. When reasonable uniformity of temperature was established by slow cooling, it was considered that the ice was at a temperature given by the mean of the readings of the four thermometers. An initial compressive load of 100 pounds



Record of Thrust exerted by 3 inch cube of ice.



Record of Rise in Temperature.

Fig. 4

NOTE—Owing to the plasticity of ice there is occasionally a drop of load during or immediately following an adjustment of balance. The condition resembles a strongly marked yield point and shows how the ice appears to be ready to slip or "flow." Such a point is shown at *P*. Disturbance of the balance, by too rapid adjustment of the position of the balance weight, had to be avoided in all tests.

Fig. 3—Testing Machine with Specimen in place.

was then applied, and from that instant the gears of the machine were not turned or adjusted in any way. The temperature of the ice was allowed to rise gradually by manipulating the dry ice control, and a thrust was exerted against the loading blocks due to the resistance offered to the expansion of the ice. This thrust was measured by balancing the floating lever of the machine at regular intervals, usually ten minutes. From this data curves were plotted, on a time base, showing (1) the mean of the temperatures given by thermometers in the upper and lower blocks; (2) the mean of the temperature in the air space surrounding the ice; (3) the thrust indicated on the machine. The distance *H*, between the loading faces of the cast iron blocks, is influenced by

- (*a*) the varying tensile force in the screws as the thrust exerted by the ice changes;
- (*b*) the elastic yielding of the cast iron blocks, washer and disc under the lower block;
- (*c*) changes of temperature of the parts mentioned in (*b*), these being in direct contact with the ice, and subject to the changes recorded by the thermometers.

The effect of increase of thrust is to lengthen the screws and to shorten the loading blocks, cast iron disc, and washer. Both these effects increase *H*. The effect of the rising temperature to which the increase of thrust is due,

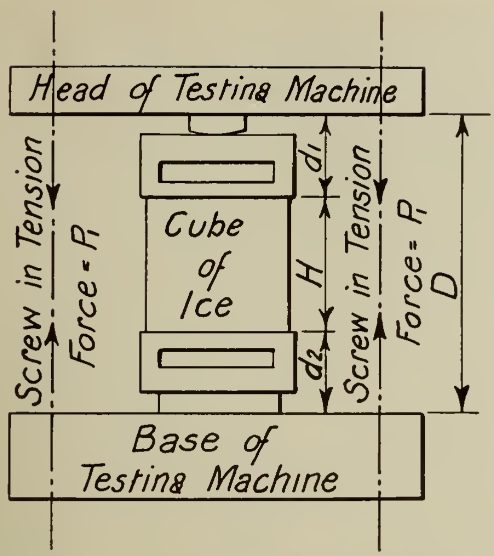


Fig. 5—Diagram Illustrating Conditions Affecting *H*.

is to increase the dimensions of the loading blocks, cast iron disc, and washer, and thus to decrease H. The temperature coefficient of cast iron is much smaller than that of ice, and the elastic yielding of the screws is small. The elastic yielding of the loading blocks, cast iron disc, and washer, was determined by direct test. The net influence of the terms involved is stated below in the discussion of results. Fig. 3 is a photograph of the testing machine with the specimen in place.

Typical Data

Several cubes were tested as described, each showing an increase of load from an initial value of 100 pounds to approximately 350 pounds for a temperature rise from about −30 degrees F. to freezing point, 32 degrees F. The first few tests served to develop a technique in handling the dry ice to control the temperatures. These tests usually occupied from four to six hours, so that the rise of temperature was more rapid than would occur under natural conditions. At times the temperature rise would be halted, as it was difficult in the early tests to produce a uniform, or even a continuous, rise of temperature. When the temperature rise was halted the load on the specimen dropped somewhat, this doubtless being due to the flow of the ice under sustained load. This general characteristic is shown in Fig. 4 which is a record of one of the early tests. The difference in temperature between the air surrounding the cube of ice and the loading blocks in contact with it was greater, in these earlier tests, than in the later ones, as the technique of manipulation of the dry ice control was developed only gradually. In later tests, from which the final data was obtained, there was little variation between the readings of the four thermometers. When the temperatures reached about 30 degrees F. the load fell off very quickly, and at 32 degrees F. the formation of a film of water at the loading face caused the load to be dropped completely.

As the result of several preliminary tests it appeared that a rise of pressure of about 200 to 250 pounds was produced on a 3-inch cube for a rise of temperature of about 50 degrees F. in five or six hours. This corresponds to about 3,200 to 4,000 pounds per square foot. It was then decided to make tests in which the temperature rise would be controlled to the rate of about 5 degrees F. per hour for several hours, this being considered a reasonable rate, such as might occur in nature. More rapid rises would probably be of short duration.

In Fig. 5, the loading system is shown in outline, to explain the nature of the strains which enter into the problem, and influence the value of H—the distance between the faces of the loading blocks. The screws connecting the head and base of the testing machine are subjected to an increasing tensile force P_1 as the thrust exerted by the ice increases. They are therefore lengthened, and the effect is to increase the distance D. The screws were kept free from direct contact with the dry ice, and were exposed to the air of the room. Their temperature was therefore assumed to be constant, so that the strain computed from the load P_1 measures the change in length. The distances d_1 and d_2 are affected in two ways—

(1) by the increasing force P_1 which compresses the washer, disc and cast iron blocks, and decreases d_1 and d_2;

(2) by the rise of temperature of the washer, disc and blocks, which increases d_1 and d_2.

All the above factors influence simultaneously the length H, between the loaded faces of the cube. The strain in the blocks due to the compressive force P_1 was measured independently, by setting the blocks, loading washer, etc., in the machine without a block of ice between them, and measuring the deformation due to load by means of a strain gauge. In the actual tests the washer was exposed to the air of the laboratory, the top of the insulating box reaching almost to the top face of the upper loading block. The whole height of the cast iron blocks will therefore not undergo the full range of temperature recorded by the thermometers, and the effect of expansion in increasing d_1 and d_2 was estimated rationally. The heights d_1 and d_2 of the loading blocks were reduced after the preliminary tests described above, partly to facilitate manipulation, and partly to make better compensation in the strains which affect the quantity H. It was decided after careful observation and calculation that the strains were such that in the net result the height H was maintained practically constant. The increase of load recorded on the machine may therefore be attributed directly to the resistance offered to the expansion of the ice as the temperature rises.

Record of Tests

The complete records follow of two tests made after the preliminary experiments had served to improve technique and to establish the validity of the recorded pressures. It is believed that in these tests the various factors which influence thrust are at play:—(*a*) resistance to expansion of ice under rising temperature, with variable coefficient of expansion; (*b*) flow of ice at different rates, and at different temperatures, under the load existing at any instant, whether that load be rising or falling, as the result of the changes of temperature produced by the method of control.

The tests carried out for the Board of Engineers of the St. Lawrence Waterways Project showed clearly the general properties of ice at different rates of loading. They proved conclusively, among other things, that ice flows at rates dependent on the intensity of load, and that the longer a given load is maintained the greater is the corresponding deformation, and the smaller the value of the modulus of elasticity E. The rate of increase of the load applied in these tests was however much greater than could arise from a normal rate of increase of temperature in a cover of ice exerting a thrust against a dam. Rough ideas as to the probable trends could be obtained by extending the curves obtained in the St. Lawrence Waterways tests, beyond the range of those tests, but the extension would be so great that little confidence could be placed in the validity of conclusions based on such assumptions. Where so many factors influence the results simultaneously, it was impossible to determine the net effect from the data available. The only practicable course therefore was to make a controlled test as described above, in which all factors have free play, and record the actual pressures attained. Such data may then be interpreted rationally, bearing in mind the probable temperature conditions in an ice cover, the lateral restraint of the ice in a direction parallel to a dam, and any other factors likely to influence the results. In the tests described the ice was free to flow in both directions normally to the direction of the applied load. Apart from this condition it is likely that a fair measure of the thrust exerted by ice under rising temperature was obtained. In any practical application of the results, account must be taken of many conditions, and an estimate of thrust is not likely to be greatly vitiated by the condition mentioned. Other factors are probably of equal or greater importance, such as the temperature variation in the ice cover during a period of rising temperature.

The records are shown in curve form in Fig. 6 and Fig. 7 from which it will be seen that very good temperature control was established. The general trend of temperature rise is well defined, and equal to a rate of about 5 degrees F. per hour.

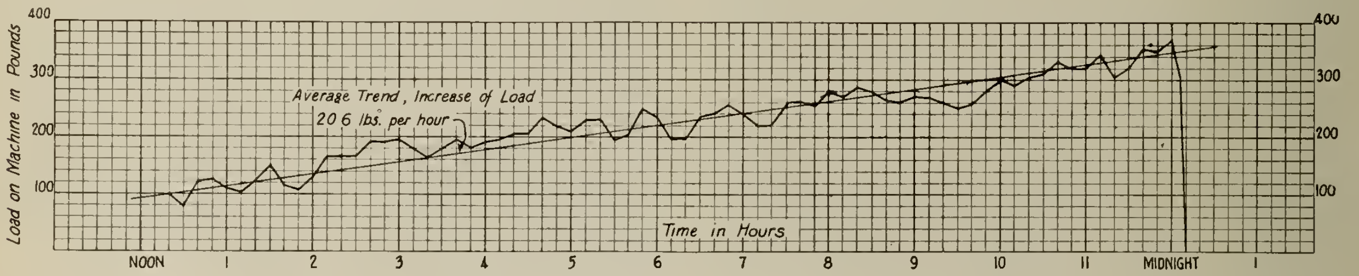
In the test recorded in Fig. 7 the effect of a period of cooling is shown clearly. This was introduced to determine the behaviour of the ice, during a period of cooling, as when the temperature drops in the evening, following a period of several hours of rising temperature.

The curves show that as the rate of rise of temperature increases the rate of rise of pressure increases, but more rapidly. The average rates of pressure and temperature rise are shown in the curves. They follow linear laws.

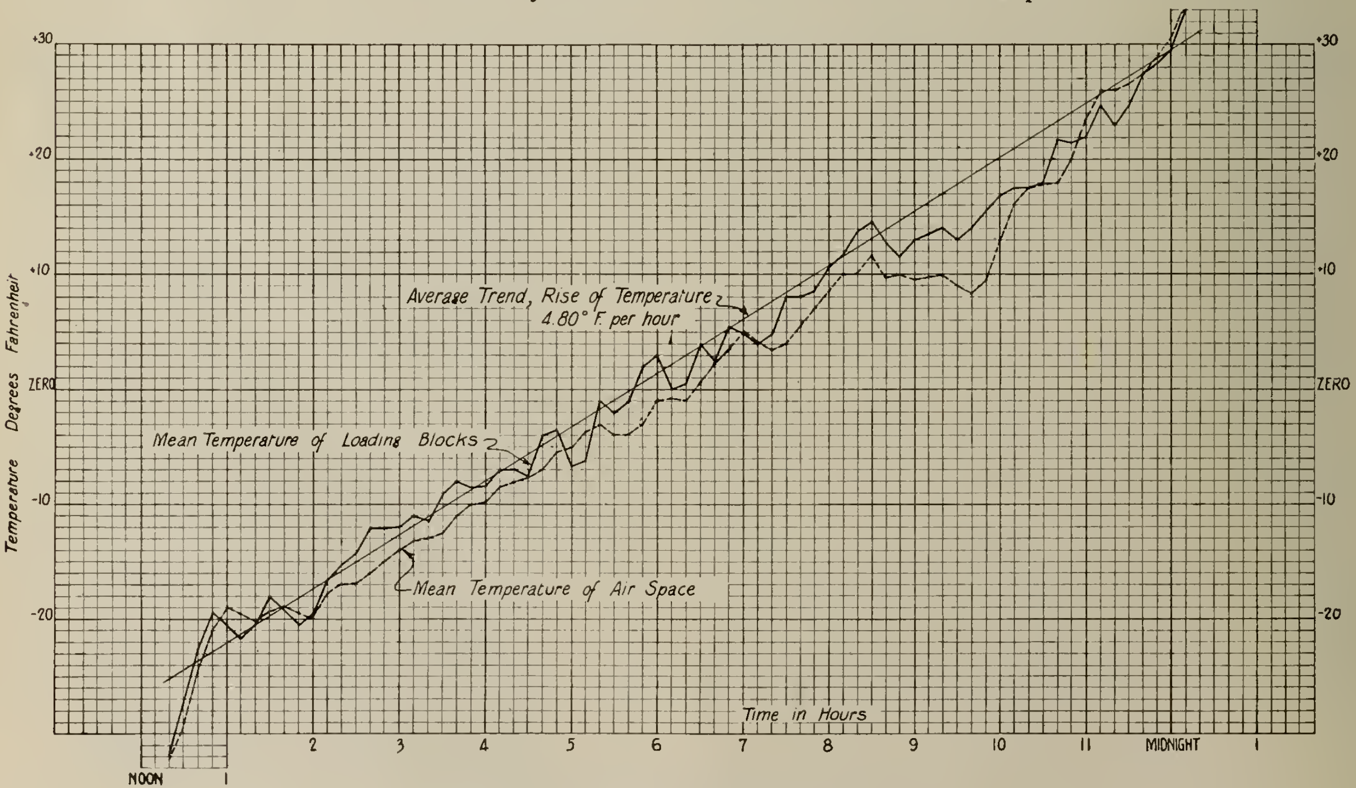
In Fig. 6 the temperature rose from say −26 degrees F. to +30 degrees F. in eleven hours forty minutes, a rate of 4.80 degrees F. per hour. During that period the actual recorded pressure increased from 100 pounds to 370 pounds—the average trend line showing a rate of increase of about 20.6 pounds per hour. This is for a 3-inch cube, and therefore corresponds to about 330 pounds per square foot per hour. If this rate of rise of temperature lasted for six hours, the pressure exerted by the ice would be of the order of 2,000 pounds per square foot. Examination of the curve shows that during the period from 8.30 p.m. to 10 p.m. the temperature rise was halted, due to a temporary loss of control. During that period the load remained approximately constant, and subsequently increased at about the former rate, as the former rate of temperature rise was resumed.

The curves in Fig. 7 show a temperature rise from −23 degrees F. to +26 degrees F. in nine hours twenty minutes, an average rate of 5.25 degrees F. per hour. The average trend line on the pressure curve indicates a rise at the rate of about 22.5 pounds per hour for a 3-inch cube, equivalent to 360 pounds per square foot per hour. The pressure exerted after a period of six hours at this rate would be about 2,160 pounds per square foot. These figures agree closely with those of the test just described.

The effect of contraction of the ice due to the cooling between 9.30 p.m. and 11.00 p.m. is shown clearly, the



Record of Thrust Exerted by Three Inch Cube of Ice Due to Rise in Temperature.



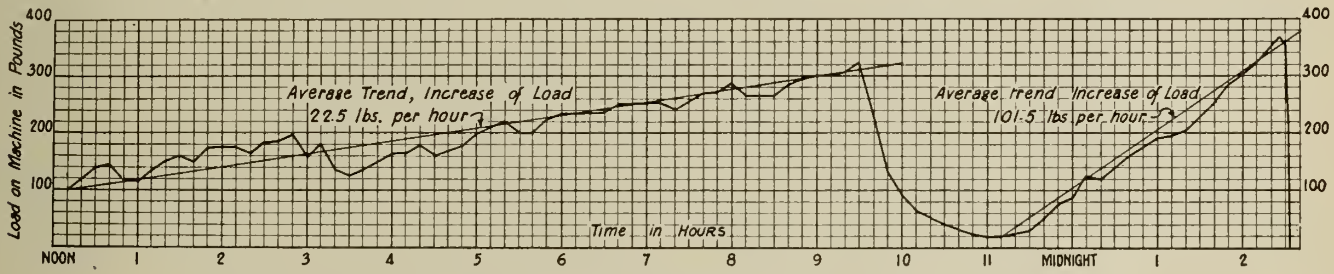
Record of Rise in Temperature During Test.

Fig. 6—Graphical Record of First Completed Test.

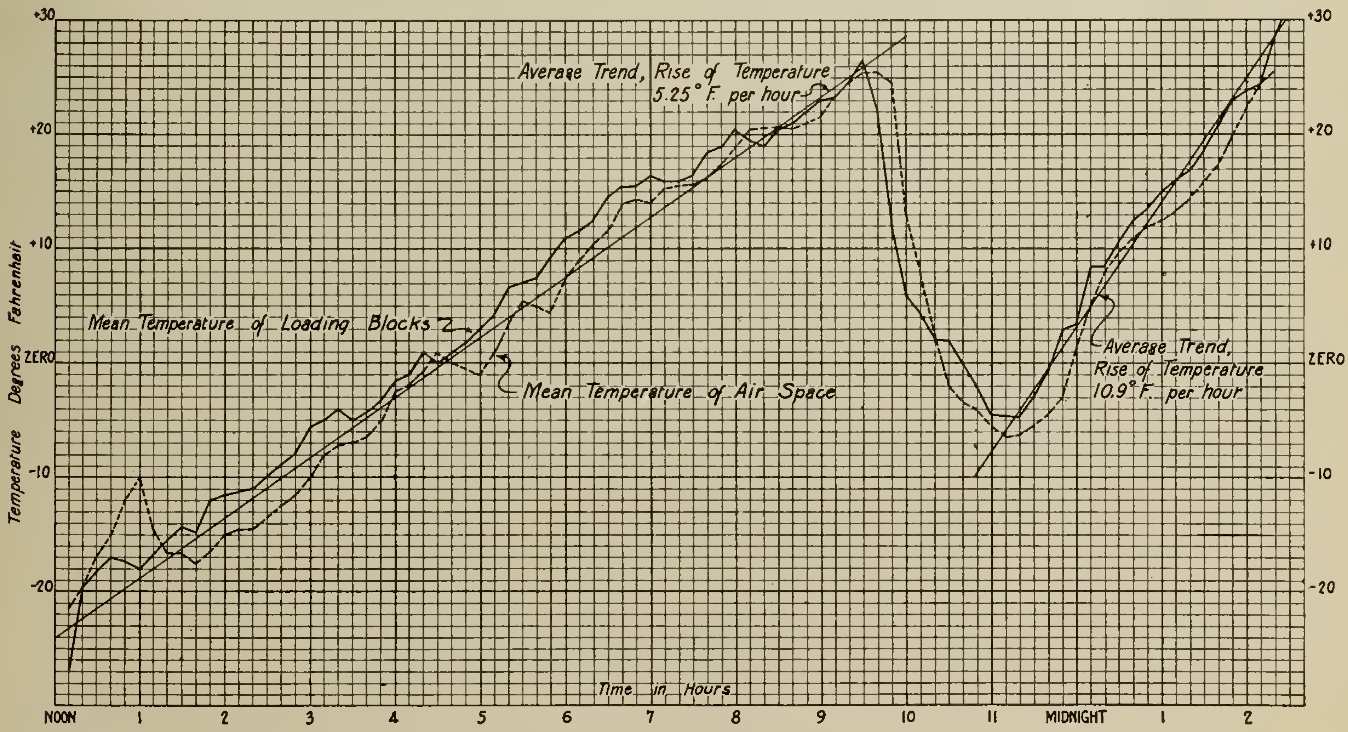
pressure dropping as the ice cooled. The load was allowed to drop to 20 pounds at 11.10 p.m., and the temperature rise was then resumed, more rapidly than before however. The rise of temperature was from −5.5 degrees F. to 30 degrees F. in three hours fifteen minutes, a rate of 10.9 degrees F. per hour. The corresponding average increase of pressure, based on an increase from 20 pounds to 350 pounds, was 101.5 pounds per hour for the 3-inch cube, or 1,624 pounds per square foot per hour. This corresponds to about 5,000 pounds per square foot if maintained for three hours, but such a rapid rise of temperature can scarcely be conceived to be possible in nature. The rate of temperature rise after the period of cooling was approximately double that of the earlier stage of the test, whereas the rate of increase of pressure was about four and one-half times that of the earlier stage of the test. The rate of increase of temperature therefore has a very marked influence. This is to be expected, because the greater the rate of rise of temperature and consequent expansion, the less time is there for the ice to flow. The pressure would therefore build up more rapidly. It is probable that the effect of change in the rate of rise of temperature will be different in magnitude at different temperatures, because of the difference in the tendency of ice to "flow" at different temperatures. Ice "flows" much more readily, under a given pressure, at temperatures near 30 degrees F. than at temperatures near zero F., and this tendency to "flow" checks the building up of pressure. Another factor however would enter into the question, viz., that of the expansion coefficient of ice which increases considerably as temperature rises. This means that a given rise of temperature occurring at a temperature near zero F. would produce less expansion than the same rise taking place near 30 degrees F. This condition, combined with the lesser tendency to "flow" at the former temperature, would determine the resulting thrust exerted. Under natural conditions, and at all stages of the tests described, there is an interplay of many effects

The influences of a halt in the rise of temperature, of a drop of temperature, of a rise of temperature at different rates, etc., are all clearly seen in the curves, and are consistent in character with the properties of ice as found in the series of tests described in the report of the St. Lawrence Waterways Project. It would therefore appear to be reasonable to use the results in considering the probable pressure of ice against a structure.

The records of the tests were examined in great detail in the light of the data obtained from the tests made for the Board of Engineers of the St. Lawrence Waterways Project. The behaviour of the ice was in general agreement with the physical properties shown by those tests, but the details of these comparisons are not given here. The comparisons strengthened the opinion that the tests now described afford a proper picture of what occurs when ice develops a thrust against a structure due to a rise of temperature.



Record of Thrust Exerted by Three Inch Cube of Ice Due to Rise in Temperature.



Record of Rise in Temperature During Test.

Fig 7—Graphical Record of Second Completed Test.

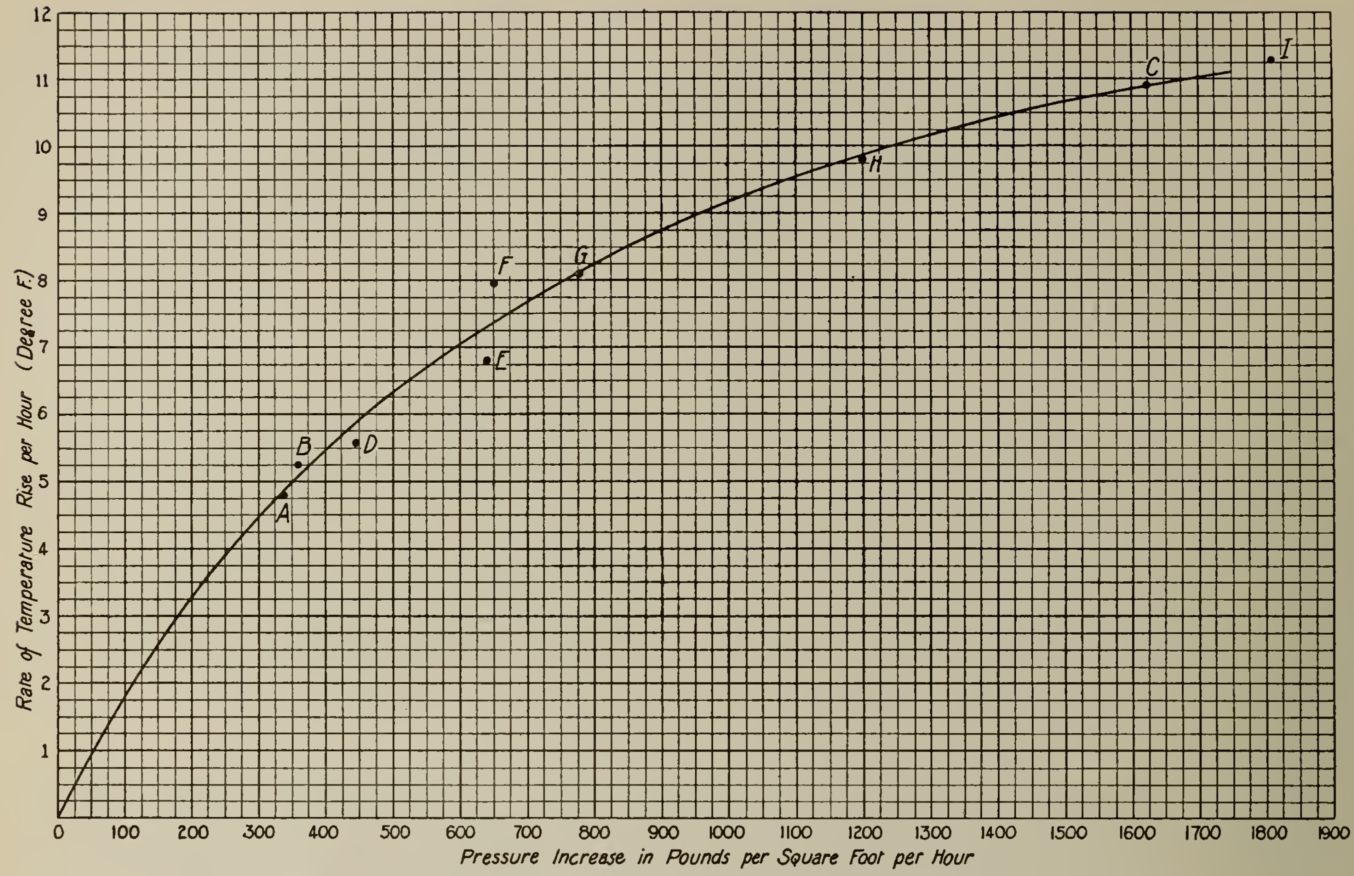


Fig. 8—Curve Showing Relation Between Temperature and Pressure Rise, per Hour.

Application of Results of Tests

The curve in Fig. 8 is plotted from the data shown on Figs. 6 and 7. The rate of increase of pressure is shown in pounds per square foot per hour, being obtained from the rate of increase of pressure recorded on the 3-inch cubes used in the tests, by multiplying by sixteen. The points *A*, *B* and *C* are established by the general trends of temperature and pressure rise over periods of several hours duration, and the curve must pass through these points and the origin. To determine more definitely the probable form of the curve, short periods of the same tests were selected during which the rate of rise of temperature and pressure differed somewhat from the values given by the general trends over the long periods. Points *D*, *E*, *F*, *G*, *H* and *I* were thus determined, and while these points cannot be regarded as being so well established as the points *A*, *B* and *C*, they help to fix more definitely the relation between the rate of rise of temperature and the resulting ice pressure. It is regretted that more points were not available for plotting this curve, but the portion for rises of temperature up to say 8 degrees F. per hour is fairly well defined. This is the portion of practical value, since rises in excess of that rate are of very short duration.

The total pressure per square foot exerted at the end of any period of rising temperature can be obtained by reading from the curve the pressure corresponding to the average rate of rise of temperature and multiplying that pressure by the number of hours in the period.

Unfortunately no hourly records of temperature were available for any point near Island Falls, but a careful search was made at the McGill Observatory for extreme rises from low temperatures, and the three extreme changes found are plotted on Fig. 9. It is not probable that the three curves represent absolutely extreme conditions, but when it is considered that they show in a few hours a variation in temperature equal to 50 per cent of the normal annual variation, they cannot be far from a maximum for any one continuous rise. It will be noted that these temperature records rise above the melting point of ice, but it is assumed for the purpose of estimating pressure that a similar rise might occur from an origin of lower temperature than that recorded on any one of these particular days, and at any other period of winter.

It will be noted that the greatest rate of rise occurred during the two hours from 1 p.m. to 3 p.m. on December 20th, 1922, and was 8.55 degrees F. per hour.

The most rapid rise of considerable duration was from 11 p.m. January 19th, 1921, until 3 p.m. January 20th, a duration of sixteen hours, during which the temperature rose from -1.4 degrees F. to 38.4 degrees F., a total of 39.80 degrees, at an average rate of 2.5 degrees F. per hour. The most sustained rise was from 7 a.m. February 1st to 9 p.m. February 2nd, 1920, an interval of thirty-eight hours, during which the temperature rose from -19 degrees F. to 33.6 degrees F., a total of 52.6 degrees at an average rate of 1.4 degrees F. per hour.

The curve on Fig. 8 shows that the increase in pressure per hour with temperature rising 2.5 degrees F. per hour is 145 pounds per square foot, and with temperature rising at the rate of 1.4 degrees F. per hour 75 pounds per square foot.

The total pressure at the end of the sixteen-hour period of January 19th and 20th, 1921, would then be $16 \times 145 = 2{,}320$ pounds per square foot.

The total pressure at the end of the thirty-eight-hour period of February 1st and 2nd, 1920, would be $38 \times 75 = 2{,}850$ pounds per square foot.

There are undoubtedly localities where the changes in temperature are more rapid than at Montreal. This is particularly true of that section of Canada which is subject to the Chinook winds. No hourly records of such changes are at present available to the authors, but suppose that the

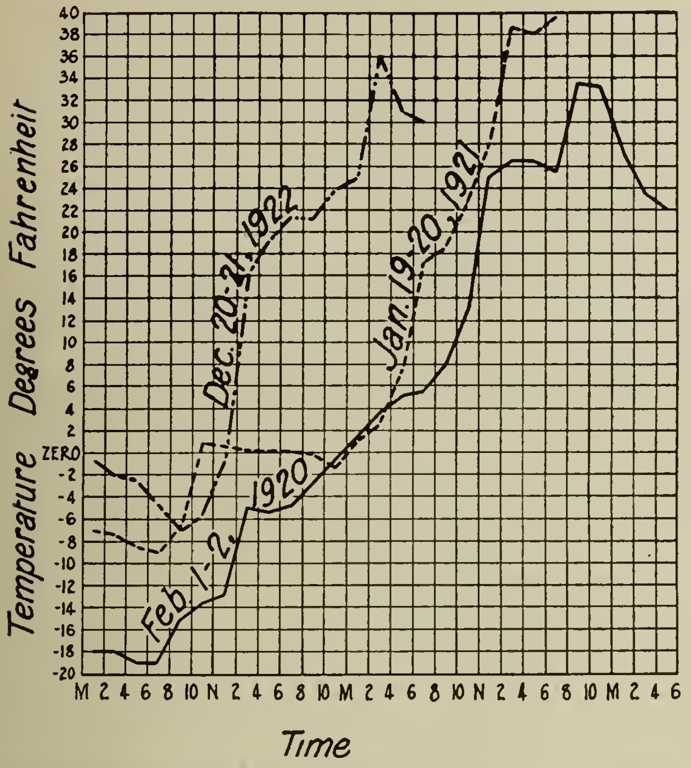


Fig. 9—Extremes of Rapidly Increasing Temperature at Montreal.

change of 52.6 degrees F. which occurred in Montreal in thirty-eight hours should take place in eighteen hours. This would be at an average rate of 2.92 degrees F. per hour, which from Fig. 8 would produce an hourly rise in pressure of 175 pounds per square foot or a total of 3,150 pounds per square foot, which is 11 per cent. more than would be produced by the same total rise in temperature over the longer period.

Up to this point the results of the investigation appear to be fairly definite, but two other important factors not yet determined enter into the problem of deciding upon the pressure per linear foot of dam.

The first is the rate and extent to which a rise in temperature of the air will be felt through the ice cover. The temperature of the ice exposed to the air will rise, but the ice layer in contact with the water will remain at a temperature near 32 degrees F. It is unreasonable to suppose that a uniform rise of temperature can occur throughout a thick cover of ice. Experimental data should be obtained under natural conditions. If it be assumed that the rise of temperature, through the ice sheet, follows a linear law, one might, as a rough approximation, apply the above figures for unit pressures, to ice of half the thickness of the ice cover.

Another factor to be considered is the effect of lateral restraint of the ice in a direction parallel to the dam. The ice of the cubes tested was free to flow in two directions, whereas in natural conditions complete freedom to flow exists only in the vertical direction. The effect of lateral restraint in the case of an elastic material such as steel, can be calculated from the values of Poisson's ratio, if the degree of lateral restraint is determined. The general effect is to increase the pressure corresponding to a given strain, in a direction at right angles to that of lateral restraint. The absence of freedom to flow laterally in one direction will probably cause the thrust to be increased in the case of an ice cover. Ice, however, is not an elastic, but a plastic substance, and the degree of lateral restraint will vary according to the physical conditions of a site such as the nature and steepness of banks, continuity of ice cover across the forebay, etc. An attempt was made to determine the influence of lateral restraint by bolting thick steel plates having a negligible coefficient of expansion across two opposite faces of a 3-inch cube of ice, and subjecting the specimen to conditions similar to those described above. It was extremely difficult to set up the apparatus in the cold storage warehouse, and the plates had to be frozen lightly to the faces of the cube. Later on, after the cube had contracted due to the lowering of the temperature at the laboratory, the nuts were turned so that they were just binding against the plates. The load on the machine did not rise as in previous tests when the temperature rose, and it was decided that considerable restraint against expansion in the direction of the screws of the machine was provided by the adhesion of the ice to the lateral plates, which probably increased greatly as the temperature rose. The plates were very tight against the cube at the end of the test. The experiment was a failure for the reasons given, and threw no light on the problem. It is difficult to see how the natural conditions of restraint can be imitated, and further testing along these lines was abandoned.

In view of these uncertainties it cannot be said that the investigation alone fixes a definite pressure to be allowed per linear foot of dam. It seems very unlikely that the temperature change throughout a sheet of ice will be sufficiently rapid to cause a total pressure based on the rate of rise of the temperature of the air, and half the thickness of the ice. On the other hand, while it appears certain that the lateral restraint will increase the pressure, it is not likely to double it. Until more light is thrown on these two factors, it is thought that it will be conservative to consider them as balancing out, and to take the pressure per linear foot of dam as that given by applying to the total thickness of ice, the pressure per square foot corresponding to a given rate of rise of air temperature, as determined by the investigation. The decision rests with the engineer responsible for the project, who must give due weight to the factors involved. An ice pressure of 10,000 pounds per linear foot was used in the design of the dams at Island Falls.

Acknowledgments

Thanks are due to the Harbour Commission of Montreal for the use of a room at their cold storage warehouse, and to Mr. S. D. MacNab, A.M.E.I.C., superintendent of the Testing Laboratory, McGill University, for his invaluable assistance in the experimental work.

Central Heating System of the City of Winnipeg

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—The principal reason for the establishment of the central heating plant of the city of Winnipeg was the desire to utilize the existing boilers of the steam electric stand-by plant during the winter months, in this way obtaining additional revenue from the outlay incurred.

The equipment of the station includes four water-tube boilers fired with pulverized coal and together capable of evaporating 440,000 pounds of steam per hour at 250 pounds pressure. There are also three electric boilers, each taking 7,500 kw., with a total capacity of 62,000 pounds of steam per hour. These boilers serve to flatten out the load curve of the hydro-electric system by using off-peak energy, in this way substantially increasing the load factor of the hydro-electric system. The three steam turbo-generators, having a total rating of 11,000 kw., exhaust to condensers, and the steam they use is not employed in the heating system, which is supplied by live steam from both the electric and coal-fired boilers. The city steam distribution system consists of a loop main and looped branches, laid out in this way with a view of eliminating dead ends. The mains range in size from 14 to 4 inches in diameter. They are laid in concrete conduit and expansion is provided for by the use of slip joints.

The system supplies the business area of Winnipeg, and two hundred and forty-six buildings are at present connected. The steam consumption ranges from 250 to 650 pounds per square foot of radiation per season. Steam reaches the various buildings at a pressure of approximately 40 pounds per square inch, which is reduced on the customers' premises to suit conditions. No steam is suppled for power purposes.

The paper concludes with a schedule of rates, information as to the monthly consumption during the past three seasons, and a discussion of the regulation and economy of operation of the plant.

Introduction

Central heating was established in Winnipeg in the year 1924 with the official opening of the steam plant of the City of Winnipeg Hydro Electric System. This station remained alone in the field until 1927 when The Winnipeg Heating Company opened a station in the residential district of Fort Rouge. Since then the development has grown until at the time of writing there are four stations in operation. This speaks well for a system that was and still is being severely criticized by certain factions.

The origin of central heat in Winnipeg was due to fear of troubles caused by the storms that periodically visit the area traversed by the transmission line between the city's hydro-electric plant at Pointe du Bois and Winnipeg. Considerable difficulties had already been met with, and, to enable the Hydro to give a guarantee of dependable service to at least the vital consumers of electricity, it was decided to erect a steam standby station within the city limits. Construction of this station had commenced when the recommendation was made that central heating be installed which could utilize the boilers of the standby plant during the winter months, when fear of an interruption of the transmission lines was at a minimum. Furthermore there was the added advantage that central heat would at least materially reduce the debt that would be incurred by a plant that might not come into useful operation for a number of years. The recommendation was approved and in October 1924 steam from the new station was turned into the distribution network for the first time. Seven years of operation have proved that this recommendation was sound, for not only has the system been paying expenses but it is reasonable to expect that in course of time it will pay off the entire debt.

Some confusion occasionally exists when discussing the stations of this city, as to the areas they serve and to which of the companies they belong. To avoid any such confusion here, it may be stated that the City of Winnipeg Hydro Electric System owns and operates but one plant which serves only the business section of the city. The remaining three plants are controlled by the Insull interests, and these operate in Winnipeg west, Fort Rouge and the River Heights areas. All of the last mentioned stations serve residential districts only, and are in no way in competition with the city's plant.

This paper has been divided into three main sections, and as a guide to the contents, the following synopsis is given.

Section 1. General description of the plant including:
- Coal handling and preparation plant.
- Boiler room.
- Turbine room.
- Electrical sub-station.

Section 2. Distribution network covering:
- Mains and services.
- Special details.

Section 3. General, covering:
- Classification of customers.
- Equipment.
- Metering.
- Rates.
- Weather and consumption.
- Economics.
- General losses.
- Heating hours.
- Temperature regulation.
- Operating statistics.

The Station

As mentioned in the introduction, this station was designed originally as a standby to the Hydro's electrical system; it differs therefore from the usual run of central heating plants, but also serves to illustrate the usefulness of central heat as a by-product. The station, shown in elevation in Fig. 1, is constructed of structural steel, brick and hollow tile, the foundations of which rest on wood piles approximately 45 feet long, driven to a rock base. It is designed for pulverized fuel, and the building is consequently divided into four sections comprising: (1) Coal handling and preparation plant; (2) Boiler room; (3) Turbine room; (4) Electrical sub-station. To familiarize the reader with the general layout, a short description of these sections, each under its own heading, follows.

Coal Handling and Preparation Plant

Bituminous coal has been used almost exclusively in the plant. This coal from the Alberta fields, delivered to the site in bottom dump cars at just under $7 per short ton, has the following approximate characteristics:

Moisture	1.5 per cent
Volatile	23.5 per cent
Fixed Carbon	60.0 per cent
Ash	15.0 per cent
Calorific Value per pound	12,800 B.t.u.
Fusion Temperature of Ash	3,000 degrees F.

The cars discharge directly into a sunk hopper at the base of which is a Simplex loader which automatically fills the 3-ton bucket of the skip hoist. This bucket elevates the coal to a receiving hopper in the roof of the building. The entire cycle of loading, elevating, discharging and returning of the skip bucket is automatic, the only manual labour required being that necessary to start and stop the apparatus by means of a push button.

The receiving hopper is fitted with a flap valve used for directing the coal into the main bunker or out to the storage yard through a chute. The yard, adjacent to the north side of the plant, has a capacity of some 4,000 tons and is equipped with a drag scraper for storing, trimming and reclaiming the coal.

Coal is discharged from the receiving hopper by a reciprocating plate driven off the crusher shaft, into a twin-roller crusher where it is reduced in size to a maximum of one inch. From the crusher the coal passes over a magnetic separator of the belt and pulley type, and into the main bunker of 160-ton capacity. This bunker has twin discharges fitted with coal gates leading into two waste gas driers. These driers are seldom used and were installed when an attempt was made to burn lignite.

From the bunker, through the driers and into the mills, the coal passes by gravity. The mills, shown in Fig. 2, pulverize the coal to 83 per cent through a 200 mesh and 95 per cent through a 100 mesh sieve. It is then lifted by exhauster fans to two cyclone separators near the top of the building, where the coal and air are separated, the air returning to the mills and the coal falling into screw conveyors which distribute it to the 60-ton pulverized fuel bunkers situated one in front of each boiler.

Boiler Room

The boiler room is equipped with four Erie City, two-drum, water tube boilers rated at 1,100 boiler horse power. Each is capable of a peak load of 110,000 pounds per hour at 250 pounds pressure (gauge).

Radial fin superheaters are fitted to three of the boilers for supplying 150 degrees of superheat to the steam for use in the turbines. No. 4 boiler is not fitted with a superheater, and is therefore used exclusively for central heating.

The four combustion chambers are of hollow wall construction, each being fitted with a water screen situated near the base of the chamber to prevent fusion of the ash and to allow it to be removed from the pit in granular form. No. 4 water screen is turned up at the rear to water cool the bridge wall, the other three screens are straight, the bridge walls being air cooled. Each chamber has a combustion space of 7,200 cubic feet, being 31 feet high above the water screen, 18 feet 7 inches between side walls and 17 feet 2 inches deep. This gives a maximum release of some 24,000 B.t.u.'s per cubic foot per hour, and it is interesting to note that although this figure is higher than is usually allowed for air cooled walls, excessive maintenance of brickwork has not been necessary.

Each chamber is fitted with seven fan-tail burners, arranged for vertical firing through the arch. These burners are fed by worm-screw feeders and supplied with primary air at approximately 16 inches static pressure.

The burners, feeders, primary air ducting and Reeves variable speed drive for the feeders can be clearly seen in Fig. 3 which is a general view of the boiler room looking along the firing floor.

Two 10-foot diameter reinforced concrete stacks, 178 feet above the centre line of the breeching, serve the four boilers, one stack for two boilers. Under normal conditions the boilers are operated with natural draught. Induced draught fans are however fitted to Nos. 1 and 2 for use in the event of heavy loads or poor natural draught conditions.

In addition to the four fuel boilers, three electric boilers shown in Fig. 4, are installed. These have an individual capacity of 7,500 kw., and each is capable of

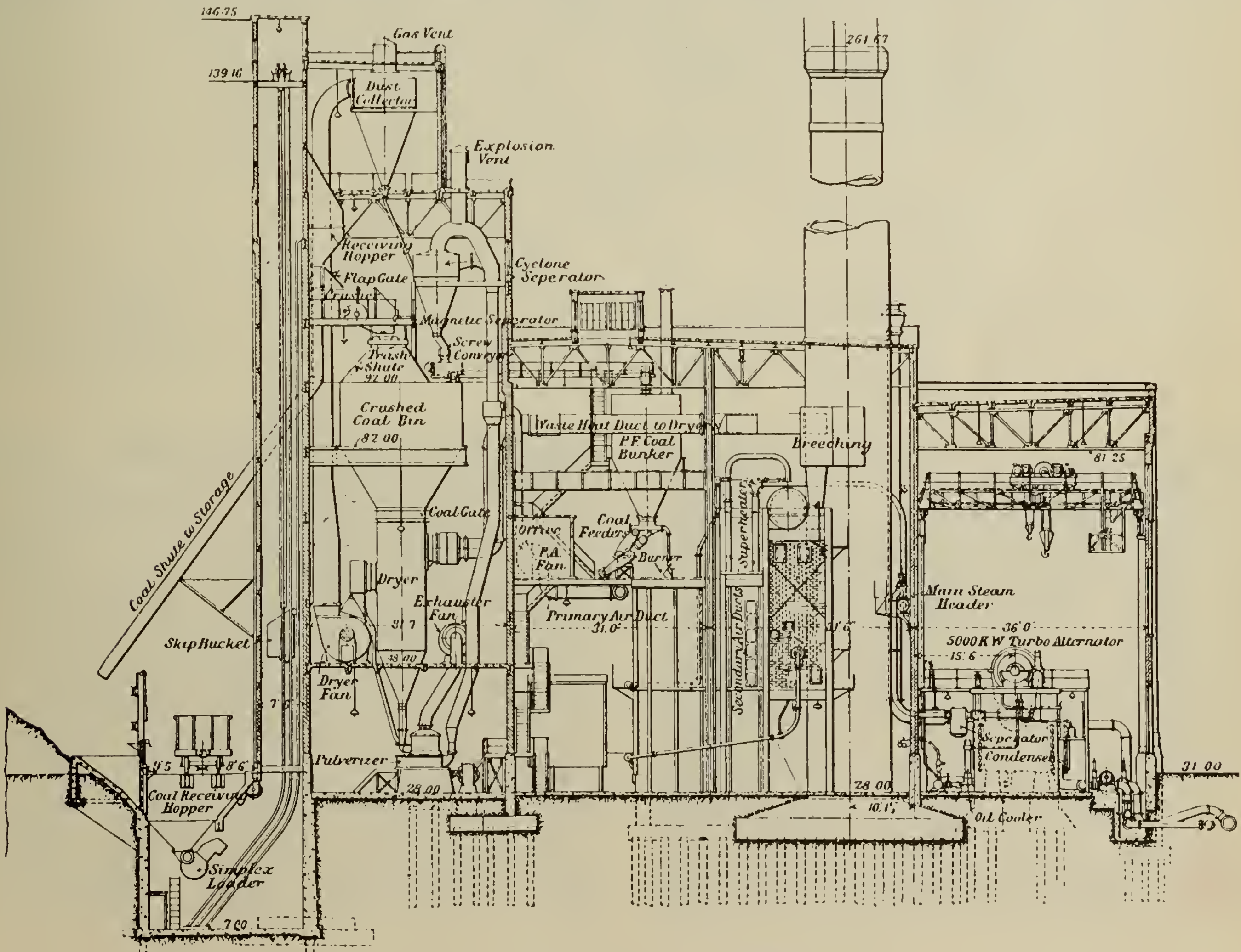

Fig. 1—Cross Section of Steam Plant.

Fig. 2—Raymond 6 Roller Pulverizing Mills.

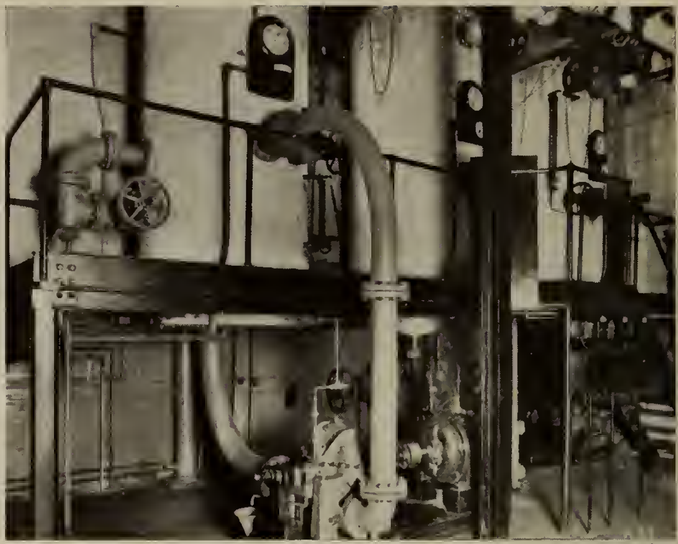

Fig. 4—Three Electric Boilers, 7,500 kw. Capacity Each.

producing approximately 21,000 pounds of steam per hour at 250 pounds pressure (gauge). Energy is supplied at 4,800 volts, 3-phase, 60 cycles per second. The operation of these boilers is very interesting as they serve primarily to flatten out the load curve of the Hydro-Electric System by utilizing off-peak energy, and secondarily to produce steam for the heating division. During 1929 some 90 million kilowatt hours were used in this manner, increasing the Hydro's annual load factor from 51.1 per cent to 63.2 per cent. In 1930 very little off-peak power was available owing to abnormally low water in the Winnipeg river, nevertheless some 40 million kilowatt hours were consumed thus boosting the annual load factor of the Hydro from 53.4 per cent to 56.3 per cent. Using off-peak power through the electric boilers results in a lower generation cost per thousand pounds of steam over that of the fuel boilers.

Fig. 5 depicts the layout of the feed water pumps and piping in the plant. This equipment consists of:—

1 Steam-turbo De Laval pump of 18,000 gallons per hour capacity.
1 Steam-turbo De Laval pump of 32,000 gallons per hour capacity.
1 Electric-drive De Laval pump of 18,000 gallons per hour capacity.
1 Steam-turbo Weir pump of 50,000 gallons per hour capacity.

Apart from the three steam driven feed water pumps, all the boiler room auxiliaries are electrically driven.

Turbine Room

Installed in the turbine room are two 5,000-kw. and one 1,000-kw. turbo-alternators. Each consists of a Howden-Zoelly multistage turbine directly connected to a Parsons alternator.

The turbines of the larger machines have six rows of blading, and when supplied with steam at 220 pounds pressure with 150 degrees of superheat and exhausting to a 28-inch vacuum (30-inch barometer) their water rate is 12.5 pounds per kilowatt hour. Generation is at 12,500/13, 200 volts, 3-phase, 60 cycles with a speed of 3,600 r.p.m.

The house unit (1,000 kw.) differs from the larger machines only in that the turbine has but four rows of blades, and exhausts into a feed water heater under a back-pressure of one pound per square inch which brings its water rate up to 23.3 pounds per kilowatt hour, and generation is at 2,400 volts, 3-phase, 60 cycles with a speed of 3,600 r.p.m.

Each alternator is totally enclosed and is ventilated by a closed air-cooling system using water coolers for reducing temperature. Embedded in each stator are six temperature detectors of the thermo-couple type. These detectors are connected to a direct reading meter, through a selector switch, so that the temperature at any one of the points may be ascertained immediately whilst the machine is on load.

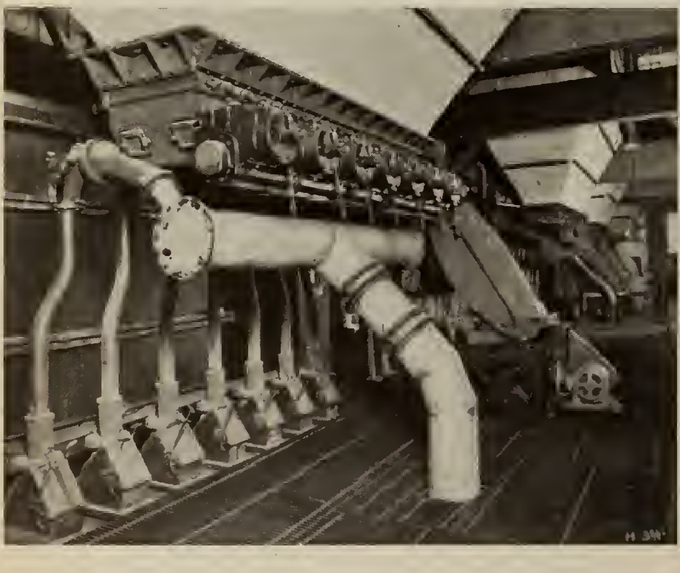

Fig. 3—Firing Floor, Showing Burning and Feeding Equipment.

Fig. 5—Boiler Feed Water Pumps and Piping.

Fig. 6—General Arrangement of Distribution System, Showing Buildings Served.

The house unit is kept running continuously under no-load conditions, so that in the event of a failure of the incoming lines, this machine can be put on the bus bars immediately, thus supplying sufficient energy to get the main turbines "alive."

All the turbine room auxiliaries are electrically driven with the exception of the emergency oil pumps, and each turbine is fitted with an atmospheric exhaust relief valve for use in the event of either the surface condensers or feed heater becoming crippled.

Electrical Sub-station

This station serves the dual purpose of being the control gallery for the turbine room and at the same time sub-station No. 6 of the Hydro-Electric System. It is fed directly from the Hydro's terminal station by two 12,000-volt overhead lines. Distribution is at 2,400 volts.

At the right of the switch room of this station are the 12,000-volt switches immediately below which are the main and auxiliary high tension bus bars. At the left are the low tension switches directly under the 2,400-volt busses. When in commission, the 5,000 kw. machines feed directly onto the high tension bus bars and so to the terminal station for emergency distribution, whilst the house unit feeds the low tension busses for local service only.

The three banks of three 2,500-kv.a., 12,000/4,800-volt transformers for use with the electric boilers, have no low tension switches, the transformers and boilers forming complete units.

Distribution Network

Distribution

Steam from both the electric and coal fired boilers is fed into a common loop main and passed through desuperheaters and pressure reducers into a distributing header at 55 to 75 pounds pressure, with zero to 40 degrees of superheat. The pressure and condition of the steam in the distributing header depends on the load being carried, and on which of the boilers are steaming. Two 14-inch trunk mains carry the steam from the plant to the outside network.

The distribution network has been laid out with a view of eliminating dead ends by looping the lines. Although this end has by no means been achieved at present, nevertheless whenever conditions warrant it, loops are completed.

Looping has much to recommend it and far outbalances its great disadvantage of costliness by reducing dead end condensation losses, avoiding inconveniencing many customers when a section of line has to be killed for adding additional load, and by making the system much more flexible in every manner. One of the first points to be settled before a loop is constructed is that of expected revenue against the fixed charges of the line; however, other points having no bearing on direct revenue often warrant the completion of a loop. An interesting example of this is found by referring to the map in Fig. 6 on which will be found a considerable length of 12-inch main on Hargrave street that is without customers. This line was laid with a view of safeguarding the customers on Portage avenue and its connecting cross streets, and had no bearing on direct revenue. Prior to construction of this loop, the entire area in and around Portage avenue was served by one 14-inch line at the corner of Portage and Main street. As the cost of this line ran into the double figures of thousands of dollars, considerable criticism was directed against the system for apparent waste of money. However, the value of the line was conclusively proven just recently when a fault developed quite near the plant on one of the 14-inch lines, and the whole of the serviced area had to be carried temporarily by the other trunk line feeding through the loop just discussed.

Another interesting point on the network is that one of the trunk lines is laid with extra heavy fittings from the plant to the corner of Portage and Main. This allows steam to be turned into approximately the centre of the system at plant pressure. The few feeders that branch from this line are provided with globe valves for throttling the steam down to the desired pressure. This line has never been used with high pressure so far, but could be so used at very short notice should conditions demand it.

The entire piping of the network is of genuine wrought iron, chosen with a view of extending the useful life of the lines, and to assist in welding which is being resorted to and is gradually replacing the older forms of service fittings which are not only expensive but rarely are in the location required for taking on new customers. The size of the network and amount of pipe in use can best be obtained by referring to the tabulation below. This table is correct to the end of November, 1931.

Mains 14-inch	5,443 lineal feet
12-inch	5,610 lineal feet
10-inch	1,055 lineal feet
8-inch	12,148 lineal feet
6-inch	3,944 lineal feet
4-inch	240 lineal feet

and 12,045 lineal feet of service lines of sizes varying from one inch up to and including 8 inches.

A typical section of main line construction is shown in Fig. 7. The adjustable rollers are used on 12-foot centres, and although somewhat heavy in first cost, they materially reduce the time and cost of setting the pipe to its final grade which is kept as near 0.5 per cent as conditions will permit. Forming, it will be noted, is used only on the inner side of the conduit, the trench being used for the outer in all but the most exceptional cases, such as at points where the line runs through disused fire tanks, etc., or in cases of very poor earth-work. The forming is never stripped from the concrete, but is left as a protective covering.

The customer or service lines are laid in a similar, although less elaborate, manner to that of the main lines. A cross section of this type of construction is shown in Fig. 8. Here only one grade stick is necessary owing to the absence of roller chairs; pipe rollers replace those of the adjustable type, and tile drains are omitted entirely. This latter was decided upon after experience had proven that obstacles were numerous on service line runs, making a drain not only very difficult to lay, but also to make it practically useless even if installed. Grades are set as near one per cent as possible, draining being towards the main line.

An interesting experiment in conduit construction was made last summer when it was found that a proposed service line would parallel and at one point cross a duct of electrical cables. Great opposition was met from the owners of the cables until a guarantee was given that the temperature rise in the cable duct would not be materially affected by the heat losses from the steam line. To meet this guarantee, the width of the trench was increased and 18-inch by 12-inch by 3-inch gypsum blocks were laid on the inside of the concrete. In addition, rock wool was stuffed into the air space of the trench where the line crossed the cables. Prior to steam being turned on, a temperature test was run on the ducts, and after steam was on and when other conditions approximated those of the first test, a second test was run. So small was the temperature rise in this case over that of the first, that the results were given as "no effect," this in spite of the fact that the service line carried 45 pounds pressure, paralleled the ducts for 90 feet at a distance of 10 feet away, and crossed the duct with only 3 inches between the two trenches. This special construction is shown in Fig. 9.

Expansion on all but the service lines is taken up by the slip type of expansion joint. These are placed at approxi-

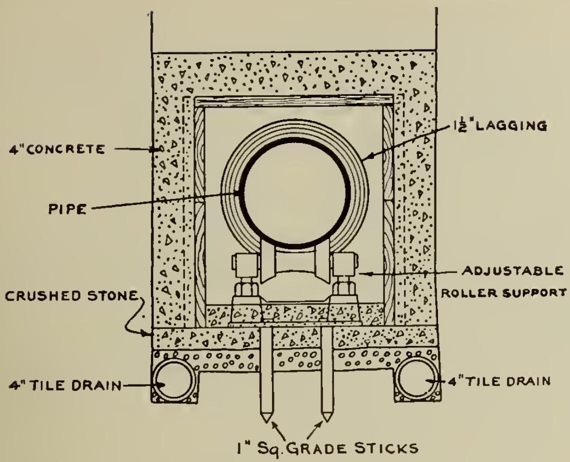

Fig. 7—Cross Section of Main Line Conduit.

mately every 300 and 250 feet on the 14-inch and 12-inch mains, and every 230 feet, 200 feet, and 150 feet on the 10-inch, 8-inch and 6-inch mains respectively. The service lines are provided with a knuckle joint to allow free play for the expansion of the service line itself and also for lateral movement due to expansion on the mains. This joint is placed as near as possible to the main line connection and consists of four, 90-degree, extra heavy, cast iron elbows, arranged as shown in Fig. 10. The flanges next to the main are installed for convenience of assembling and dismantling the service. This type of joint also allows the service to be at the most advantageous height for overcoming obstacles.

All lines, both main and service, are insulated with 1½ inches of asbestos sponge felt, wired on and covered with a protecting layer of tar-paper. Fittings, valve and expansion joint bodies are lagged with magnesia slabs cemented on and canvas covered.

The mains are anchored by steel braces to the walls of the ducts between manholes and graded to drain to the manholes where the condensate is passed through high pressure steam-traps to the sewers. Typical manholes are equipped with condensate meters to check the losses on the network from this cause.

The pipe lines are laid as a general rule at such a depth that the service lines off them will avoid any pipes or trenches that may parallel the run. This necessitates a deeper trench than would otherwise be constructed, being on an average of 6 to 7 feet below the surface. At this depth, the services are below the ducts of the electrical and telephone companies, and between the pipe elevations of the gas and water companies, the latter of which lie at 5 and 8 feet respectively.

General

Classification of Customers

To date two hundred and forty-six buildings are connected to the system. These are representative of the type

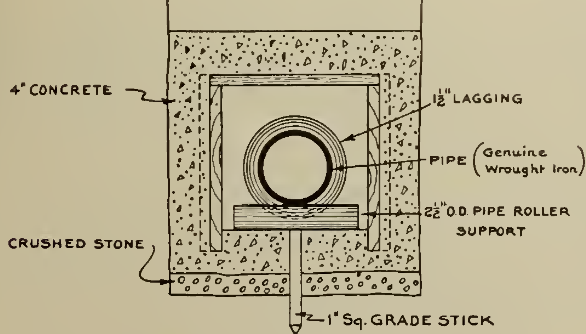

Fig. 8—Cross Section of Service Line Conduit.

found in all down town areas, and include amongst their number office blocks, warehouses, churches, schools, garages and filling stations, banks, hotels, clubs, theatres, cafes and restaurants, fire and police stations, and stores of all descriptions, but not, to date, any private dwellings. Naturally such a variety of buildings cannot be grouped as a whole for obtaining averages of consumption per square foot of radiation, or per hundred cubic feet of space. Classification is therefore made according to the volume per square foot of radiation. Such a classification brings the similar types of buildings together, and once so classed, preliminary investigations of consumption can be carried out on new or prospective buildings by the use of figures obtained from Table 1, below. Mean temperature for heating season spread over the last seven years is 27.3 degrees Fahrenheit, so that the averages shown in the last column of the table below are quite representative.

Equipment

In general, steam is supplied to the various buildings served at a pressure of approximately 40 pounds and

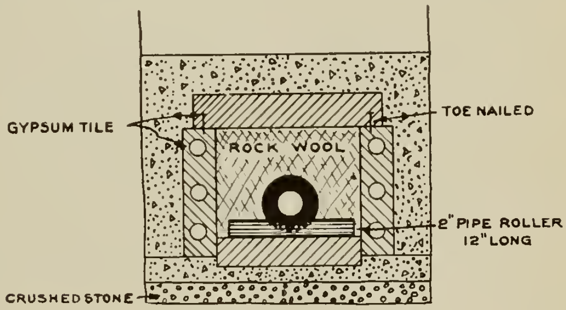

Fig. 9—Special Insulation on Service Line Conduit.

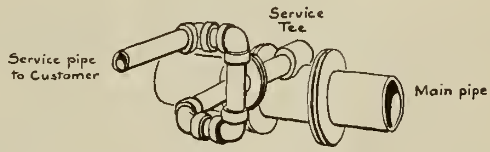

Fig. 10—Knuckle Joint for Service Line Expansion.

reduced in the customer's premises to suit conditions. No steam is supplied for power purposes, but a few customers utilize it for cooking.

Table 1

Steam Consumption Per Season for Various Customers

	Season 1928-29		Season 1929-30		Season 1930-31		Average for 3 Seasons	
	lbs. Sq.ft. Rad.	lbs. 100 Cu.ft.	lbs. Sq.ft. Rad.	lbs. 100 Cu.ft.	lbs. Sq.ft. Rad.	lbs. 100 Cu.ft.	lbs. Sq.ft. Rad.	lbs. 100 Cu.ft.
Churches...........	348	356	267	276	225	233	280	288
Office Blocks........	411	674	412	669	348	573	390	639
Business Blocks with Club Rooms......	414	563	449	612	376	516	413	564
Wholesales..........	438	418	447	420	387	373	424	404
Garages............	526	879	528	1254	360	886	471	1006
Hotels..............	523	756	523	755	417	581	488	697
Theatres...........	510	385	571	381	500	376	527	381
Business Blocks with Suites..........	568	806	553	782	466	664	529	751
Hot Water Heated Blocks..........	593	731	650	785	580	709	608	742
Mean Temperature..	27.2		26.5		30.1		27.9	
Degree Days........	11,733		11,788		10,801		11,440	

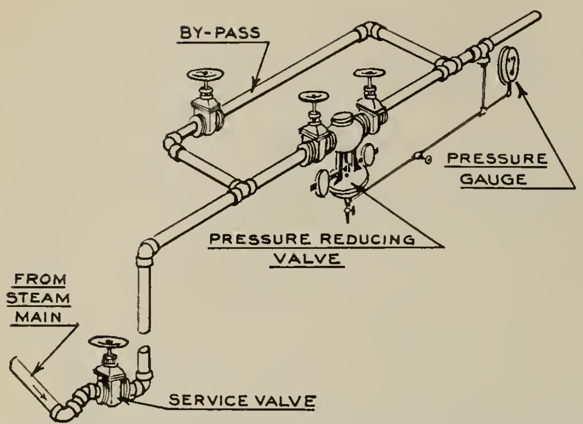

Fig. 11—Standard Equipment at Inlet of Customer's Premises.

The equipment necessary for reducing pressure has been standardized by the system, and consists of a pressure reducing valve, control, by-pass and return valves as shown in Fig. 11; a low pressure trap and strainer, and in some cases, a thermostat. In addition to this, a heat exchanger is supplied in cases of hot water heated buildings. This equipment is supplied and maintained by the system, the customer being charged an annual sum equivalent to 12 per cent of the value of the equipment. Should the customer so desire it, he may purchase the equipment outright, in which case maintenance and servicing if undertaken by the system is charged for according to standard rates prevailing at the time. Such a practice is not advocated unless supervisory control is given by the owners to the system, otherwise leakages and general wastages cannot be satisfactorily checked.

Metering

Consumption is measured by means of a rotary condensate meter placed at the outlet of the customer's heating apparatus. This meter, shown diagrammatically in Fig. 12, and in connection with the equipment in Fig. 13, is particularly suitable for such service since it is capable of accurate measurement on widely varying flows. The meter discharges direct to the sewer as there are no return mains to the plant.

Rates

The following schedules gives the rates charged by the system for steam:—

Open Order Rate:—For temporary or special steam service.
$2.00 per 1,000 pounds of condensation.

Season Rate:—For continuous use during the heating season.

First 25,000 pounds of the total monthly consumption
$1.40 per 1,000 pounds

Next 50,000 pounds of the total monthly consumption
$1.20 per 1,000 pounds

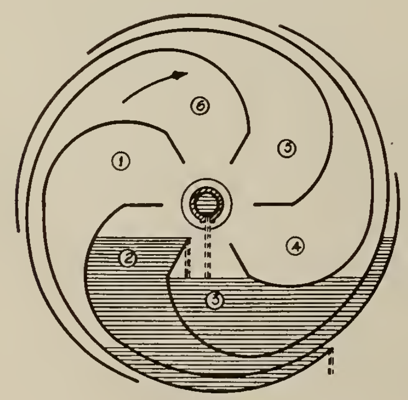

Fig. 12—Rotary Condensate Meter.

Next 125,000 pounds of the total monthly consumption
$1.10 per 1,000 pounds

Next 300,000 pounds of the total monthly consumption
$1.05 per 1,000 pounds

For all in excess of 500,000 pounds per month
$0.90 per 1,000 pounds

Subject to a 5 per cent discount for prompt payment.

Weather and Consumption

Owing to ease of control, central heating lends itself readily to heating according to weather conditions, and by so doing results in excellent economy, especially during the milder months of the year, when compared with the individual furnace.

The variation of heating in accordance with weather demand is shown in Table 2, below. These figures are averages of monthly sales spread over the last six years of operation of the system.

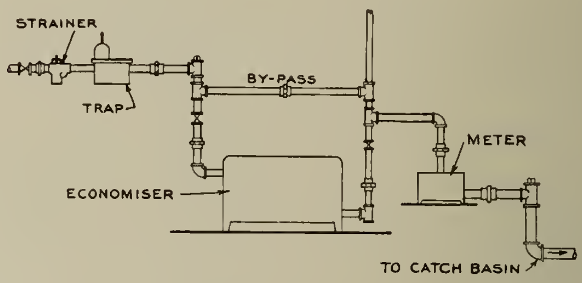

Fig. 13—Standard Equipment at Outlet of Customer's Premises.

Table 2

Average Monthly Consumption

September	3 per cent
October	7 " "
November	12 " "
December	16 " "
January	20 " "
February	17 " "
March	13 " "
April	8 " "
May	4 " "

The above figures follow very closely the degree day averages for the nine months of the heating season, shown at the end of Table 3.

Table 3

Degree Days

	1928-29	1929-30	1930-31	Average
September	548.5	480.0	377.7	469
October	889.7	744.0	964.1	866
November	1,194.0	1,533.0	1,395.0	1,374
December	1,618.2	2,057.5	1,677.0	1,784
January	2,480.0	2,393.2	1,880.2	2,250
February	1,971.8	1,624.0	1,461.6	1,686
March	1,488.0	1,581.0	1,559.3	1,543
April	861.3	810.0	870.0	847
May	681.5	565.6	616.2	621

These figures are based on an inside temperature of 70 degrees F. and are obtained by multiplying the number of days in the month by the difference of mean outside temperature and base temperature of 70 degrees. For example, consider the month of November:

$$\text{Degree days} = (70 - 24.2) \times 30 = 1,374.$$

Fig. 14 is a combination of charts purposely grouped to try and present a picture of variations in consumption and costs with variations in weather. Whilst these charts are based on the whole system, they are sufficiently accurate for preliminary investigations of the average building. The season 1929-30 was chosen for illustration, as the mean temperature was only 0.2 degrees above the ten year average, the season being in all respects a normal one. As the charts are self-explanatory, no comments will be made further than to recommend that they be given some thought and study by the reader.

So that these charts may be compared with other cities, Fig. 15 has been added showing the mean tem-

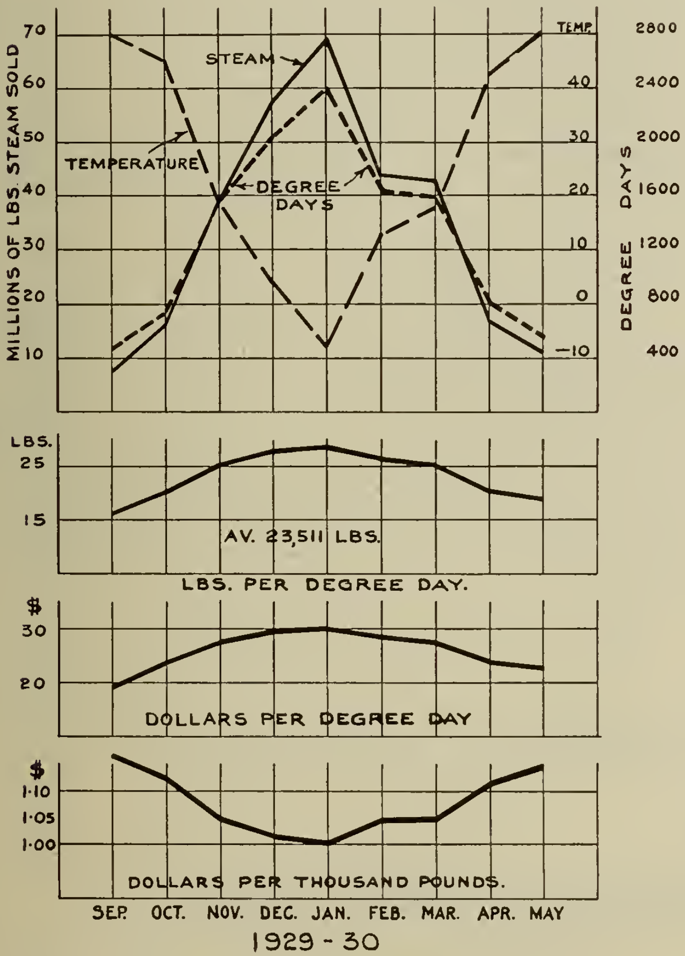

Fig. 14—Weather, Consumption and Cost Charts.

peratures as recorded by the Dominion Bureau of Statistics for a few of the leading cities of the Dominion.

Economics

The proper and efficient solution of the problem of economic utilization of heat really lies with the designing engineer and architect. However, in the best of layouts, leakages and wastages are bound to occur and as sellers of heat, the system makes a practice of advising rectification of such leakages whenever they become too apparent. This practice was adopted during the first year of operation, and has proved most beneficial as it is a practical demonstration of co-operation, a result that always produces satisfaction in the minds of the customer. It is a point well worth considering by all involved in central heating, since one dissatisfied customer will do more harm than half-a-dozen boosters can do good.

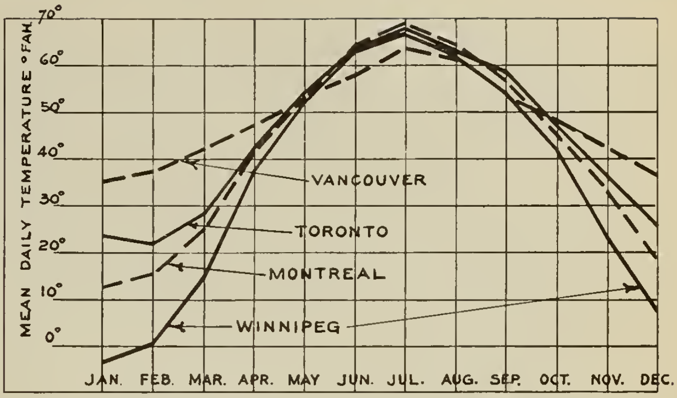

Fig. 15—Mean Temperatures for Various Cities.

Whenever a new building is added to the system, a careful study is made of the apparent requirements of the occupants. Should these appear excessive or abnormal, an investigation is made and the findings reported to the owners. These findings can, in general, be classed under three headings, for invariably the losses are due to either inadequate knowledge of or insufficient attention to the smaller points which involve:—

(*a*) General leakages and losses.
(*b*) Longer heating hours than are necessary.
(*c*) Improper regulation of temperature.

A brief discussion of these points under their respective headings follows in the hope that it may prove useful as a guide to consumers and others interested in central heating.

General Losses

Few consumers realize the amount of heat that is lost in the condensate, a large percentage of which can be economically recovered at little expense, in several different ways. A radiator installed just ahead of the meter inlet can be utilized to heat the basement, or it can be installed in an entrance for tempering the air, the condensate being piped up to the required location, or in the case of a hot water installation, the condensate can be run through coils for tempering the incoming water. Any of these uses are highly recommended by the system, not only because by their use the customer gains free heat but also because their use materially reduces the chances of steam blowing into the meter.

Faulty or badly fitting storm windows and doors are very common sources of heat loss. From these two sources alone, costs may be increased by some 15 per cent over proper conditions.

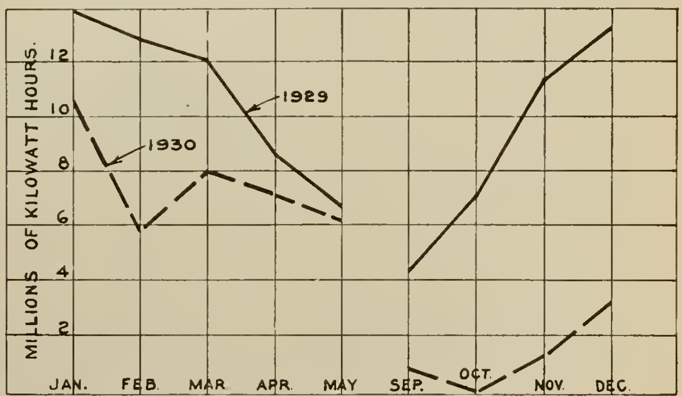

Fig. 16—Electric Boiler Consumption.

Improper size and placing of radiators, also adds to general wastage, but the principal cause of waste is the human element, which becomes conspicuous by the abuse of the open window. A very prevalent, but none the less mistaken, idea exists that because air is cool it is necessarily fresh and pure. The result is that far more windows are open than are necessary for proper ventilation, and to compensate for this the steam valves are opened wide, with the results that costs mount out of all proportion to weather conditions. The open window not only causes loss in the room concerned, but also to other rooms in the office, due to the ability, unfortunate in this case, of the human being for retaining impressions.

Limiting the Number of Heating Hours

A building, unless fully occupied at night, need not carry the same temperature throughout the twenty-four hours. All that is required at night is sufficient temperature to prevent the building becoming chilled. If this is brought to mind together with the fact that a building can be heated approximately three times as quickly as it cools when unoccupied, great savings can be effected by materially reducing the number of hours that steam is on. Furthermore, in a semi-occupied building, only that portion which is inhabited need be heated, and even if to do so requires alterations to existing equipment, it will invariably pay to run a separate line to those parts requiring heat. This is often found in cases of buildings having night watchmen. An individual line cares for the heating requirements of the watchman's office, whilst the rest of the building is being carried at a substantially lower temperature. The separate pipe also pays well in the case of domestic hot water heating by steam, for in this case a twenty-four-hour load may be carried on the heater irrespective of the load requirements of the building proper.

Regulating Temperature

Each degree above 70 degrees increases the cost of heating by about 3 per cent, and since 70 is an ideal temperature in which to work, some savings can be effected by not allowing the building to become heated above this temperature, except, of course, in special cases which are outside the scope of this paper.

Such a temperature may be controlled and maintained in one of two general ways, first by hand operation, and secondly and by far the most economical, is by means of a thermostat. Hand control, whilst reducing initial expenditure, is wasteful insofar that control depends on the regular reading of thermometers placed at various points in the building, and operating a valve to suit conditions as noted by the thermometer. To do this to any degree of accuracy would require the undivided attention of one man, and as such is never the case, wastages are bound to occur. On the other hand, unless there is adequate and well balanced radiation, to permit quick heating with satisfactory results throughout the building, automatic control cannot be economically used, and here again the results are brought back to the designing or heating engineer.

Operating Statistics

As the operating statistics for 1931 were not completed during the writing of this article, the statistics for the last two complete years are added with a view of showing the general size and operation of the system:

	1929	1930
Pounds of steam sold to customers	312,035,100	297,417,680
*Pounds of Steam generated		
by Electric Boilers	252,462,840	119,651,560
by Coal-fired Boilers	175,794,171	306,631,845
Kilowatt hours used by Electric Boilers	90,165,300	42,732,700
Tons of coal burned under boilers	10,433	18,045
Connected square feet of radiation	662,555	725,183
Peak load in pounds per hour	214,000	235,000
Number of customers (active)	193	220

Consumption of off-peak power was curtailed during the latter part of 1930 due to abnormally low water in the Winnipeg river, necessitating relieving the power plant at Pointe du Bois of as much load as possible. This is clearly seen in the curve, Fig. 16.

*Includes steam to turbines and plant auxiliaries.

THE FORTY-SIXTH ANNUAL GENERAL

and

GENERAL PROFESSIONAL MEETING

of

The Engineering Institute of Canada
Will be held at the Royal York Hotel
Toronto

on

TUESDAY, WEDNESDAY and THURSDAY
FEBRUARY 3rd, 4th and 5th, 1932

The Forty-Sixth Annual General and General Professional Meeting

The Annual General Meeting for 1932 will be convened at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 14th, 1932, at eight o'clock P.M. After the transaction of formal business, the meeting will be adjourned to reconvene at the Royal York Hotel, Toronto, at ten o'clock A.M., on Wednesday, February 3rd, 1932, continuing with the Professional Sessions on the two following days.

Programme of Meeting at the Royal York Hotel, Toronto

(*Subject to minor changes*)

Wednesday, February 3rd

9.00 a.m. *Registration.*

10.00 a.m. *Annual General Meeting.*
Reception and discussion of Reports from Council, Committees and Branches. Discussion of proposed amendments to By-laws and other matters.

12.45 p.m. *Formal Luncheon,* at which the Toronto Branch will be hosts to all members and their ladies.
Welcome to members by C. S. L. Hertzberg, M.E.I.C., Chairman of the Toronto Branch, who will preside, and by His Worship the Mayor of Toronto.

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

4.30 p.m. *Reception and Tea for Ladies.*

8.00 p.m. *Smoking Concert.*
Entertainment for Ladies. Theatre party.

Thursday, February 4th

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

Room A. Chairman—Prof. R. W. Angus, M.E.I.C.
The Central Heating Plant of the Toronto Terminals Railway Co.—by J. A. Shaw, M.E.I.C., General Electrical Engineer, Canadian Pacific Railway, Montreal.
The Central Heating System of the City of Winnipeg—by G. W. Oliver, Winnipeg Hydro-Electric System, Winnipeg.

Room B. Chairman—R. O. Wynne-Roberts, M.E.I.C.
The Niagara Falls (Ont.), Pumping and Filtration Plant—by H. G. Acres, M.E.I.C., Consulting Engineer, and S. W. Andrews, H. G. Acres & Co., Niagara Falls, Ont.
Chairman—G. H. Rogers, A.M.E.I.C.
Recent Developments in Long Distance Telegraph and Telephone Communication—by F. B. Coles, Carrier and Telephone Engineer, Canadian Pacific Telegraphs, Montreal.

Room C. Chairman—Prof. C. R. Young, M.E.I.C.
Structural Details of Maple Leaf Gardens, Toronto.—by G. Townsend, A.M.E.I.C., Structural Engineer, and Charles W. Power, Toronto Manager, Ross & Macdonald, Inc., Montreal.

12.45 p.m. *Buffet Lunch* (informal).

2.15 p.m. *Professional Sessions for the Presentation and Discussion of Papers.*

Room A. Chairman—Prof. L. M. Arkley, M.E.I.C.
The New Railroad and Automobile Ferry-Steamer "Charlottetown"—by W. Lambert, M.E.I.C., Naval Architect, Montreal.
The Use of Low Rank Fuels—by Prof. E. A. Allcut, M.E.I.C., University of Toronto, and H. L. Wittek, Consulting Engineer, Toronto.

Room B. Chairman—Brig. Gen. C. H. Mitchell, C.B., C.M.G., M.E.I.C.
Hydro-Electric Developments on the Lièvre River—by H. S. Ferguson, M.E.I.C., Consulting Engineer, New York.
A Study of Ice-Thrust in Connection with the Design of Hydro-Electric Plants—by Prof. E. Brown, M.E.I.C., McGill University, Montreal, and Geo. C. Clarke, M.E.I.C., Fraser-Brace Engineering Company, Montreal.

6.45 p.m. *Annual Dinner of The Institute, the President in the chair.* Members and ladies present will be addressed by Dr. W. Hamilton Fyfe, Principal of Queen's University.

9.30 p.m. *Reception and Dance*

Friday, February 5th

9.30 a.m. *Professional Session.*
The morning will be devoted to the consideration and discussion of matters pertaining to Railway-Highway Transportation. Dr. W. W. Colpitts, M.E.I.C., of Coverdale and Colpitts, New York, will be Chairman.
The subject will be introduced by Mr. S. W. Fairweather, Director, Bureau of Economics, Canadian National Railways, Montreal, whose paper will be: "The Influence of the Motor Vehicle on Modern Transportation." He will be followed by R. M. Smith, A.M.E.I.C., Deputy Minister of Highways, Ontario, W. A. McLean, M.E.I.C., of Wynne-Roberts, Son & McLean, Consulting Engineers, Toronto, and other prominent speakers, who will present papers dealing with other phases of Railway-Highway Transportation.

12.45 p.m. *Buffet Lunch* (informal).

2.15 p.m. *Arrangements have been made for visits to a number of engineering works of interest in and near Toronto, including the following:*
Toronto-Leaside Transformer Station, 220,000 volts, Leaside,
North Toronto Sewage Disposal Plant, Leaside,
Dominion Motors Corporation (Durant Chrysler), Leaside,
Canada Wire and Cable Co. Ltd., Leaside,
Maple Leaf Gardens,
Bell Telephone, Adelaide-Elgin Local and Long Distance (including trans-Canada) exchange,
Central Heating Plant, Toronto Terminals Railway,
Canadian Bank of Commerce, Head Office Building,
Star Building,
Waterworks Tunnel and High-level Reservoir,
Trips to various bridges in vicinity of Toronto,
Toronto Transportation Commission Shops.

Wednesday, February 3rd, and Thursday, February 4th

A special Ladies Committee has been appointed to arrange for the entertainment of visiting ladies, and drives and visits to points of interest have been arranged for these days. (See Ladies Programme.)

Friday evening will be left free, to permit members to visit friends or fulfil other engagements.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XV JANUARY 1932 No. 1

The Future of The Institute

During the forty-five years of the existence of The Institute there have been several occasions on which important changes in its constitution, policy and methods have been made, which have enabled it to keep pace with changing conditions, and to enter on wider fields of usefulness. In the opinion of many of its members a time has again arrived when it is desirable to review the situation. The Institute, like other organizations of its kind, cannot stand still, and for many reasons it is now of special importance that its destinies be guided along the right lines. With this end in view Council recently appointed a Committee on Development, under the chairmanship of J. L. Busfield, M.E.I.C., and entrusted to that committee the duty of reviewing the constitution and aims of The Institute in the light of conditions as they now exist, and making recommendations as to such changes in our organization as may seem advisable. The inclusion of nine of our past-presidents in its membership secures the benefit of their long experience of Institute affairs, and the matured judgment of such senior members. Before preparing its final report the Committee will take steps to obtain expressions of opinion from the branches, as well as from such individual members as desire to offer their views. The findings of a committee of this kind, however, to be effective, must be based on mature consideration, and time is needed for this, so that its report is not likely to be available until the fall of 1932.

During the past ten years the conditions under which engineering work is done in Canada have changed materially. A smaller proportion of our members are now engaged in consulting work on their own account; a larger proportion are in the employ of large organizations; many are engaged on highly specialized work, or in work which is rather industrial than professional in its nature, and it is becoming more and more difficult to decide to what extent the technical experience of a member has involved professional responsibility as required by the present by-laws.

During this time there has also been a marked and very satisfactory development of the organization and activities of the various Provincial Associations of Professional Engineers. These bodies, almost without exception, are now operating under provincial enactments which give them a measure of real power. They are well established, and with increasing effect are performing their legitimate function of regulating and defining the professional status of their members. The relationship of these legally constituted provincial bodies, in which membership is, or should be, compulsory for professional engineers, to The Institute, a Dominion-wide technical organization in which membership is voluntary, is a difficult problem. The principal aim of The Institute is educational, and our efforts are complementary to those of the associations, but along somewhat broader lines. It is most encouraging to note that in 1931 the Professional Associations took the initial steps towards co-ordinating their acitivities and unifying their requirements, an event which has made it more than ever necessary for The Institute to have a definite plan along which the advance of the next few years may be directed.

The above are only a few of the important problems confronting the newly established Committee on Development. One of its first tasks must necessarily be a review of the objects of The Institute as set forth in Section 1 of our By-laws. These took their present form as a result of the report of the Committee on Policy issued in 1922, and it will be proper to inquire whether, as they now stand, they express adequately the aims which The Institute should have under conditions existing to-day.

There are many points in connection with the organization and management of The Institute which will demand attention, particularly the methods now prescribed for the election of officers, our annual fees, the grades or classes of membership and the qualifications required for these, and the functioning of the decentralized organization of The Institute. There is a real difficulty, especially in hard times, in the case of members who have to pay two fees, one to the Professional Association, and another to The Engineering Institute of Canada. Circumstances of this kind must be considered in relation to the financial structure of The Institute, and the way in which branch activities are financed by rebates from Headquarters.

The maintenance and growth of membership is a vital matter for all technical societies, and presents special problems in the case of an organization like The Institute, whose activities extend over so great an area, whose members are so widely scattered, many living far from the main centres of population, and whose membership embraces all branches of the profession.

Among other points which will be touched by the work of the Committee on Development, may be mentioned The Institute's policy as regards its publications, the encouragement of our members to contribute accounts of their work and professional activity to The Institute's proceedings, the work of our Employment Service Bureau and Information Service, and the extent to which Headquarters can assist in the maintenance and development of branch activities.

The committee realizes the magnitude and importance of the task before it, and will welcome the assistance of the membership, either in contributing suggestions, information, or expressions of opinion.

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, December 15th, 1931, at eight o'clock p.m., with Vice-President W. G. Mitchell, M.E.I.C., in the chair, and five other members of Council present.

A letter was read from the Secretary of the Toronto Branch drawing Council's attention to the action of the city of Oshawa in calling for tenders for the design of sewage disposal works on a competitive basis.

From the advertisements it was noted that engineers are asked to compete in the preparation of designs and specifications for a work of considerable magnitude, associating themselves with contractors in submitting tenders based on their designs, and that no provision is made for their remuneration, or for an independent judgment on the scheme submitted, nor does the city undertake to employ the engineer whose scheme is adjudged the best.

After considerable discussion it was decided that a letter should be addressed to the city of Oshawa pointing out the objectionable features of this method of obtaining engineering services, and that the members of The Institute be advised that in the opinion of Council they should refrain from taking part in any competition carried out under such conditions.

A report was presented from the committee on possible affiliation of the Military Engineers' Association of Canada with The Institute, and it was decided that the case would be met by the formation, under Section 52 of the By-laws, of Military Engineering Sections of The Institute at points where there are a sufficient number of engineer officers.

A letter was presented from the Secretary of the Canadian Engineering Standards Association advising that that Association had received a request from the Royal Architectural Institute of Canada to consider standards covering building materials, and that it is proposed to call a conference in the near future to consider this question. The Institute was asked to appoint two representatives to attend such a conference, which would probably be held in Toronto. It was unanimously resolved that Colonel C. S. L. Hertzberg, M.E.I.C., and W. B. Dunbar, A.M.E.I.C., be appointed to represent The Institute at the proposed conference.

The attention of Council was drawn to a pamphlet containing information on the amount of foreign building and construction materials used in Canada, received through the courtesy of the Royal Architectural Institute of Canada. The desirability of engineers specifying the use of materials made in Canada wherever possible was discussed, and the Secretary was directed to send a copy of the pamphlet to all members of Council, and to give it such publicity as might be possible among the membership.

Sixteen resignations were accepted, three reinstatements were effected, one Life Membership was granted, and a number of special cases were dealt with.

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

Elections		*Transfers*	
Members	1	Student to Assoc. Member	2
Associate Members	2	Student to Junior	3
Juniors	1		
Affiliates	1		
Students admitted	16		

The Council rose at ten forty-five p.m.

OBITUARIES

Robert Jack Anderson, A.M.E.I.C.

Members will learn with regret of the death of Robert Jack Anderson, A.M.E.I.C., which occurred at his home at St. Lambert, Que., on November 21st, 1931.

Mr. Anderson was born at Glasgow, Scotland, on April 24th, 1887, and was educated at Allan Glen's Technical School, and the Royal Technical College, Glasgow, and later was an apprentice with Sir Wm. Arrol and Company Ltd., bridge engineers, Glasgow.

Mr. Anderson remained with Sir Wm. Arrol and Company Ltd., until March, 1913, being successively draughtsman, structural designer, and assistant engineer. Coming to Canada, in 1913, Mr. Anderson joined the staff of the Dominion Bridge Company as draughtsman, and from August of the same year until August, 1915, was engineer in charge of bridge inspection and survey party with the Canadian National Railways. During the War Mr. Anderson enlisted with the Canadian contingent, later being transferred first to the Royal Engineers and then to the Royal Air Force in which he became a staff captain. Returning to Canada in 1919 he returned to the service of the Canadian National Railways, which connection he retained until 1929 when he joined the staff of the Peter Lyall Construction Company as engineer.

Mr. Anderson joined The Institute as an Associate Member on May 26th, 1920.

Robert Montgomerie, A.M.E.I.C.

Regret is expressed in recording the death of Robert Montgomerie, A.M.E.I.C., which occurred in Glasgow in October, 1931.

Mr. Montgomerie was born at Beith, Ayrshire, Scotland, on May 1st, 1872, and was educated at Ayr Academy and the Great West of Scotland Technical College. From 1899 to 1894 he was a pupil with Messrs. Niven and Haddin, Glasgow.

From 1894 to 1898 Mr. Montgomerie was assistant engineer with Messrs. Niven and Haddin, and from 1898 to 1903 was assistant engineer in charge of construction of thirty-three miles of new railway line in Bengal, India. In 1903 Mr. Montgomerie came to Canada, and became connected with the Canadian Pacific Railway Company, with which service he remained for a number of years. In 1919 he was with the Canadian National Railways at New Glasgow, N.S. In 1920 Mr. Montgomerie returned to Glasgow, Scotland, where he joined the firm of Montgomerie Stobo Company.

Mr. Montgomerie joined The Institute (then the Canadian Society of Civil Engineers) on May 14th, 1909.

Dean Thomas Welsh, A.M.E.I.C.

It is with much regret that the untimely death of Dean Thomas Welsh, A.M.E.I.C. which occurred at Hamilton, Ont., on October 29th, 1931, is recorded.

Mr. Welsh was born at Port Colborne, Ont., on September 26th, 1900, and graduated from the University of Toronto in 1924 with the degree of B.A.Sc.

From May, 1924, to June, 1926, Mr. Welsh was instrumentman and draughtsman on pavement surveys and construction for the city engineer's department of Hamilton, Ont., and until November, 1926, was assistant engineer in the Thunder Bay District for the Department of Northern Development. In 1926 Mr. Welsh was assistant to the chief of party on Fort Frances-Kenora location survey, and in 1927-1928 was assistant engineer on a relocation survey, Ferguson highway; from March to August, 1928, he was resident engineer on the Ferguson highway (Falkenbury-Huntsville division) and in August, 1928, became resident engineer in charge of construction of Driftwood-Smooth Rock Falls road, all for the Department of Northern Development, with which department Mr. Welsh was connected at the time of his death.

Mr. Welsh joined The Institute as a Student on November 22nd, 1920, and was transferred to Associate Membership on November 16th, 1928.

PERSONALS

L. G. McNeice, A.M.E.I.C., is now engineer with the Orillia Water, Light and Power Commission, Orillia, Ont. Mr. McNeice was at one time town engineer, Manager and Treasurer of Wallaceburg, Ont., and more recently was manager of the Wallaceburg Hydro-Electric System.

J. Norman Smith, M.E.I.C., who has been in private practice as a consulting engineer in Toronto, is now connected with R. A. Ross and Company, Montreal. Mr. Smith was at one time electrical engineer with the Toronto Power Company, and was also attached to the Toronto Railway Company for a time.

C. E. Nix, S.E.I.C., of the Shawinigan Water and Power Company has been transferred from La Tuque, Que., to the Rapide Blanc project of the company, where he will be in charge of the survey of the flood contour and clearing inspection. He will be located at Flammand, Que. Mr. Nix graduated from the University of Alberta in 1931 with the degree of B.Sc.

Charles Valiquette, Jr.E.I.C., formerly with the Quebec Highways Department, is now proprietor and manager of the Provincial Construction, general contractors and specialists in road construction, Outremont, Que. Mr. Valiquette was for four years with Imperial Oil Limited as road engineer and assistant to the manager of the Fuel Oils Department for the Quebec Division. He graduated from the University of Montreal in 1925 with the degree of B.A.Sc.

T. S. Glover, A.M.E.I.C., is now on the staff of the Hamilton Advertisers Agency, specializing on the advertising of industrial and engineering concerns. Mr. Glover is a graduate of the University of Toronto, from which he received the degree of B.A.Sc. in 1922. Following graduation he was engaged with Messrs. Fraser Brace, Limited, as assistant engineer on the water power development at Humber Arm, Newfoundland, following which he occupied the Colonial Office appointment of assistant engineer in the Department of Public Works in Nigeria. Mr. Glover returned from Nigeria in 1927, and in 1928 accepted the position of assistant sales manager with Sawyer-Massey Limited, at Hamilton, Ont.

New Manitoba Power Commission

Of the three members who form the hydro-electric power commission recently appointed by the Manitoba government, two are members of The Institute.

D. L. McLean, A.M.E.I.C., who in addition to being chairman of the new commission, also acts as general manager of the city of Winnipeg Hydro-Electric System, graduated from McGill University in 1909 with the degree of B.Sc. Following graduation he became assistant to J. B. McRae, M.E.I.C., consulting engineer, Ottawa, and later was assistant chief engineer for the International Commission. He was then appointed chief engineer in connection with the water power surveys of the Winnipeg rivers being carried on by the Dominion Water Power Branch, Department of the Interior. Later Mr. McLean became chief engineer of the Manitoba Drainage Commission, and in 1922 was appointed deputy minister of public works for the province of Manitoba. In 1929 he was made Manitoba Power Commissioner. Mr. McLean has taken a prominent and active part in the affairs of the Winnipeg Branch of The Institute and represented it on the Council in 1926 and 1927.

D. L. McLEAN, A.M.E.I.C.

J. L. Sanger, A.M.E.I.C., the second member of The Institute on the commission, was educated at Faraday House, London, England, and before coming to this country in 1911, was superintendent of distribution for the Midland Electric Power Company. Since 1911 he has been connected almost entirely with the city of Winnipeg Hydro-Electric System, having held the following offices: superintendent of distribution, power house superintendent and chief engineer, which last position he has held for the past eight years.

A. C. Tagge, M.E.I.C., Honoured

A. C. Tagge, M.E.I.C., for many years president of the Canada Cement Company and well known in cement manufacturing circles throughout Canada and the United States, was elected an honorary member of the Portland Cement Association, during the Association's twenty-ninth annual meeting which was held recently.

Mr. Tagge was born at Ann Arbor, Mich., in 1870, and received his early education in the public schools of Ann Arbor and his technical education at the University of Michigan, graduating from the latter institution in 1897 with the degree of B.Sc. In 1898 Mr. Tagge was with the Link-Belt Machinery Company at Chicago, and two years later was employed by the Osborne Engineering Company, Cleveland, Ohio. In 1901 he was appointed erecting engineer and superintendent of the Peninsular Portland Cement Company, resigning that position in 1902 to come to Canada as engineer with the International Portland Cement Company at Ottawa. Mr. Tagge remained with this company until 1905 when he occupied a similar position with the Western Canada Cement and Coal Company. Two years later he returned to Ottawa as engineer and superintendent of the International Portland Cement Company, and in 1909 accepted the position of general superintendent with the Canada Cement Company. He occupied this position until 1917, when he was made assistant general manager of the company. In 1927 Mr. Tagge became president of the company, holding that office until 1931 when he retired. He is, however, still a member of the board of directors of the company.

Beaudry Leman, A.M.E.I.C., general manager of the Banque Canadienne Nationale, is a member of the Royal Commission appointed to enquire into the Canadian railway situation. Mr. Leman, who is a graduate of the University of Lille and of McGill University, commenced his engineering career in the employ of the Shawinigan Water and Power Company, devoting six years to the development of hydro-electric enterprise. In 1906 he took an active part in the establishment and construction of the railway which connects the city of Three Rivers with the towns of Shawinigan Falls and Grand'Mere. During his professional career, Mr. Leman identified himself with hydro-electric developments in the province of Quebec. For some years he represented a group of Belgian and French banks interested in Canadian enterprises, and in 1912 entered the service of the Banque d'Hochelaga, rising rapidly to the important position which he now holds with the Banque Canadienne Nationale. Mr. Leman is president of the Canadian Bankers' Association, and a director of the Shawinigan Water and Power Company, the Montreal Tramways Commission and the Provincial Transport Company Ltd., and has acted as a member of the Electric Service Commission of Montreal and of the National Advisory Committee on the St. Lawrence Waterways project.

CORRESPONDENCE

The Editor,
Engineering Journal,
2050 Mansfield Street,
Montreal.

Sir,

I have read with great interest the address given before the Hamilton Branch of The Institute, by E. P. Muntz, M.E.I.C., as published in the December issue of The Journal, and I sincerely hope that every member of The Institute will take the opportunity of reading this address and furthermore will take to heart the lessons contained therein.

Mr. Muntz draws a very interesting parallel between The Institute and the railways, both having to contend with a new form of competition. In both cases the ultimate objective of new and old organizations comes to the same point. Railways and motor vehicles compete with each other for transportation, but in many instances the two are complementary. Similarly The Institute and the Associations compete with each other for the welfare of the engineer, but in many regards the work of the organizations must also be complementary.

In view of the fact that membership in the Associations is more or less compulsory for many engineers, giving these bodies an advantage over The Institute with its purely voluntary membership, the thought arises as to whether all the functions of both organizations could be better undertaken by the professional associations, especially if they are able to carry out their plan of co-ordination through a central Dominion wide body. Even if such a co-ordinated body existed today—I would suggest that its primary function being the regulation of the right to practise, its activities and organization must be of a different type from the activities and organization of The Engineering Institute whose primary object is the acquirement and interchange of professional knowledge. This largely comes about because obviously there are hundreds, if not thousands, of engineers in Canada today who do not come under the requirements of the professional associations (and this condition will undoubtedly always obtain), but who nevertheless, are men with whom the interchange of professional knowledge can take place with benefit to all parties concerned. This very situation should be sufficient warrant for the maintenance of The Engineering Institute of Canada as a separate entity, with its own definite and well defined functions. There are many other excellent reasons upon which I will not dwell for fear of occupying too much space.

The foregoing conclusion is based on the assumption of the co-ordination of the professional associations, but as this has not yet taken place, and may take years to accomplish—or might never be accomplished—*it becomes all the more necessary for The Institute to put its house in order and develop itself in the strongest possible manner for the benefit of the profession it serves.* From one other viewpoint, I would say that in my opinion, the ultimate objective of both forms of association, namely the welfare of The Institute, is reached by entirely separate roads which undoubtedly will converge to some common meeting point as the objective is approached, and, of course, there will be a number of secondary cross roads interconnecting the two main highways.

Mr. Muntz has made reference to a committee working on The Institute's problems, and expressed the hope that this committee will bring in its report at the Annual Meeting. He refers, of course, to the Committee on Development, of which I have the honour (onus might be a more suitable expression) of being chairman, but I am very much afraid that any report except perhaps a very skimpy progress report will be impossible for the Annual Meeting. It is only a month ago that the personnel of this committee was approved by Council, and before it can bring in its final recommendations it will have to review most thoroughly all the activities and functions of The Institute, study the relationship between The Institute and the Associations, and indeed other societies as well. It will have to give opportunity to every branch and to every member to express views on the development of The Institute. With the amount of work involved and the desire of the committee to produce recommendations of a really worthwhile nature which may indeed be somewhat revolutionary in their terms, involving major changes in the organization, it will only be possible to produce a report in time for the Plenary meeting of Council next fall, which would mean that it would be placed before the membership at the Annual Meeting in 1933.

As a starting point in the work of the committee consideration has been given as to whether the "objects" cited in Section 1 of the By-laws are expressed in the best possible terms, and if they are really representative of what The Institute of the future hopes to accomplish, and it has been felt desirable to give prominence to the acquirement and interchange of professional knowledge as being the first and foremost objective of The Institute, and this will be used as the foundation upon which to build the structure of the future.

Yours very truly,
J. L. BUSFIELD, M.E.I.C.,
Chairman, Committee on Development.

Capital and Labour in Germany

In the course of a statement on "the present serious economic position" of the country, submitted to the Federal Chancellor by the principal German employers' organizations, including the Federation of Employers' Associations and the Federation of Industry, it is declared that the existing distress is due partly to the arbitrary intervention of foreign countries, the disastrous results of which have been aggravated by the world depression, and partly to the endless legislation limiting the freedom of action of private industry and ruining its productive capacity. German political authorities, it is contended, must learn that there can be no compromise between the capitalist and the socialist economic systems. They must decide definitely, publicly and unreservedly for the one method or for the other. It seems to the signatories indisputable that if such a decision is made in full realization of the responsibilities involved, it cannot be otherwise than in favour of the individualist system, which has proved its vitality and its productive power, while all attempts at collective organization have ended in failure.

A reply to the employers' statement has been issued on behalf of all the German trade unions. In it, it is claimed that the events of September showed as never before the collapse of a large part of the economic structure and the necessity for a systematic intervention by the state in national economy. The attempt to ascribe the tremendous economic distress to intervention of the state and to German social and wage policies cannot, it is declared, be upheld. In reality (the statement continues), the causes of the German economic distress are to be found in the general effects of the present economic system throughout the world, in international political disturbances, and in the lack of confidence among the nations. These would be intensified by any policy of exaggerated protection, bounties, super-rationalization, misdirected capital investment, and any systematic reduction of purchasing power. Reductions of wages and salaries, and also retrenchment of measures of social policy, have been brought about during the past eighteen months with the object of finding a way out of the existing depression. The result has been a tremendous increase of the general distress. Every step further in this direction leads to a still lower depth of misery. The policy of narrow interests pursued by the employers' organizations cannot result in the conquest of the depression.—*Engineering.*

Light-Weight Battleship Engines

Some authentic details are now available concerning the machinery installation of the German "pocket battleship" *Deutschland*, which is equipped with eight double-acting two-stroke M.A.N. Diesel engines, each of 7,000 b.h.p., their normal service power being about 6,250 b.h.p. Each engine has nine cylinders of 420 mm. bore with a piston stroke of 580 mm., and develops the maximum power mentioned at 450 r.p.m. Each set of four units drives one propeller shaft through a Vulcan hydraulic coupling and reduction gear, the propeller rotating at 250 r.p.m. There are thus only two propellers, although eight engines are installed. The weight of the engines, excluding the propellers and auxiliary plant, is 8 kg. per b.h.p. (at the higher rating), and the scavenging air is supplied from four double-acting two-stroke Diesel engines each driving a rotary blower. While these engines run at 425 r.p.m. the blowers are driven through gearing at over 3,000 r.p.m. The fuel consumption is 0.34 pound per b.h.p. hour, or about 0.38 pound per b.h.p. hour including the power needed to drive the scavenging blowers. All the engines have now been completed, and are being installed in the ship, which will probably go on trials at the end of 1932.—*Times Trade and Engineering Supplement.*

Construction Materials Produced in Canada

Information which should be in the hands of all those responsible for the purchase of material and equipment in the building and construction industries is contained in a pamphlet which has just been issued by the Royal Architectural Institute of Canada, drawing attention to the very large sums annually spent outside of Canada, and particularly in the United States, on the purchase of material and equipment which is manufactured or produced in Canada, and for which there is really no necessity to go outside our own borders. This matter has recently been investigated by Mr. Norman Holland, Chairman of the Industrial Commission on Unemployment, Montreal. While the information in the pamphlet, which has been furnished by him and by the Dominion Bureau of Statistics, Ottawa, was actually prepared for the information of architects, the subject is also of interest to engineers. It seems evident from the figures that there are some Canadian engineers who do not take the trouble to acquaint themselves with what is now produced in Canada or who allow their judgment to be overwhelmed by the mere weight of advertising.

The United States is, of course, the principal source of the products in question, and it is noteworthy that most of the money we pay to that country is for goods shipped to us in the manufactured form, whereas a great part of their expenditure in Canada is for raw material, much of which is then sent back to us in the finished state. It is roughly estimated that every dollar spent on a finished article represents fifty cents worth of labour; thus, if we buy a million dollars of manufactured articles from a foreign source we prevent our own workmen from earning half a million dollars in wages. In any case when goods must be bought outside our own country, Canadians should bear in mind that Great Britain is one of the best customers we have. She buys from us twice as much as we buy from her, which is just the reverse of the situation with regard to the United States.

The figures in the following table (taken from the pamphlet) will be a surprise to many who do not yet realize the amount of money spent by Canadians in the United States for construction materials alone:

Canadian Imports of Building Materials from the U.S.A.

Abstract of a return by The Dominion Bureau of Statistics, Exterior Trade Branch.

	Year ending March 31 1929	Year ending March 31 1930	Year ending March 31 1931
Brick and Tile, Various	$2,599,644	$3,486,077	$2,368,052
Cement, Lime and Plaster	420,450	436,570	376,974
Glass	518,883	319,519	278,029
Iron, Structural	10,438,170	12,628,132	5,083,665
Iron Piping	2,320,398	3,527,286	1,845,735
Nails	30,346	72,843	23,208
Lumber	10,185,641	9,068,068	4,491,008
Wood Doors and Millwork	736,079	739,564	471,570
Paints and Varnishes	4,037,839	4,133,966	2,942,588
Stone, Marble and Slate	1,017,041	1,366,221	965,225
Insulation	326,279	434,256	332,941
Hinges and Butts	200,840	173,465	115,729
Sanitary Fixtures	449,514	513,183	427,180
Electric Fixtures and Appliances	4,265,599	5,454,035	3,686,608
Refrigerators	1,319,011	1,913,555	2,377,573
Hardware	1,196,439	1,341,325	817,369
Other Appliances	754,557	791,846	341,983
Yearly Totals	$40,816,730	$46,399,911	$26,945,437

Note:—These returns show at a glance the relative diminution of Canadian building activity in recent years and the gigantic amount (largely unnecessary) of material and equipment obtained from the U.S.A.

It will be noted that many items mentioned in this table apply to engineering as well as architectural construction, this being particularly the case in regard to structural and reinforcing steel, culverts, wrought iron pipe, valves and fittings, ventilating and heating equipment, electric equipment and fittings, telephones, and insulating materials for heat and sound.

The Royal Architectural Institute is to be congratulated on the constructive action they have taken, and in communicating with its members regarding this matter, the president of that body has made an important suggestion which in the opinion of the Council of The Engineering Institute of Canada is equally applicable to our own membership, with the substitution of the word "Engineer" for "Architect." It is that wherever possible there be incorporated in specifications the following clause, or its equivalent:

"The contrator shall purchase and use in the carrying out of works covered herein, materials, supplies, tools and implements manufactured in Canada, unless otherwise definitely specified, provided that the same be of suitable quality and be obtainable in Canada on terms and conditions as favourable as elsewhere, of which the Architect shall be the sole judge; and the contractor shall not purchase any materials, supplies, tools or implements for the carrying out of the said works, other than those produced in Canada, without the previous consent, in writing, of the Architect."

More detailed information on this subject is contained in the pamphlet above referred to, copies of which can be obtained, on request, from Headquarters.

ELECTIONS AND TRANSFERS

At the meeting of Council held on December 15th, 1931, the following elections and transfers were effected:

Member

LANG, Eugene C., B.Sc., (Armour Inst. Tech.), asst. to executive vice-president and chief engr., Utilities Power and Light Corporation, Chicago, Ill.

Associate Members

EASTWOOD, Donald Ross, B.A.Sc., (Univ. of Toronto), Beauharnois, Que.

MITCHESON, Septimus, designing dftsman., United Engineers and Constructors (Canada), Limited, Montreal, Que.

Junior

FOULIS, Allan Dodge, B.Sc., (N.S. Tech. Coll.), mgr., scale dept., Canadian Fairbanks Morse Ltd., Saint John, N.B.

Affiliate

PINKERTON, Wallace A., B.Sc., (Queen's Univ.), instructor, Institute of Technology and Art, Calgary, Alta.

Transferred from the class of Junior to that of Associate Member

LEGGET, Robert Ferguson, B.Eng., M.Eng., (Univ. of Liverpool), res. engr., constrn. divn., Power Corporation of Canada Ltd., Montreal, Que.

SCOTT, William Orville Craig, B.A.Sc., M.A.Sc., (Univ. of B.C.), inspecting engr., Greater Vancouver Water District, Vancouver, B.C.

Transferred from the class of Student to that of Junior

CRUMP, Norris Roy, B.Sc., (Purdue Univ.), shop foreman, C.P.R., Lethbridge, Alta.

LANG, John Taylor, B.Sc., (N.S. Tech. Coll.), asst. engr., N.S. Advisory Board of Fuel Investigation, Halifax, N.S.

NEILSON, Charles Shibley, B.Sc., (Queen's Univ.), designing, detailing, checking struct'l. steel, Canadian Bridge Company, Ltd., Walkerville, Ont.

Students Admitted

ARCHIBALD, Manning Clifford, B.Sc., (Dalhousie Univ.), 207 South Park Street, Halifax, N.S.

BALDRY, George Simpson, (Univ. of Man), 810 Wolseley Ave., Winnipeg, Man.

BRADDELL, Eberhart Sylvester Patrick, (Univ. of Man.), Ste. 14, Miller Apts., 524 Sargent Ave., Winnipeg, Man.

HOUGHTON, Thomas Walter, (McGill Univ.), 730 Upper Belmont Ave., Westmount, Que.

LADNER, Frank Ellis, (Univ. of B.C.), 3926 Kingsway, New Westminster, B.C.

LOCHHEAD, Kenneth Young, (McGill Univ.), 42-10th Ave., Lachine, Que.

MOORE, George Albert, (McGill Univ.), 61 McGee Ave., Westboro, Ont.

McLEAN, Gordon Mitchell, (N.S. Tech. Coll.), Nova Scotia Technical College, Halifax, N.S.

SCHOFIELD, William, (McGill Univ.), 5333 Hutchison St., Montreal, Que.

PAMENTER, Archibald Francis, (N.S. Tech. Coll.), 71 Jubilee Rd., Halifax, N.S.

PARSONS, Ezra Churchill, B.Sc., (Acadia Univ.), Nova Scotia Technical College, Halifax, N.S.

SCHNELLER, Armin Geoffrey Ewald, (Univ. of Sask.), 1710 Victoria Ave., Saskatoon, Sask.

SHAYLER, Stanley Vickers, (Univ. of B.C.), 2441-21st Ave. E., Vancouver, B.C.

SINCLAIR, George Melvin, (Univ. of B.C.), Salmon Arm, B.C.

VERNER, Edwin A., (Univ. of B.C.), Burnaby Lake, B.C.
*VILLEMURE, J. Phileas, dftsman., City of Grand Mere, Grand Mere, Que.
WILLIS, Clarence H., (Univ. of B.C.), 2812-12th West, Vancouver, B.C.

*Has passed Institute's examinations under Schedule "A."

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Junior Institution of Engineers: List of Members, October, 1931.
National Council of State Boards of Engineering Examiners: Proceedings, Twelfth Annual Convention, October 1-3, 1931.
Institution of Engineers and Shipbuilders in Scotland: Transactions, Vol. 75, Part 1, November, 1931.
The Royal Society of Canada: Transactions, Third Series, Vol. 25, Section 5, May, 1931.
North-East Coast Institution of Engineers and Shipbuilders (Inc.): Transactions, Vol. 47, 1930-31.
The Institution of Civil Engineers: Minutes of Proceedings, Vol. 231, Part 1, 1931.

Reports, etc.

Bureau of Statistics, Transportation Branch, Canada:
Preliminary Report on Statistics of Steam Railways in Canada, 1930.

Dept. of Marine, Hydrographic Service, Canada:
Tide Tables for the Atlantic Coast of Canada for the year 1932.

Dept. of Mines, Geological Survey, Canada:
Memoir 165: Studies of Geophysical Methods, 1928 and 1929.

Dept. of Mines, Mines Branch, Canada:
Chrysolite Asbestos in Canada.

Bureau of Mines, United States:
Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1930.
Mercury in 1930.
Graphite in 1930.
Silica in 1930.
Gold and Silver in 1929.
Coke and By-Products in 1929.
Bulletin 337: Jigging, Classification, Tabling and Flotation Tests of Coals Presenting Difficult Washing Problems.

Bureau of Standards, United States:
Misc. Pub'n. No. 131: Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1931.

Governor of the Panama Canal:
Annual Report, 1931.

National Electric Light Association:
Water Heating Committee, Commercial National Section: Electric Water Heating.
Industrial Heating Committee, Commercial National Section: Steel Strip and Sheet Annealing in the Electric Furnace and Atmosphere Control.
Electrical Apparatus Committee, Engineering National Section: Outdoor Substation Design.
Farm Equipment Committee, Commercial National Section: Plans for Selling Farm Equipment Which are Proving Successful.
General National Committee: Report of the Educational Committee, 1931.

Ohio State University, Engineering Experiment Station:
Bulletin No. 60: Strength of Concrete Block Plasters Under Varied Eccentric Loading.
63: Ohio Coal Investigation. Part 1: An Economic Study of the Use of Hocking Valley Coal with Underfeed Stoker Equipment.
64: Relative Heat Transfer Through Refractories.

University of California:
Bulletin of the Dept. of Geological Sciences: Borophagus Littoralis from the Marine Tertiary of California.

Technical Books, etc.

Presented by C. J. Tagliabue Manufacturing Company:
Tag Manual for Inspectors of Petroleum, 20th rev. ed. [1927].

Presented by The Asphalt Institute:
Asphalt Road Construction Series: Manual No. 1: Road-Mix Types.

Presented by Morton C. Tuttle Company:
The Choice of a Building Contract, by Morton C. Tuttle.

Purchased:
Fluid Meters, Part 2: Description of Meters. Published by the American Society of Mechanical Engineers, Special Research Committee on Fluid Meters.

Catalogues.

C. L. Berger & Sons, Inc.:
Manual of Berger Instruments of Precision for Engineers, Surveyors, [and] Astronomers, [350 pp.].

The Herbert Morris Crane & Hoist Company, Ltd.:
General Catalogue, Book No. 30. [234 pp.].

United States Steel Products Company:
Carnegie Steel Company—Steel Sheet Piling. [92 pp.].

Priestman Brothers, Ltd.:
Priestman [Excavator Catalogue]. [20 pp.].

International Nickel Company, Inc.:
Gears Made of Armor Plate [7 pp.].

Monarch Machine Tool Company:
Monarch-Keller Form Turning Machine [24 pp.].

National Fire Proofing Company of Canada, Ltd.:
"Report of Test of Natcoflor Panel," and, "The Theory and Design of Natcoflor," [13 pp.].

Hamilton Gear & Machine Co. Ltd.:
Roldweld Welded Steel Gears [2 pp.].

BOOK REVIEWS

Applied Kinematics

By J. Harland Billings. Van Nostrand, New York, 1931, cloth, 6 x 9 in., 173 pp., figs., $2.50.

Reviewed by Prof. N. M. Hall, M.E.I.C.*

This volume by Professor Billings of The Drexel Institute, Philadelphia, appears in its first edition, and covers a course in kinematics of machines of the kind which is now generally accepted as adequate for sophomore engineering classes, as an introduction to subsequent advanced work and also to dynamics of machines and machine design.

As the author states, it has been compiled from lecture notes developed during eight years of teaching of the subject.

The chapter headings are very similar to those of several other books that have recently appeared under the same title, and include amongst others: Theory of Mechanisms; Relative Velocities and Accelerations in Machine Parts; Cams; Gearing and Flexible Drives; the treatment of several specific and more complex mechanisms; and finally a series of drafting room problems.

The text is concise and clearly written, and a wide use is made of graphical methods. Many drawings and graphical solutions are used, but included also are numerous photographs of sectionalized cuts, and of actual machine parts and complete machines, with which the second year student will be already acquainted. These include the automobile, aeroplane engine, steam locomotive, the more common machine tools, the domestic refrigerating machine, and the like.

The list has been admirably chosen for arousing the attention and interest of students who are in the transition stage between the more abstract part of their engineering course and that part which has direct application to actual engineering problems.

Conventional methods and proofs are used; and reference is also made, for example, to the phorograph; and credit has been given to Professor Rosebrugh of the University of Toronto who devised it.

To instructors who are looking for such a book, this volume is commended for their examination.

*Professor of Mechanical Engineering, Dept. of Engineering, University of Manitoba, Winnipeg, Man.

The Choice of a Building Contract

By Morton C. Tuttle. Morton C. Tuttle Company, Boston, 1931, board, 6¼ x 9½ in., 46 pp., $1.00.

Reviewed by G. L. E. Price*

The purpose of this book is to answer the question, "If I sign a building contract of this type what is likely to happen to me?" The comparison of the different types of building and engineering contracts, and the study of their practical application is not only interesting in itself but is of great importance, whether from the viewpoint of the owner, the engineer or the contractor. The reviewer has often thought that it would be a great boon to owners, architects, engineers and contractors alike if someone with the necessary unbiassed knowledge would write a book like that of Mr. Tuttle. The task has now been accomplished, and the subject has been treated in a clear, concise and masterly manner. Mr. Tuttle's work reduces this so much debated subject to simple terms which present the case for and against each type of contract with the utmost fairness to all parties. The book is, in fact, a non-technical and frank discussion of the merits and demerits of the various forms of contracts commonly used in building and construction work, and can be strongly recommended for the guidance of those concerned in the promotion or direction of such operations.

*Vice-President, George A. Fuller Co. Limited, Montreal.

Experimental Mechanics of Materials

By H. Carrington. Pitman & Sons, London, 1930, cloth, 5 x 7½ in., 84 pp., figs., tables, $1.00.

Reviewed by Lieut.-Col. E. J. C. Schmidlin, M.E.I.C.*

Professor Carrington has written this little book as a laboratory manual for students taking the usual college course in primary strength of materials. As it is not intended that the book should be used in any sense as a text-book, it deals only with the purely mechanical side of laboratory work, no explanation or derivation of the formulae and expressions used being given, as a rule. The manual is an excellent example of its type, all the usual experiments in strength of materials being dealt with, and the instructions for each experiment being clearly and concisely given. The only weakness which is noticeable is that the apparatus and methods of one specific laboratory only are referred to (presumably that of the Manchester College of Technology). The book would be improved for general college use if the apparatus were described in more general terms, and the details of manipulation were left to the staff of the laboratory using the manual.

A feature which is worthy of note is the inclusion of a worked-out table of Brinell Hardness Numbers. These tables are not easily found, and are immense labour-savers if any extended series of hardness tests is being run.

It is to be regretted that the author has not also included a few standard specifications for the various materials of engineering. These can, of course, be obtained easily enough by the student, but it would be an undoubted advantage if they were included in the laboratory manual, where they would be readily available during actual laboratory attendances.

Professor Carrington's book, as will be obvious from the preceding paragraphs, is not designed for the graduate engineer, and will have little interest for the latter, unless he is a teacher. Standardized details of commercial testing technique are not dealt with.

*Senior Professor of Engineering, Royal Military College, Kingston, Ontario.

Economic Control of Quality of Manufactured Product

By W. A. Shewhart. Van Nostrand, New York, 1931, cloth, 6¼ x 9¼ in., 501 pp., figs., tables, $6.50.

Reviewed by C. D. Rutherford, F.I.A., F.A.S.*

In modern methods of manufacture the articles produced are continually being inspected, often at various stages in the process of manufacture and in any event when the process is completed. Where the quantities manufactured are large and the value of the product not great it may be necessary for economic reasons to examine samples only, and providing the sample itself fulfils certain standards the lot from which the sample is taken will be passed as satisfactory. Occasionally also where the product must be destroyed in the process of testing the method of inspection by sample may be applied to more expensive products.

The present book deals fundamentally with the means by which such samples can be measured so that the conclusions as to the lot from which the sample is taken may be as accurate as possible. The customary practice in the past has been to decide what percentage of defectives may be allowed in the sample without causing the rejection of the lot. The author shows that the percentage of defectives in the sample is not too reliable a guide to the percentage of defectives in the lot unless the size of the sample is increased to a point which is not always practical from an economic standpoint. He then proceeds to show what other statistical information can be obtained from the sample and how for practical purposes the tabulation of certain easily obtained statistics can be made a much surer and more accurate guide as to whether the standard of quality is being maintained.

The title is perhaps a little misleading, in that the author ventures no suggestions as to the point at which the cost of inspection makes it uneconomical. The whole object of the book is concerned rather with the methods of determining quality for economic purposes.

Many of the logical concepts in the work are extremely difficult to grasp, especially those concerned with the fact that the indefinite factor known as quality must in testing be associated with certain physical measurements that are more or less perfectly associated with what is really desired to be measured. Fortunately, while the underlying principles are of great importance, it is not necessary for the practical use of the results that all the implications of the argument should be fully grasped. It is dangerous at all times to use formulae in a blind and haphazard manner without knowledge of the underlying requirements, but given a reasonable grasp of the main argument of the book and a sound appreciation of the limitations to which the author has called attention, the statistical tests which are given should prove a valuable means of determining whether the manufacture of the articles being inspected is producing as high a quality as can be reasonably anticipated from the specifications or whether there is present some disturbing factor or faulty process which is affecting the general level of the quality.

*Assistant Actuary, Sun Life Assurance Company of Canada, Head Office, Montreal.

School Ventilation

Report of the New York Commission on Ventilation. New York, 1931, cloth, 5 x 7½ in., 73 pp., tables, $1.00.

Reviewed by E. A. Ryan, M.E.I.C.*

This little volume represents the final report outlining the conclusions and recommendations of the New York Commission on Ventilation. It summarizes to a large extent the previous findings of the Commission, which were published in 1923, and corroborates or corrects in some instances similar conclusions reported as a result of numerous experiments and observations made in various school buildings.

Following a brief outline of the history of ventilation and fundamental figures on design up to present day development, the report gives the results of the Commission's most recent findings in comparing the operating results of a large number of systems of different kinds installed in school buildings throughout the state of New York. A careful reader may gather from the report that it is prejudiced against mechanical ventilation and that its conclusions are based on somewhat weak foundations. Reference is made to elaborate and costly systems of ventilation which have been installed in a number of buildings and the statement is made on page 13 that of two hundred and four such systems in use in school buildings, only one hundred and four are in regular use. This seems strange, and the question may well be asked, why? Is it because they are not suited to the purpose, or is it, as is generally found to be the case, because those assigned to operate them are ignorant of the systems and equipment, and, therefore, incompetent and afraid to operate them. No reasons are advanced for this state of affairs, which is a condition that would not be tolerated in respect of other types of building equipment.

The general impression given by the report is that ventilation of school buildings by means of open windows is considered the equal of mechanical systems, if not the better means for school purposes. This presupposes close attention by a large number of individual teachers and leaves the control in their hands, as contrasted with a well defined method of operation which could be much more readily attained under central control with a mechanical system. The conclusions reached overlook the practical aspects of the situation in advocating open window gravity ventilation—the satisfactory results of which are dependent on so many variables difficult of control.

Reference is also made to initial and operating costs, but unfortunately comparisons have been made theoretically between mechanical systems and gravity systems in which the quantities dealt with are entirely different. Obviously for the same amounts of air handled the cost of heating must be alike, but it is well known that it is much more expensive in first cost of equipment to heat by means of a large number of small units than to instal equipment for heating in one central unit—the efficiency of which is very much greater.

A further recommendation of the report is that existing school ventilation laws be revised and that they permit of the adoption of gravity ventilation when in the opinion of a committee formed for the purpose this appears to be warranted. This is, of course, a radical step and may prove to be a retrogressive one unless strong measures are taken to ensure that it will not permit of abuse.

It is somewhat disappointing to note that the conclusions and recommendations of such an important Committee should be so indefinite. After eighteen years of work one would expect something less vague and more practical. It will be very interesting to see what comment on this book will be made by Societies of Heating and Ventilating Engineers, State Legislatures, School Boards, etc.

The book contains a list of the other publications of the Commission and a brief bibliography of the subject.

*Consulting Engineer, 1188 Phillips Place, Montreal.

De Laval Steam Turbine Company, Trenton, N.J., have recently issued Catalogue B-3, a 12-page booklet describing and illustrating the De Laval Balanced Single Suction Series Pumps. Heads higher than those practicable for a single stage centrifugal pump can be generated by connecting two or more independent single stage pumps in series, but while such an arrangement is generally used when relatively large capacities are required, the cross-connecting piping introduces additional frictional surface and involves extra space and cost. Copies of the new catalogue may be secured from the offices of the company at Trenton, N.J.

BRANCH NEWS

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., News Editor.

THE ST. LAWRENCE WATERWAYS

At a general meeting of the Calgary Branch of The Engineering Institute of Canada held at the Board of Trade rooms on Thursday evening, October 22nd, Mr. H. G. Nolan, M.A., Barrister of Calgary, gave a very interesting address on the "St. Lawrence Waterways Project."

In opening, Mr. Nolan explained that his address would be non-partizan, non-political and non-engineering and that his information was based on that secured by the Canadian Club for the purpose of giving an unbiassed view of the situation to Canadians.

The speaker then gave a brief historical sketch of the development of the St. Lawrence watershed to a world trade route and described the developments in canal systems along the route, showing that with the work already completed and that in immediate prospect Canada already had a large stake in the project.

He pointed out that the pressure being brought to bear for immediate construction of the canals yet required to open the Great Lakes for ocean going vessels came primarily from the western states which urgently required cheaper transportation for their farm products and that if the St. Lawrence were not opened up there was another route available in the United States. The Canadian proponents of the scheme hoped that it would produce cheap transportation for Canadian wheat and pointed to the possible 4,000,000 h.p. which might be developed in Canada, a load which at present rate of increase would readily be taken up in Canadian markets within a very few years. The opponents of the project argued that there are already sufficient trade routes available for the west and that any further large development of power would be entirely for the benefit of United States markets as Canadian markets would not absorb so large a new block of power.

After the address, which was illustrated by slides, refreshments were served to the members and their guests.

REPORT ON PLENARY MEETING OF COUNCIL

At a regular meeting of the Calgary Branch held at the Board of Trade on Friday, November 6th, R. S. Trowsdale, A.M.E.I.C., Councillor of the Branch, gave a very comprehensive report to the members of the Plenary Meeting held at Headquarters in September. He gave an outline of the purpose of these meetings and proceeded to outline the proceedings and the activities of the various committees during the past year. He felt that the affairs of The Institute were in a satisfactory state in spite of adverse times, but that unceasing efforts must be put forth to maintain this condition, in which the Branches could greatly assist.

After Mr. Trowsdale's report was completed, S. G. Porter, M.E.I.C., President of The Institute, spoke briefly on various aspects of the affairs of The Institute and complimented Mr. Trowsdale on his very efficient representation of the Branch at the Plenary Meeting and on his very ably prepared report.

JOINT MEETING WITH PROFESSIONAL ENGINEERS

Members of the Calgary Branch of The Engineering Institute were asked to join the members of the Professional Engineers Association of Alberta at the Renfrew Club on the evening of Saturday, Nov. 7th. Of the sixty guests present, fully one-half were members of The Institute. R. S. Trowsdale, R.P.E., A.M.E.I.C. was in the chair.

The provincial committee on closer relations with the various professional engineer's associations throughout the Dominion reported at the afternoon meeting, which report was adopted by both the Executive and the district meeting and the committee was instructed to continue its efforts.

THE HUMAN SIDE OF RAILROADING

At the dinner in the evening, J. P. Johnson, District Superintendent of the Canadian National Railways, addressed the guests on "The Human Side of Railroading." The steel, rolling stock, signalling systems, bridges and other physical assets of the road all depend upon the efforts and faithful service of the engineer.

The speaker spoke of the progress of the railroads as "the reward of the human effort" and outlined the part they have played in the development of Canada in uniting the scattered provinces.

G. A. Gaherty, A.M.E.I.C., President of the Calgary Power Company, contributed interesting reminiscences of his recent visit to "Bolivia and Latin America," its history and traditions and the living conditions of its inhabitants.

Quite a number of out-of-town members came from Edmonton, Lethbridge and country points for the meetings, many of them members of our own organization, and a very pleasant day was spent by those in attendance.

THE GRAIN HANDLING SITUATION

A general meeting of the Branch was held in the Elk's Hall at 8:00 p.m. on Monday, November 16th, at which about thirty members and friends gathered to hear C. D. Howe, M.E.I.C., of Port Arthur, Ont., speak on "The Grain Handling Situation."

The speaker was introduced by the chairman of the Branch, R. C. Harris, M.E.I.C.

Mr. Howe reviewed the development of form and methods of construction of the modern grain elevator from the earliest examples built about 1850 to the present time and the relation of the present export of grain to the handling and storage facilities of the Dominion.

In the early days, said the speaker, and still in some parts of the world, the grain is handled in sacks, but in Calgary, a modern city, it has always been handled in bulk. The first elevators were frame structures but the fire menace was found to be so serious that a change was made to steel. This, however, did not prove entirely successful as a large proportion, about one in five, collapsed, and a change was made to hollow tile with steel reinforcement construction. These were found to be expensive and as fire destroyed the tile, the expense of reconstruction also was large.

Gradually a change was made to reinforced concrete construction following the Paris Exhibition of 1902, at which examples of this art were exhibited. The first elevator of this type was built at Minneapolis in 1904. The greater part of the reinforcement was in an axial direction and many of the elevators of this type collapsed. To remedy this defect a change was made by introducing more radial stress members and it has been found possible to reduce the wall thickness by approximately one-half.

The first concrete elevator was built in Canada in 1907 and since that time practically all central elevators for storage and cleaning have been of radially reinforced concrete construction.

Country elevators, said the speaker, continued to be and still are usually made of wood because of the expense of concrete delivered to the site and of the foundations required to carry the heavier structure. The fire hazard is not very great and cost had to be kept low.

In 1913 practically all our grain went eastwards, about 60 per cent through United States ports and 40 per cent by Georgian Bay to Montreal. To provide storage and transshipment facilities the elevator capacity at Port Arthur and Fort William had grown to about 30,000,000 bushels.

Now, continued the speaker, due to the opening of the Panama canal, a change has occurred. Grain is moving westwards as well as eastwards. In 1916 the first elevator was constructed at Vancouver but this was not used until 1922, and it appeared that a false move had been made. In the latter year, however, ocean freight changes brought Vancouver into active competition with the eastern route and in 1923 53,000,000 bushels were shipped from that port, which firmly established it as a port for grain shipment.

The storage facilities at Vancouver have been increased from 1,250,000 bushels in 1916 to 15,000,000 bushels at the present time and it is likely they will be doubled in the near future in spite of the improvements in the eastern route due to the building of the Welland canal and the Hudson's Bay Railway. He thought that Churchill would develop slowly but would, in time, become a port for grain shipment of considerable importance. The shipment should be somewhat cheaper than via Montreal but the short open season of about three and a half months will be somewhat against its rapid development. northern Saskatchewan is hoping that the Bay route will give to its grain the same boost that the opening of Vancouver gave to Alberta grain.

After the lecture a large number of slides were shown, illustrating the development of the modern elevator and improvement in methods and types of construction.

A large amount of interest was shown by those who took part in the resulting discussion, including Messrs. Bennett, J. Dow, M.E.I.C., M. H. Marshall, M.E.I.C., J. A. Spreckley, A.M.E.I.C., J. J. Hanna, A.M.E.I.C., and F. N. Rhodes, A.M.E.I.C.

The very hearty appreciation of those present was evidenced by the manner in which the vote of thanks to the speaker, proposed by Messrs. Turner-Bone and Richards was responded to by those present.

ANNUAL BALL

The fifth annual ball of the Calgary Branch took place on the evening of Thursday, November 29th, at the Palliser hotel.

The ball was under the distinguished patronage of His Honour Lieutenant-Governor W. L. Walsh and Mrs. Walsh, Mr. S. G. Porter, President of The Engineering Institute and Mrs. Porter, Dr. R. C. Wallace, President of the University of Alberta and Mrs. Wallace, His Worship Mayor and Mrs. A. Davison.

Beautiful lighting effects were arranged in the main dining room of the hotel where the dancing took place and the guests were received in the reception room by the hostesses, Mrs. R. C. Harris, Mrs. F. M. Steel and Mrs. R. S. Trowsdale.

To vary the dance programme novelty dances were put on by entertainers during the evening. Some two hundred and eighty guests were present.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil. E.I.C., Branch News Editor.

A meeting of the branch was held in Hamilton on November 17th, 1931, at which several members of the Association of Professional, Engineers of Ontario were present, together with several visitors from Galt and Brantford. It was preceded by an informal dinner to give the members an opportunity of meeting the speakers before the meeting. There were twenty present at the dinner.

Modern Bridge Construction

E. P. Muntz, M.E.I.C., occupied the chair, and called on R. K. Palmer, M.E.I.C., to introduce the speaker, Professor C. R. Young, M.E.I.C., of the University of Toronto, who delivered an illustrated lecture on "Modern Bridge Construction." The first series of slides dealt with arch bridges and showed the Sydney Harbour bridge in process of erection. Then came the bridge connecting Bayonne, N.J., with Slaters island which was made just two feet longer in space than the Sydney arch on 1,652 feet.

This bridge was erected on false work bents and the closure made at a point about 248 feet away from the centre. McKee's Rocks arch at Pittsburgh which is of the same type was closed however on a centre pin and transformed with a two-hinged arch after erection.

No lateral bracing is provided in the deck of this span, shear being taken by the brickle plate floor.

An unusual type of arch appropriately named the "Dinosaur" which had been built in Germany was next shown.

Some remarkable examples of suspension bridges were then shown.

The Royce bridge in Germany in which the horizontal component of the pull in the cables is taken up as thrust in the stiffening girders being first. This idea was used for the 7th and 9th streets bridges in Pittsburgh.

Then came the Mannheim suspension bridge in which the cables are built up of wires of both round and square cross section which interlock to make a more compact rope.

The St. Johns bridge at Portland, Oregon, of 1,207-foot span uses twisted cables.

Each cable consists of ninety-one 1½-inch diameter ropes which were pre-stressed in the shop for half an hour. The load was then slacked off to equal the dead load stress, the cables being then marked and cut. Incidentally this method saved nearly two months of erection time.

Not many multiple span suspension bridges are in existence but the speaker showed a slide of one in Syria which had been started by the Turks and finished by the French.

It consisted of three spans and approaches. This type of structure is liable to considerable deflection under heavy traffic and ties connecting the tops of the towers have been suggested but not so far used.

The longest span so far completed is the new George Washington bridge over the Hudson. The central span is 3,500 feet with side spans of 650 feet. At present there are but two 28-foot 9-inch roadways, the centre 30-foot lane being unpaved while a lower deck for high speed interurban service is also intended eventually.

A number of reinforced concrete bridges were shown, many being of European design.

A freak design at Montrose, Scotland, which resembled a suspension bridge in outline being illustrated as a bad example of this construction.

Next came a rigid frame bridge in Brazil which was erected as a cantilever.

The girders were set in forked bearings allowing movement during erection and were concreted in after closure.

A Swiss arch of 142-foot span but having a rib of 11½ inches maximum depth illustrated what could be done in economizing in concrete. Finally came the three span arch bridge at Brest, France, which is the most remarkable reinforced concrete bridge built to date. The falsework was built up on shore and floated out, taking only 48 hours to move and place the forms.

The secondary stresses were taken care of by jacking the arch rib.

Professor Young closed his talk by showing two unconventional types, a three chord triangular section truss of 266 feet built at Duren, Germany, for a double track railway, and a through truss without any diagonals in which the joints are calculated to resist the bending stresses.

There was an extensive discussion following Mr. Young's address, in which various members took part, including P. B. Motley, M.E.I.C., Montreal. In his discussion, Mr. Motley paid tribute to the late H. E. Vautelet, M.E.I.C.

Following the vote of thanks which was moved by F. P. Adams, A.M.E.I.C., seconded by H. A. Lumsden, M.E.I.C., the speaker called on A. H. Harkness, M.E.I.C., to open the discussion on the proposed amendments to the Act of the Association of Professional Engineers.

Association of Professional Engineers of Ontario

A. H. Harkness, M.E.I.C., and H. Hellmuth of Toronto addressed the branch and outlined the proposed amendments to the Act of the Association of Professional Engineers, which is going before the Ontario Legislature shortly.

Mr. Harkness traced the early history of the struggle for the formation of provincial associations. A committee was formed composed of members of the A.S.M.E., A.I.E.E., Chem.E.A., Land Surveyors and E.I.C. This committee drew up the provision of the Act and presented it to the Legislature in 1922. Unfortunately the very clause that gave strength to the Act was deleted, "That an engineer shall be a member of the Association before he can practice."

Another point on which it is proposed to introduce legislation is the Interpretation Act, by which an engineer of recognized standing (i.e. a member of the A.P.E.) shall be engaged when certain legal clauses call for the endorsation of "an engineer." Considerable opposition from rural districts has been encountered to this section.

Mr. Harkness urged the members of the branch to approach their local members of Parliament, to seek any means by which favourable publicity can be given to this question.

Mr. Hellmuth, organizer of the A.P.E., then spoke and presented some very convincing arguments as to why the amendments to the Ontario Act shall be passed.

He pointed out the high professional standing of practitioners of Law and Medicine and how the Act proposed elevating the Engineering Profession. The A.P.E. is not a Technical Association and does not usurp the duties of the various societies representative of the various branches of engineering.

In Prince Edward Island and Ontario an engineer can practice as such without registration and without passing an examination. Life and property can therefore be endangered through the employment of unqualified engineers.

The proposed amendments will protect registered engineers. Only the lack of interest of the public and the laxity of the engineers themselves is responsible for the condition as it now stands. Mr. Hellmuth then read extracts from an article prepared by J. S. Ewart, K.C., who gave arguments against points that might be raised by opponents of the Act under the heading "Class Legislation," "Trade Unionism" and "Closed Corporation."

The discussion which followed was very interesting and showed how keenly the members felt in regard to the legislature.

A meeting of the Branch was held in the Royal Connaught hotel on December 3rd, 1931. On account of the general interest in the subject, invitations had been issued to the Hamilton Chamber of Commerce and the Hamilton Traffic Club. The attendance included several members of these organizations, together with a number of visitors from Buffalo, Toronto, Galt, Brantford and other places.

Transportation

H. B. Stuart, A.M.E.I.C., introduced the speaker, Professor W. T Jackman, Professor of Transportation at the University of Toronto, and explained the proposed series of meetings on Transportation. Professor Jackman's paper deals with the Canadian Transportation problem in a general way. Following this meeting, there will be a series of meetings at which the various phases of the subject will be dealt with in detail, probably in the following order: Air, Waterways, Highways and Trucks, and, lastly, Railways.

Professor Jackman dealt with his subject "Some Problems in Canadian Transportation" in a very masterly manner. His paper has been published by the Hamilton Branch, and distributed to the Branch membership.

Professor Jackman dealt with the competition between trucks on the highways and the railroads. He pointed out that trucking is, essentially, complementary to the railroad services, and felt that the best solution for the problem was to organize the truck companies as subsidiaries to the railroads.

He also referred to the St. Lawrence waterways, the problem of competition between a privately-owned railroad and a government-owned railroad, and devoted some time to the future of transportation.

Following the address an opportunity was afforded to those present to hand in written questions, which Professor Jackman answered.

A meeting of the Branch was held in the Westinghouse Auditorium on Wednesday, December 16, with E. P. Muntz, M.E.I.C., in the chair. Before the speaker of the evening was introduced the following Branch Nominating committee was appointed:

H. A. Lumsden, M.E.I.C., *Chairman*
W. L. McFaul, M.E.I.C.
W. F. McLaren, M.E.I.C.
J. Stodart, M.E.I.C.
W. A. T. Gilmour, Jr.E.I.C.
Branch Chairman } *Ex officio*
Branch Secretary }

Arc-Welding

H. U. Hart, M.E.I.C., introduced the speaker A. M. Candy, general engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, who spoke on "Arc Welding."

Mr. Candy prefaced his remarks by giving a description of some of the official tests which were conducted at the Massachusetts School of Technology. He showed interesting diagrams and pictures which gave the advantage of the welded beams over the riveted. He showed three equivalent beams, each 15 feet long. The first a riveted beam, the second a riveted design in which welding replaced the rivet and the third a welded beam designed for such fabrication.

Beam No. 1 of the usual riveted type, weighed 798 pounds. This specimen was tested by centre loading on a block 5 inches wide, the span being 14 feet and ⅛ inch. Failure took place by buckling of the top flange, the yield point being 55,000 pounds and the ultimate load 68,900 pounds. Section modulus was 61.1.

Beam No. 2, identical with No. 1, except that its parts were welded together. The top flange angles were welded to the web plate by intermittent welds 1 inch long on 3 inch centres along the toe of both the top angles. The backs of the angles were welded together and to the edge of the flange plate intermittently using 2-inch long welds on 3-inch centres. With centre loading on 14 foot span, the beam failure occurred by crimping of the top flange. The elastic limit reached was 65,000 pounds, the ultimate being 77,200 pounds and maximum bending was 270,000 foot pounds, giving a maximum fibre stress of 53,800 pounds per square inch based on the section modulus of 60.2.

Beam No. 3 was designed strictly to take all advantage of the possibilities in joining steel members by using the electric arc. No angle iron was used—just plate material. The top flange was welded to the web plate intermittently along each side of the web plate. The bottom flange was welded to the web plate for a distance of 6 inches from each end and then intermittently with 2-inch welds on 4-inch centres. The web stiffeners were welded solid to the flanges around the entire periphery at each end of the stiffener. Each was also welded 2 inches on each side of the neutral axis and at intermediate points 1 inch long at each side of the stiffeners. Under test, the elastic limit reached was 65,000 pounds; the ultimate load 78,000 pounds. Buckling of the top flange finally caused failure. The finished beam weighed 656 pounds or approximately 18 per cent lighter than the riveted beam and 16½ per cent less than beam No. 2. This shows the advantage of designing the piece for welding by placing the metal in locations where the greatest strength can be developed with the amount of material used. It also demonstrates the fact that the parts to be joined need not be lapped as is required where rivets are to be used for securing the members. Maximum fibre stress was 52,700 pounds per square inch with the section modulus of 62.2.

The speaker pointed out that one of the many important advantages rendered possible by welding is the continuous effect obtained by construction.

Another interesting test described was the vibrational one whereby both riveted and welded members were vibrated 1,750 times per minute, a distance of ⅛ inch. The riveted material failed in three-quarters of an hour. The welded material was given a further seven hours' test to determine the actual seat of failure.

The speaker pointed out that the average work done by welders is surprisingly high and shows a consistency which is remarkable; to maintain this, each welder is subjected to a test every four to six weeks.

In effecting the transition from a cast to a welded structural design, he also stated that it is well to avoid trying to make an exact copy in rolled steel of the physical form of the cast construction. An attempt to obtain similarity in appearance will almost always certainly result in a structure more expensive than necessary and at the same time probably less rigid for a given weight of material than is possible were the design adapted to available steel shape.

An interesting application of arc welding was shown in the bridge at Chicopee Falls, Mass. The bridge, an 80-ton structure, having an overall length of 175 feet, is made up from rolled steel, eight beams, arc welded together.

An arc welded pipe line was also shown which connects the Westinghouse plant at Trafford with a heat unit at the foundry 1,700 feet away. Arc welding allowed a very convenient and flexible means of construction for pipe lines.

Mr. Candy pointed out that perhaps welded design is not as beautiful as riveted or cast, but that may be because the familiarity of the one has built up a certain convention from which we are afraid to depart. In all exterior construction work, such as bridges, it has been proven that the arc welded construction is much easier to paint than the riveted and, therefore, is quite an item in saving.

Mr. Candy answered a great many questions from different members and W. F. McLaren, M.E.I.C., moved a hearty vote of thanks to the speaker for the exceedingly able and interesting address, which was carried unanimously.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.

Trans-Canada Telephone Line

The regular bi-monthly dinner meeting of the Lethbridge Branch was held on November 14th, 1931, in the Marquis hotel. The speaker was Mr. J. D. Baker, Deputy Minister of Telephones for Alberta, who addressed the members on the "Trans-Canada Telephone Line."

N. Marshall, M.E.I.C., occupied the chair and the speaker was introduced by Mr. W. Russ, district plant chief at Lethbridge for the Alberta Government Telephone system.

Mr. Baker came West from Winnipeg in 1903 with the Bell Telephone Company and later in 1908 when the government took over the operation of the telephone lines joined the staff of the Alberta Government Telephone system. At the present time Mr. Baker is the oldest member of the staff, being appointed to his present position in 1929.

The talk was illustrated by lantern slides and the branch is once more, as on previous occasions, indebted to Mr. Cyril Watson, who operated the projector.

The orchestra under the leadership of George Brown again entertained during the dinner with an excellent programme of music.

Mr. and Mrs. Rhyddid Williams were the guest artists of the evening and both contributed generously to the programme.

The final line in the Trans-Canada Telephone line should be completed by the 15th of January. When this is done it will be possible to speak from Vancouver to Halifax over an all Canadian line, comprising the various provincial telephone systems in the west, and the Bell Telephone Company's lines in Ontario and Quebec.

This enormous undertaking, estimated to cost some $11,000,000 to complete, of which Alberta's share will be $925,000, should be ready early in the new year.

Mr. Baker stated that telephone engineers endeavour not to use radio for trans-oceanic messages, if at all possible to do otherwise, due to the uncertainty of atmospheric conditions.

Turning to the more technical side of the telephone, the Deputy Minister discussed the pitch of various musical instruments, comparing these to the pitch of the normal human voice. The lowest pitch of a man's voice is 82 cycles per second while the high pitch of a woman's voice is 870 cycles per second.

The speaker then explained briefly the simple telephone and discussed wave lengths as an indication of frequency, showing several slides illustrating musical wave forms.

The transmission losses of various types of equipment were discussed and several factors governing telephone communication outlined.

From this Mr. Baker went on to discuss the carrier system of telephoning as used on Trans-Canada Telephone lines.

Carrier current consists fundamentally, he said, of substituting one frequency of electric waves for each frequency of sound waves to be transmitted. In an ordinary telephone system the electric and the sound waves have the same frequency but in the carrier system the electric waves have a much higher frequency. The ordinary voice may be clearly transmitted on a band of from 200 to 300 cycles per second. The superimposition of a high frequency from a oscillatory circuit, on voice currents in a suitable vacuum tube modulator sets up two bands of frequency. One of these is above and the other below the oscillatory frequency. By the use of a suitable filter the carrier and the lower side bands are suppressed. Due to interference troubles the frequency of the lower band is limited as well as that of the upper band. This permits only six bands being sent out over the same wire. As the amplifiers used are unidirectional the sending and receiving must be kept separate so that there are only three talking channels.

At the receiving end these signals are sorted by filters and demodulated by reintroducing the carrier which brings back the original frequencies. These then become as ordinary speech in the telephone.

Carrier current telephony gives rise to many problems in connection with line transposition, it is however to be recommended for long distances of 200 miles or more.

The first carrier system in Alberta was purchased in 1924 and used between Edmonton and Calgary.

A trans-Canada telephone line has been the dream of Canadian engineers for many years. There were two great barriers, the Rocky mountains and the desolate country along the north shore of Lake Superior. These have, however, been overcome and the final route nearly completed although it is only three years since the preliminary study of the line began.

Starting at Vancouver the line runs through the Kettle Valley and the Crows Nest to Macleod thence to Calgary; across the prairies to Winnipeg, along the C.P.R. right of way to Sudbury, thence to Toronto, Montreal and Halifax. A total of 4,333 miles.

Concluding his address, the Deputy Minister briefly discussed the subject of television, a practical demonstration of which he saw in the Bell Telephone Laboratories in New York. So far as they have gone, he said, it is perfect, although much remains to be done, as at present an image only 5 inches by 7 inches is available.

Following the address the chairman moved a hearty vote of thanks to the speaker for a most interesting and instructive talk.

Annual Ladies' Night

The Lethbridge Branch of The Engineering Institute of Canada held its annual "Ladies' Night" in the club dining room of the Marquis hotel Saturday evening, December 12th, and more than sixty members, their wives and friends sat down to an excellent Christmas dinner.

The orchestra under the direction of George Brown played appropriate music during the dinner and also accompanied the rollicking period of community singing which followed and which was led by Mr. James Haimes, A.M.E.I.C.

The artists of the evening were Mr. and Mrs. W. Meldrum and and Mr. George Brown, who rendered a number of violin solos

At the conclusion of the musical programme there was a half hour intermission which afforded a splendid opportunity for the members, their wives and friends to get better acquainted.

The second part of the evening was given over to the viewing of a series of motion pictures and the thanks of the branch are again due to Cyril Watson who so very kindly operated the projector.

The first picture entitled "The Yukon" illustrated vividly the trip into the northland and included some splendid views of White Horse—the "Metropolis of the North."

This was followed by "The Miracle of the Locomotive," which graphically illustrated the building of a locomotive from the pattern room to the finished engine.

Next were shown two pictures, "China's Forbidden City" and "Mystic India," the first scenes in and around Peking and the second a trip across India including some splendid views of the city of Delhi.

The concluding film was entitled "The Story of a Duchess," and presented an excellent picture of the construction of a huge ocean liner.

This concluded the meetings of the branch for the year.

It was a large and representative gathering of branch members under the chairmanship of N. Marshall, M.E.I.C., that met in the club dining room of the Marquis hotel to welcome home their first chairman and one who in the ensuing ten years had attained the highest position in the organization—that of president of The Institute. The president's paper was preceded by the usual dinner and social hour so popular at these functions.

The entertainment committee under the convenorship of their energetic chairman, James Haimes, A.M.E.I.C., are to be congratulated on arranging a musical programme of high standard such as that provided by Mr. George Brown's orchestra and Mrs. C. Geiger and Mr. G. Evans with their songs.

In opening his address Mr. Porter discussed at length the subject of branch membership. Branch activities he said constitute the real life of The Institute due to the fact that so small a part of the membership are able to attend the annual meetings. From this the speaker went on to outline methods of increasing membership laying special emphasis on the part the affiliate members in the activities of the branches.

Following these introductory remarks the president presented a paper entitled "The Engineering Profession" in which he discussed at some length the status of the engineer and his relation to the general public.

At the conclusion of Mr. Porter's address, H. Meech, M.E.I.C., in a few well chosen words moved a hearty vote of thanks to the speaker, which was carried amid applause.

London Branch

Frank C. Ball, A.M.E.I.C., Secretary-Treasurer.

J. R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the Branch was held on the 18th of November in the Hotel London and was well attended, about forty members, affiliates and guests being present.

The speakers of the evening were, A. H. Harkness, B.A.Sc., M.E.I.C., of Toronto, and Mr. H. Hellmuth, also of Toronto.

The subject of the former speaker was "Solution of Some Structural Engineering Problems in Modern Buildings," and Mr. Hellmuth, Organizer of the Association of Professional Engineers of Ontario, spoke on the facts connected with that body and of its activities in connection with the Professional Engineers Act which it is proposed to put through at the next session of the Parliament of Ontario.

The Chairman, W. R. Smith, A.M.E.I.C., called the meeting to order and it was moved by W. C. Miller, M.E.I.C., and seconded by F. W. Farncomb, M.E.I.C., that the minutes be taken as read. Adopted.

It was proposed by F. T. Julian, A.M.E.I.C., and seconded by R. W. Garrett, A.M.E.I.C., that the Executive committee be authorized to make the nominations for officers of the Branch for the ensuing year. This was adopted.

W. C. Miller, M.E.I.C., gave a notice of motion for the amendment of the Constitution, if necessary, to admit of the adoption of a letter ballot for the election of officers of the Branch instead of taking the ballot at the Annual General Meeting as has been the custom in the past and thus taking up the time of the special speaker engaged on these occasions.

In introducing Mr. Harkness, the first speaker of the evening, Colonel I. Leonard, M.E.I.C., called attention to the fact that the speaker was President of the Association of Professional Engineers of Ontario and said with regard to the proposed promotion of an Act of Parliament for the protection of the profession in Ontario, Mr. Harkness knew the situation thoroughly, had always given good advice and his standing amongst the engineers of the province entitled him to be considered as one of their bulwark members.

Engineering Problems in Modern Buildings

Mr. Harkness dealt particularly with the engineering problems met with in the construction of the Bank of Commerce building in Toronto. His address was illustrated by lantern slides and several slides at the close of his address were given showing various features of the Canada Life building at Toronto and of the Sun Life building at Montreal*.

The Bank of Commerce building, Toronto, stands 485 feet above the street level and comprises thirty-five storeys. Below street level there are three full basements and part basement below these for boiler room and coal storage — totalling 50 feet below street level. The building is faced throughout with masonry and is of pleasing appearance.

The foundations rest on shale and samples of this were taken and tested for compressive strength and the foundations spread to give a safe unit-bearing stress. The walls of the adjoining buildings were made safe by establishing piers of underpinning at 12 feet intervals and installing beams carrying the walls between these piers. The foundations were excavated by steam shovel and the earth removed by trucks operating along inclined roads until too deep for this; then a temporary truck hoist was installed and a bridge therefrom at road level enabling the trucks to be filled at the bottom, hoisted to road level and then run off to dump.

Owing to the exterior architectural design and the layout of the interior it was impossible to install superimposed steel columns throughout the buildings and special beam and girder construction was therefore necessary to carry and transfer the staggered load of columns above to those below. The whole block of 168 feet by 190 feet is covered by a building seven storeys high while the tower containing the remaining storeys only occupies a portion of this area. The banking hall covers a large area and is some two or three storeys high—thus heavy girders, some of 53-foot span, had to be installed to carry the concentrated loads of the columns above together with the distributed floor loads. The complicated connections involved were clearly described by Mr. Harkness as was also the methods employed of combating the wind pressures on a tall building of this type. In the latter case the reactions of this pressure were taken as acting through the floor members which were adequately braced accordingly thus transferring the pressure to at least two vertical rows of internal columns which in turn were built up by steel gusset plates and angles to resist both bending and sheer forces. A notable feature of this construction was the adoption of 30-inch Bethlehem steel beams for columns which lent themselves to the adequate resistance of side pressure while still giving the requisite sectional area of steel for vertical loads and the ratio slenderness and at the same time not exceeding the weight of H-beams which otherwise would have been installed for the latter purpose only.

In tall buildings of this nature it was found that the wind pressure differed in intensity at different levels at the same time.

In reply to a question by R. W. Garrett, A.M.E.I.C., the speaker said that riveted joints had been adopted in this building although welded joints were rapidly coming to the fore and where quietness was required this was a great advantage.

A general discussion followed the speaker's remarks and a vote of thanks proposed by W. C. Miller, M.E.I.C., and seconded by W. R. Smith, A.M.E.I.C., was unanimously carried.

The chairman, who had been a school fellow of Mr. Hellmuth, introduced him to the meeting.

Association of Professional Engineers of Ontario

Mr. Hellmuth outlined the purpose and activities of the Association of Professional Engineers of Ontario and made it perfectly clear that it was not a technical organization, except in the matter of admission to membership, but was solely formed for the protection of its members from unqualified and unscrupulous competition and by the same light affording protection to the public from the dangers of employing unqualified practitioners. He also stressed the fact that the Province of Ontario was without proper legislation for the protection of its qualified engineers, at the present time, while other provinces and the United States had such protection. One result of this was that while Ontario engineers were barred from practising outside the province, engineers from outside could at the present practise in Ontario without restriction and in competition with its own engineers.

It was proposed at the ensuing Parliamentary session to introduce a bill dealing with these matters which, if passed, would afford adequate protection to the engineering profession in Ontario and put it on an equal footing with other provinces.

He strongly urged the members of the Association here and elsewhere to use whatever influence was in their power with Members of Parliament or otherwise to help this bill through the Ontario Legislature.

A discussion followed on various phases of the proposed bill, which were fully explained by both Mr. Harkness and Mr. Hellmuth.

The remarks of the speakers on the matter were fully appreciated and endorsation of the proposed legislation was manifest.

Moncton Branch

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

Modern theories of the origin and constitution of the earth were the subject of an extremely interesting address delivered before the branch, on October 29th, by Professor H. W. McKiel, M.E.I.C. G. E. Smith, A.M.E.I.C., chairman of the branch, presided and introduced the speaker.

Origin and Constitution of the Earth

Various theories have been evolved during the past few hundred years as to the origin of our planetary system. The latest explanation is that our sun, in collision with another sun, disintegrated or exploded, and the detached portions, of which the earth is one, form our present planetary system. The age of the earth and other celestial bodies science has determined with a considerable degree of accuracy. It is estimated that three billion years have passed since the earth became solid. The sun has existed for ten trillion years, while our universe came into being not less than two hundred trillion years ago. Some interesting facts regarding the composition of the earth have recently been discovered. By timing the velocity of earthquake vibrations, it has been found that the outer or solid crust of the earth is 1,800 miles thick, while the interior is of molten material.

A hearty vote of thanks was tendered Professor McKiel on motion of G. C. Torrens, A.M.E.I.C., seconded by H. J. Crudge, A.M.E.I.C.

Unit Cars

On November 17th, T. H. Dickson, A.M.E.I.C., gave an address on the unit cars of the Canadian National Railways, before the Engineering Society of Mount Allison University, Sackville, the members of which are student members of The Institute. Mr. Gordon Wagner presided. A vote of thanks was moved by C. D. MacDonald.

A very interesting meeting of the branch was held on November 26th, at which Major H. W. L. Doane, B.Sc., M.E.I.C., was the principal

*See Engineering Journal, February 1931.

speaker. G. C. Torrens, A.M.E.I.C., Councillor of the branch, presided. Previous to Major Doane's address, Mr. A. Lorne McKendrick entertained the gathering with a splendid rendition of one of Kipling's Barrack Room Ballads descriptive of the engineer. Also, a five minute talk, describing the roof of the new Moncton Stadium, was given by James Pullar, A.M.E.I.C.

MODERN HOT-MIX ASPHALT PAVEMENTS

Major Doane spoke on the construction of sub-grade, base and wearing surface of modern hot-mix asphalt pavements, and illustrated his remarks with numerous lantern slides and moving pictures. The first requisite of a good road, declared the speaker, was adequate drainage. A proper sub-grade was also of prime importance, without which any pavement, no matter how good, was bound to crack and break up. The various types of asphalt surfaces were dealt with in detail and pictures shown describing their manufacture. The best guarantee of a good job, stated Major Doane, was the selection of a contractor who had a reputation to maintain.

A vote of thanks was tendered the speaker, on motion of F. O. Condon, M.E.I.C., seconded by A. S. Gunn, A.M.E.I.C.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

A Branch Dinner-Meeting was held at Thorold on December 7th with about thirty members present. A. H. Harkness, M.E.I.C., and Mr. H. Hellmuth of Toronto were the guest speakers and explained the objects and provisions of the new act which is to be placed before the Ontario Legislature at the coming session.

Nearly an hour's discussion followed, indulged in by the following members: Messrs. M. B. Atkinson, M.E.I.C., A. W. F. McQueen, A.M.E.I.C., J. H. Bradley, A.M.E.I.C., C. G. Cline, A.M.E.I.C., W. Jackson, M.E.I.C., L. L. Gisborne, A.M.E.I.C., Woods, E. G. Cameron, A.M.E.I.C., J. C. Street, M.E.I.C., A. L. Mudge, M.E.I.C., A. J. Grant, M.E.I.C., Paul Manning, A.M.E.I.C., and at the close of the meeting a resolution was adopted appointing a committee, with Mr. E. G. Cameron as chairman, to interview the local Members of Parliament and ask their co-operation in furtherance of the Bill.

During the opening remarks and subsequent discussion many of the difficulties inherent in any such legislation were explained and the methods with which it is proposed to deal with them.

Briefly, the act as proposed is drafted along broad lines with considerable latitude in interpretation. The burden of such interpretation will be left in the hands of the Council, of which the Lieutenant-Governor in Council appoints three members. It is considered that a committee having such wide powers will, in its decisions, carry out the spirit of the act fairly, and with a greater prospect of success than would be achieved by an attempt at exact definitions or limitations. The findings of this committee will not necessarily be final as an appeal may always be made to the courts.

The act has been drafted along the lines of legislation originated by The Institute some ten or twelve years ago, and will not go so far as some of the provincial acts at present in force. Thus, there should be very little question as to its adoption and experience will indicate whether and when subsequent amendments are necessary or desirable

No attempt has been made to define the word "engineering," but the various branches of engineering over which the act has jurisdiction have been named and all engineers who are engaged in responsible positions in these branches will be subject to the provisions of the act. The interpretation of the term "responsible positions" is left with the Council.

Protection of the Ontario engineer from foreign or unqualified competition is one of the purposes of the act, but its chief object is that the public will have a much greater degree of protection than is enjoyed at the present time. Unqualified persons will not be allowed to hold the responsibility for the design and construction of structures which may imperil human life if failure occurs. It is also designed to fit in with future possible Federal Legislation.

The Professional Engineers under this act will remain a purely protective association. No attempt at social or educational work is contemplated; such spheres of influence being considered as belonging to associations already in existence.

COLUMBIAN OIL FIELDS

Several members of the Branch motored to Buffalo on December 17th to hear a lecture on the Colombian oil fields presented before the Buffalo Society of Civil Engineers by Captain H. K. Wilcox of New York.

Captain Wilcox gave a vivid description of his exploration trip across a gap in the Andes Mountains to determine a feasible route for a pipe line to deliver oil from what is known as the "Barcoe Concession" to the Carribean coast line.

The concession, which is one of the three known oil fields in Colombia, consists of some 5,000,000 acres and was granted to a local patriot in the year 1905 for "services rendered." In 1917, he sold his interests to two New York capitalists for the sum of $100,000, and they in turn passed it on to an unnamed oil producing company for $500,000 cash and a quarter interest.

The concession lies along the south west border line of Venezuela and logically should be developed through that country because a spur of the Andes lies to the westward and separates it from the main portion of Colombian territory. Political difficulties however prevent this at present and hence Captain Wilcox was retained to find a solution and succeeded in discovering a feasible route to the eastward through jungle and a pass with an elevation of only about 5,000 feet at the base of a mountain now named Mount Wilcox.

Ottawa Branch

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

INDIA'S NORTHWEST FRONTIER

At the noon luncheon on November 26th, a member of the local branch, Major G. R. Turner, A.M.E.I.C., Assistant Director of Engineer Services, Department of National Defence, Ottawa, gave an illustrated address upon the subject of the "Northwest Frontier of India." G. J. Desbarats, C.M.G., M.E.I.C., chairman, presided at the luncheon, other head table guests including A. E. MacRae, A.M.E.I.C., H. E. Ewart, R. Meldrum Stewart, M.E.I.C., John McLeish, M.E.I.C., Major-General A. G. L. McNaughton, M.E.I.C., Major-General A. H. Bell, A. F. Macallum, M.E.I.C., Col. H. H. Matthews, and Colonel J. L. H. Bogart, A.M.E.I.C.

Major Turner, who had spent several years in the area described, gave a most interesting insight into the character of the inhabitants who constituted a major problem in British administration of India's northwest frontier. These were for the most part fanatical Mohammedans, proud, hardy, tireless and self-reliant, seething with blood feuds and under little control even of their own chiefs. These people, inhabiting a region lying upon the borders of Afghanistan with altitudes reaching to 11,000 feet and subject to extremes of climate, a country which the speaker characterized as a "tangled mass of huge rocky peaks and small bare desolate plains interspersed at intervals with narrow fertile valleys," were practically an independent people over which the British exercised only a nominal form of administrative control through political officials. Depending at times even for their livelihood upon raids conducted upon the fertile lands of the more peaceful inhabitants of the south, these natives, as may be imagined, presented real difficulties to the British authorities.

How the British officials in connection with their problems of administration, have brought railroads and developed highways into the country was ably told by the use of lantern slides before a capacity audience. Much of the address dealt with the technical aspects of the engineering work which was carried on by the military authorities in this connection.

The policy of the government in India during the past decade or more in the region described has been to develop the country in the interests of civilization and to give work on construction and protection to improve the economic conditions. By giving the tribes themselves a stake in the country and improving economic conditions the necessity is obviated for conducting raids upon the part of the inhabitants. That this policy is having its effect was evident from the figures giving the number of raids conducted along the whole frontier during a period of years. In a six-year interval, for instance, the number of raids dropped from six hundred and eleven to twenty-nine with a corresponding drop in the value of property looted and the number of persons kidnapped and held for ransom.

NEW OTTAWA WATER PURIFICATION PLANT

At an overflow luncheon meeting on December 10th, W. E. Macdonald, city water works engineer of Ottawa, gave an address upon the "City of Ottawa Rapid Sand Water Purification Plant." Dealing, as it did, with a local civic project which would have its effect upon living conditions in the city, the address was of more than usual interest. At the head table, in addition to the chairman, G. J. Desbarats, C.M.G., M.E.I.C., and the speaker, there were: Hon. H. A. Stewart, K.C., Minister of Public Works; J. J. Allen, Mayor of Ottawa; J. B. Hunter, Deputy Minister of Public Works; Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines; Frank C. Askwith, A.M.E.I.C., Commissioner of Works for Ottawa; A. F. Macallum, M.E.I.C., John Murphy, M.E.I.C., F. H. Peters, M.E.I.C., John McLeish, M.E.I.C., and Noulan Cauchon, A.M.E.I.C.

By the use of slides and diagrams, Mr. MacDonald traced the course of the project from the construction of the initial plant for experimental purposes to the main new plant which required only a few more months for completion. Until recently very little was known regarding the possibilities of securing an attractive water supply from the highly coloured water of the Ottawa river and for this reason a small experimental trial plant for research purposes was deemed advisable.

This small plant was constructed in February, 1929, and had only been in operation a short time when it forcefully brought to the attention of those in charge that its construction was well merited. Radical modification from week to week was carried on in many essential forms to permit of proper coagulation, sedimentation and filtration, the data obtained being most invaluable in connection with the subsequent design of the main plant.

The site of the main 35 million gallon plant is on Lemieux island in the centre of the Ottawa river one-half mile upstream from the

Chaudiere falls. The sedimentation basin is situated in a natural bay of the river and the main pumping station is a building 160 feet in length, located immediately adjacent to the sedimentation basin and directly over the suction channel, which is 20 feet in depth and extends to the full length of the building.

The main pumping station is a combination of a low pressure and a high pressure service, the line of demarcation being at a point where the suction channel enters the building.

Directly to the south and adjoining the pumping station is located the new chemical building. It has been definitely proved that the Ottawa river water requires an unusual amount of chemical treatment and it has therefore been necessary to give a considerable amount of study to the design of the chemical building to ensure proper application of chemicals.

The purification building, to which the treated water from the suction well of the pumping station is conveyed, occupies an area 464 feet by 322 feet and includes the distribution chambers, static mixing tanks, coagulation basins, settled and waste water ducts, sand filters, wash water tank, pipe and operating galleries and the filtered water reservoir.

The filter gravel to a total depth of 20 inches is placed in the beds in five layers ranging in size from two inches to one-sixteenth inch. The filter sand, consisting of round, hard, durable, insoluble grains free from clay, loam, dirt or other impurities and foreign matter, has a depth of 34 inches.

The filtered water reservoir, having a capacity of six million Imperial gallons, is constructed upon the solid rock immediately below the sand filters and occupies an area of 376 feet by 132 feet.

Provision is made for regularly cleaning the filter beds, the wash water tank for this purpose being placed directly above the mixing tanks.

The speaker went into an explanation of the method of operation of the plant, tracing the course of the water from its raw to its filtered state throughout. A point of particular interest in this connection was the fact that experiments have shown that the floc produced in the Ottawa river water, by the addition of aluminium sulphate which acts upon the alkaline salts in the water, is extremely delicate. The types of static mixing basins designed and constructed in this plant have accordingly been the result of much experimental work and are radically different from the usual form of mechanical mixing tanks so generally adopted in other cities in recent years.

Another feature is the installation of what is known as an automatic master controller to constantly regulate the rate of filtration of all ten filters so that the rate of flow will be governed by the level of the water in the clear water reservoir.

After the various steps in the filter plant operation, including coagulation, sedimentation and filtration, have removed practically all of the harmful bacteria in the water, final sterilization is effected by the application of a very small amount of liquid chlorine. As a matter of interest the chlorine dose will be reduced from 18 pounds per million gallons for the raw water to less than 3 pounds per million gallons for the filtered water.

The design, construction and supervision of the entire plant was carried out under the direct control of Mr. MacDonald; and the firm of Gore, Nasmith and Storrie, consulting engineers of Toronto, was retained to prepare the plans and specifications.

At the close of Mr. MacDonald's address, Mayor J. J. Allen in a brief speech predicted the opening of the new plant in February or March of 1932. He also extended an invitation to the members and their friends to make a personal inspection on the following Saturday afternoon, the 12th of December.

Visit to Purification Plant

Following upon the invitation extended by the mayor, the members of the local branch and their guests, including the ladies, paid a visit to the purification plant on Saturday afternoon, December 12. About one hundred and fifty were present, the interest of the inspection being considerably enhanced by the fine mild weather which prevailed.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch was held in the Windsor hotel, on Friday, November 27th, following the regular dinner.

Lumbering in North America

The speaker of the evening was Mr. Lynn Hollingsworth of the Soo Lumber and Mill Company, and he had taken as his subject, "Lumbering in North America."

Lumbering in North America began with the arrival of the pilgrims to the New England states and the colonists to eastern Canada. Operations were confined in individual needs, whipsawing being a very laborious and slow method of sawing. The invention of the circular saw in the early nineteenth century gave an impetus to the industry which grew rapidly, reaching its peak in 1909 after which it declined slightly. Numerous inventions, such as the band saw, were mentioned as they helped to speed up the industry.

The speaker described the extent and product of the operations carried on throughout Canada and the United States. The extensive trade in lumber was described, the production and import and export of each district being given. British Columbia fir may be found on the market in the southern states and Georgia pine from the southern states is marketed in various parts of Canada, an illustration of the wide trade in lumber.

In conclusion the speaker said that we need not worry about the industry dying, as at the present rate of consumption there is enough timber in Canada to last a century if none were destroyed by fire.

Discussion followed the address, an interesting point being the difficulty of marketing North Shore birch, though it is the choicest to be had. This the speaker said was owing to the fact that the maple found with the birch is of such poor quality as to be unsaleable, making the expense of getting out the birch alone prohibitive at the present time.

A set of slides from the National Development Bureau entitled, "Lumbering in Canada," was then shown. These illustrated the various features of the industry in Canada.

A hearty vote of thanks was tendered Mr. Hollingsworth for his interesting address, on motion of Messrs. C. H. E. Rounthwaite, A.M.E.I.C., and J. W. LeB. Ross, M.E.I.C.

Toronto Branch

W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.

The Engineer and Public Affairs

Horace L. Brittain, B.A., M.A., Ph.D., managing director of the Bureau of Municipal Research, gave a most interesting address to the Toronto Branch of The Engineering Institute of Canada on Thursday, November 19th. The speaker was introduced by Lt.-Col. C. S. L. Hertzberg, M.C., M.E.I.C., chairman of the Branch. Dr. Brittain, who was born in the Maritimes, has spent many years in the study of educational and municipal affairs. He addressed the large gathering in part as follows:

Since the earliest times the engineer or his prototype has had a large part to play in public affairs. Possibly the first engineer was a military engineer. The old testament bristles with references to fenced cities and we know, for example, that the site of Jerusalem was fortified long before the appearance of the Hebrews in Palestine. Prehistoric Hellas had fenced and walled cities. Babylon had elaborate fortifications. The Romans became expert in the laying out of fortified military camps, they developed powerful siege-machinery, and their military roads which radiated from Rome to all parts of the Empire were so well constructed that parts of them are still in use. Their aqueducts were outstanding contributions to peace time engineering and their knowledge of hydraulics was considerable.

During the middle ages, engineering activities were largely in the field of military engineering. In the nineteenth and early twentieth centuries, however, civil engineering, in its various branches, has completely outstripped in amount and significance military engineering. These centuries were marked by large railway construction, just as the present decade is marked by large highway construction. While it is true that the Romans made considerable advance in sanitary engineering and while some of their structures are still in use, the modern development of sanitary engineering is largely of independent growth. Electricity is an old phenomenon in human experience, but electric engineering, notwithstanding its huge strides in recent years, is just at the threshold of its achievements. Mining engineering is, of course, very ancient, but the modern mining engineer in such countries as Canada, in co-operation with the mechanical and chemical engineer, is adding huge increments of wealth to human resources.

Striking as the development of engineering is in the history of the race, the growing importance of engineering in public affairs is even more striking. Highway engineering is almost entirely governmental. Sanitary engineering is predominantly so, while there is scarcely any phase of engineering which does not find a place in municipal, provincial or national activities. As government assumes more and more functions, undertakes more and more services, the services of technical men become essential A recent classification of the civic service of Toronto contained one hundred and seven engineering positions. Out of some sixteen departments in the Toronto civic government, four have functions which involve engineering activities as the basic element. These are Works Department, Street Cleaning Department, City Planning Department, City Architects Department, while the Parks Department and Health Department involve important engineering activities. It is interesting to note that a former head of the Laboratory Division of the Civic Department of Public Health is now a member of a prominent firm of engineers.

A recent classification of the Dominion Civil service showed some two hundred and fourteen different grades and ranks in the engineering profession involving, of course, a much greater number of individual positions. Among the different kinds of engineering referred to are: Architectural Engineering, Cartography, Hydrographic Engineering, Mechanical Engineering, Military Engineering, Electrical Engineering, Geodetic Engineering, Hydrometic Engineering, Power Development Engineering, Mining Engineering, Sanitary Engineering, Surveys Engineering, Electro-Chemical Engineering, Exploration Engineering, Research Engineering, Electro-Mechanical Engineering, Radio-Electric Engineering, Reclamation Engineering, Hydraulic Engineering, etc.

There are some engineering positions scattered among other services. No doubt a similar list could be compiled in the provincial field.

The growth of the Council-Manager form of government for municipalities has drawn particular attention to the large place which engineering has attained in municipal administration. The first manager of the first large city in the United States to adopt the system was a prominent engineer. The first manager of a city of over 400,000 population to adopt the system is an engineer and the engineering profession has been well represented in the over four hundred cities which have adopted it in Canada, Ireland and the United States. In general, when a city has a large programme of capital improvements before it, the trend is toward an engineer, and in cities which have reached a stage of quiet physical development the tendency seems to be to appoint a financial man.

There appears to be a widespread impression that in public affairs where, in normal times, the obtaining of capital funds is all too easy, the engineers as a whole are not sufficiently interested in keeping down expenditures, but are impelled by their training to give first consideration toward doing a good job of engineering from the physical standpoint. In private undertakings where conservation of capital investment is essential, financial control is strongly exercised from the outside and the average engineer is sufficiently trained in costing and cost records to stay inside the control, no matter how stupid and short-sighted he may consider the managers of the undertaking to be, so long as the factor of safety is adequately taken care of. In the average municipality, in ordinary times, there is not the same strong urge for economy, and the financial officer is simply one among equals. If the engineer is a man of strong personality with a strong instinct for construction, he may so dominate the situation as to obligate the municipality to large capital expenditures. However, even if the feeling has at present considerable basis in fact, this need not be the case if our engineering schools supply the necessary economic and financial training. Engineering essentially is the adaptation of available means to desired ends, and the engineering profession should be, at least as well as any other, capable of exercising the necessary economic and financial control. A recent bulletin issued by the Detroit Bureau of Governmental Research contained the following passage:

> "This new type of government is most important and matters a great deal (as distinguished from the simple forms which preceded it). And it is a government of science and inventions—of segregated budget and accrual accounting, of serial bonds and sinking funds, of toxins, anti-toxins, of rapid sand filters, activated sludge, kilowatts and powdered coal, peak loads, radio control, outdoor and institutional relief, core tests and so on through a long list of technical services which democracy demands, and can pay for, but obviously cannot administer."
>
> "But can democracy hire a personnel to do these things for it? Can it simplify its machinery of government and eliminate duplication so that tasks can be well done? Can it devise other than a political yard stick for measuring the results?"

I believe it can, and that the engineering profession has a great opportunity for public service in supplying the necessary point of view and a large part of the necessary personnel and leadership.

It is not necessary that the chief administrator of a large city should have the technical knowledge required by the various services rendered by the city. The first qualification, after the usual character qualifications, is the ability to choose and handle personnel. To discharge their functions properly, a man must have a true conception of the value of technical training in its various fields, and a flair for judging men and the use of the helps which have been devised for that purpose. It is conceivable in any particular case that a particular physician, lawyer or teacher might be the best manager of some particular city, but the ordinary training of an engineer, if broad enough, supplies more points of control with the operation of public administration than any other.

Even if it is necessary to add a year to the engineering course, the following suggestions would make subject for discussion:

1. That *all* engineering students be required to take a *real* course in economics.
2. That every engineering department of a university offer a major course in municipal government including the broad features of budgetary control, such course to be required of most students.
3. A course in modern scientific personnel administration with the necessary psychological background be made available to all engineering students.

An interesting discussion followed in which A. M. Reid, A.M.E.I.C., Mr. H. C. Powell and the speaker took part. The following points arose: 1. That the time would probably come when the sieve would be made finer in engineering education and that only young men of promising ability and character would be given degrees. 2. That great care should be exercised in the selection of the teaching staff for engineering colleges.

R. E. Smythe, A.M.E.I.C., moved a vote of thanks, stating that the speaker had paid a tribute to the profession and also a challenge.

W. E. Ross, A.M.E.I.C., after being welcomed to the Branch by the chairman, seconded the vote of thanks and complimented the speaker on his address. "In his opinion," added Mr. Ross, "the engineer should have a more extensive training in English, both written and spoken." Most engineers do not exert the influence they should, because they lack the technique of conveying it to others. This can be taught, because in Peterborough the cadets engineers have been encouraged to give short addresses and the improvement in address is apparent.

The Beauharnois Development

At a capacity meeting of the Toronto Branch of The Engineering Institute on Thursday, November 26, 1931, J. A. Knight, B.A.Sc., M.E.I.C., chief engineer of the Beauharnois Construction Company, outlined, in a most interesting manner, the engineering problems involved in the construction of the great power canal. Mr. Knight illustrated his address and showed two motion films of the work, giving all present a clear idea of the great development.

The chairman, Major C. S. L. Hertzberg, M.C., B.A.Sc., M.E.I.C., introduced the speaker, welcoming him back to his "home" branch. A great many members of the Toronto section A.I.E.E. were also present at the meeting.

In the interesting discussion which followed, General C. H. Mitchell, C.B., C.M.G., D.Eng., M.E.I.C., congratulated the speaker on the magnitude of the work under his direction, and the efficient way in which the work was scheduled and carried to a successful conclusion.

J. W. Falkner, B.Sc., A.M.E.I.C., moved a fitting vote of thanks.

Mr. Knight is to be congratulated on his address, which was logical, comprehensive and lucid.

The Effect of Building Materials on Paint Films

By H. M. Llewellyn, B.Sc., A.I.C.

Many instances of failure of paint applied to building materials have been reported to the Building Research Station. In particular, trouble is often experienced in the decoration of wall plasters, Portland cement renderings and asbestos cement sheets with ordinary oil paints and washable distempers.

Investigation of failures has shown that they are usually due, *not to any defect in the paint itself*, but to the nature or condition of the material to which it is applied. The types of failure which occur most commonly are blistering, peeling, flaking, softening or stickiness and bleaching or discoloration. In general, it may be stated that of these, the first three are usually due mainly to physical or mechanical causes, while the others are the result of chemical attack of the paint film by substances which come into contact with it.

The chief factor which affects the soundness of the paint film is the moisture content of the material at the time of painting. If it were practicable to delay painting until the material had become quite dry, very few failures would occur. When, however, as is usually the case in practice, some moisture remains in the structure when decoration is commenced, there is a potential danger not only from the water itself but on account of substances which may be dissolved in it.

The Effect of Moisture

The presence of moisture alone may affect a paint film in several different ways. It is quite commonly specified that a plastered wall should be painted immediately after the plaster has been trowelled. In such a case there is usually a very considerable amount of water in the plaster and the backing. If this moisture has no ready egress elsewhere it may damage the paint, for sufficient hydrostatic pressure may be developed to distort the film and cause blistering. Under conditions in which air has been drawn into the wall on partial drying, the redistribution of water after painting may result in air becoming compressed by capillary forces into the pores just beneath the paint and so causing air blisters to form. This effect is also seen when water enters the material, at a time subsequent to painting, from some external source such as a leaking roof, or through porous walls or a defective damp course.

There is also the consideration that any oily film adheres less readily to a damp surface than to a dry one. Any force tending to disturb the paint film will then have little resistance to overcome, and liability to flaking or peeling will be increased.

Another example of the effect of moisture is the blistering of paintwork exposed to heat, e.g. on walls behind radiators. Here the force which actually causes the blistering is the expansion of air or water-vapour in small air-pockets which are liable to be formed behind the film when paint is applied to a damp surface.

It is important, therefore, that care should always be taken to ensure that no water is entrapped behind a paint film. The danger is greatest when both sides of a wall are sealed by impervious films; if the wall is open to the air on one side, the risk from this source is very greatly diminished, since the water will tend to escape by the easiest route. If it is essential to decorate a surface which it is known has not had time to dry completely, it is advisable to employ a more porous medium than oil paint, e.g. distemper, which will allow evaporation of water to continue slowly.

The Effect of Dissolved Substances

Many building materials contain salts and other substances which are soluble in water, and the presence of these in solution may affect paint both physically and chemically.—*Abstract from Bulletin No. 11 issued by the Department of Scientific and Industrial Research, England.*

Preliminary Notice

of Applications for Admission and for Transfer

December 22nd, 1931

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, 1932.

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

ANDERSON—CLARENCE AUBREY, of Halifax, N.S., Born at Halifax, N.S., Feb. 8th, 1891; Educ., One year special student, Dalhousie Univ., 1914-15; Three year evening course at technical schools; 1910-11, workshop, Nova Scotia Telephone Co. Ltd.; 1911-14, lab. asst., Nova Scotia Technical College; 1916, machinist, Starr Manufacturing Co.; 1916-17, machinist and power plant operator, Halifax Electric Tramways; 1917-20, traveller and branch mgr., Sydney, N.S., Can. Gen. Elec. Co. Ltd.; 1920-21, asst. to elec'tl. engr., Halifax Shipyards; 1921-23, dftsman., Maritime Tel. and Tel. Co. Ltd.; 1923-24, managing engr., light, power and pumping plants, Town of Summerside, P.E.I.; 1924-26, operator, N.S. Power Commission; 1926-28, supt., mech'l. and elec. equipment, Canadian Govt. Elevators; 1928 to date, elect'l. supt., Halifax Harbour Commissioners, Halifax, N.S.

References: J. J. Macdonald, A. G. Tapley, C. H. Wright, H. Fellows, L. Cunningham.

BREITHAUPT—PHILIP WILLIAM, of 214 Queen St. South, Kitchener, Ont., Born at New York, N.Y., Dec. 16th, 1898; Educ., C.E., Rensselaer Polytech. Inst., 1922. One year, post-graduate work, Engineering Economics, Harvard Univ.; 1922-24, timekpr., material clerk, lines and grades, asst. supt., with Turner Construction Co., Graybar Bldg., New York; 1925-26, asst. valuation engr., The Barrett Company, New York; 1926-29, field engr., Turner Construction Co., New York; 1929-31, consultant engr., Charles R. Ward, Brooklyn, N.Y.; at present, civil engr., with W. H. Breithaupt, M.E.I.C., Kitchener, Ont. (1918 (6 mos.), Cadet, R.A.F.). A.M. Amer. Soc. C.E., 1929.

References: W. H. Breithaupt, S. Shupe, M. Pequegnat, R. O. Wynne-Roberts, J. A. L. Waddell.

COWIE—ALFRED HENRY, of Montreal, Que., Born at Liverpool, England, Feb. 18th, 1890; Educ., B.Eng., 1910. M.Eng., 1916 (in absentia), Liverpool University; 1914-19, overseas on active service, M.C. and Bar. Present rank Lt.-Col.; 1910 to date, with the Dominion Bridge Company, Ltd., Montreal, as follows: 1910-11, struct'l. dftsman., bridges and bldgs.; 1911-13, checker, struct'l. details; 1913-14, and 1919-21, struct'l. designer; 1921-22, contracting struct'l. steelwork; 1922 to date, assistant general manager.

References: J. H. Brace, F. P. Shearwood, L. R. Wilson, P. B. Motley, P. L. Pratley, J. Grieve.

DESSERUD—ANTON, of 52 Alexandra Ave., St. Lambert, Que., Born at Sigdal, Norway, May 17th, 1891; Educ., Civil Engr., Tech. Univ. of Norway, Trondhjem, 1919; 1919-21, asst. engr. with Prof. Olav Heggstad, Board of Electric Supply of Norway, design, survey, reports on power plants; 1921-24, hydraulic and constrn. engr., in the Civil Service of Dutch East India, Bandoeng, Java, design and constrn. of power plants; 1924-25, hydraulic designer, Electric Bond & Share Co., New York; 1925-26, dftsman., Ford, Bacon & Davis, Inc., New York; 1926-28, dftsman. on design of dams, hydro-electric structures, reinforced concrete, and 1928 to date, squad leader on design of power plants, Power Corporation of Canada, Montreal.

References: H. S. Grove, L. C. Jacobs, G. H. Kohl, C. N. Mitchell, J. H. Trimingham, J. S. H. Wurtele.

FEICK—CLAYTON GEORGE EMMERICH, of 1539 Bishop Street, Montreal, Que., Born at Wiarton, Ont., April 18th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1928; 1925 (May-Sept.), constrn. dept., Toronto Hydro-Electric System; 1925-27, installn. dept., and from 1928 to date, power telephone engr., Northern Electric Company, at present in shop costing dept. (Work included investigating power plant requirements and submitting recommendations; machine room, storage battery room and other layouts; designing power boards, distribution panels and circuits; writing specifications for above types of equipment and checking specifications.)

References: W. C. Adams, W. N. McGuinness, H. Miller, J. Clancy, W. V. Cheshire, W. H. Jarand, H. G. Thompson.

FRANKLIN—HARRY SIDNEY, of 117 Brighton Ave., Ottawa, Ont., Born at London, England, Mar. 2nd, 1895; Educ., 1911-14, elect'l. engrg., Regent Street Polytechnic, London, England; 1914-19, with Royal Engrs.; 1919-21, Strand Electric and Engrg. Co., London; 1924 (May-Dec.), charge of substation constrn., General Electric Company, New York; 1925-28, charge of substation constrn., and electrification of Virginian Railway, for Gibbs & Hill Inc., New York; 1926-27, charge of power house and substation constrn., Dixie Construction Co., Birmingham, Ala.; 1927 (Mar.-July), charge of design and constrn. of extension to Temiskaming Mill, for Fraser Brace Engineering Co., Montreal; 1927-30, charge of power house and substation design and constrn., Gatineau Power Company, Ottawa; 1930-31, charge of elect'l. design and constrn., for Town of Edmundston, N.B.; August 1931 to date, charge of elect'l. installn., Chats Falls, Morrow & Beatty, Fitzroy Harbour, Ont.

References: H. A. Thompson, W. G. C. Gliddon, G. G. Gale, W. E. Blue, D. G. Wallace.

JEPSEN—VIGGO, of Montreal, Que., Born at Gellerup, Denmark, March 22nd, 1904; Educ., 1923-27, Three years day course, Technical School, Horsens, Denmark; 1919-26, engaged in bldg. constrn. work during summer months, in Denmark; 1927 (6 mos.), engr. and dftsman., Experimental Office for Artillery, Royal Danish Army; 1928-29, instr'man., on prelim. surveys for hydro-electric development, and 1930-31, instr'man. on constrn. of hydro-electric development, Shawinigan Water and Power Company; 1929-30, asst. engr. on hydraulic surveys; 1931, layout engr., for power station and school bldg., John MacGregor, Ltd.; 1931, instr'man and dftsman., in charge of party, for hydro-electric development, Shawinigan Engineering Company, Montreal, Que.

References: J. A. Grant, C. R. Lindsey, C. Luscombe, J. B. Macphail, M. R. Murray, R. G. Swan.

LEAK—CHARLES RICHARD WILLIAM, of Regina, Sask., Born at Manchester, England, Aug. 22nd, 1904; Educ., Commn. as D.L.S. Home Study; 1926-27, asst. on surveying and engrg. work, K. N. Crowther, A.M.E.I.C., and D. A. Smith, A.M.E.I.C.; of Regina, Sask.; 1928-31, three years under articles to Dominion Land Surveyors with the Topographical Survey of Canada—asst. chief of party in the field and engaged on the plotting of topog'l. maps from aerial photographs; at present, office engr. and map dftsman., Dept. Natural Resources, Regina, Sask., misc. surveying and engrg.

References: F. H. Peters, D. A. Smith, T. J. Tyrer, R. H. Murray, S. Young, M. P. Bridgland.

MacDONALD—DONALD STEWART, of 255 Ossington Ave., Toronto, Ont., Born at Tweed, Ont., April 26th, 1900; Educ., B.Sc., Queen's Univ., 1924; 1919 (Jan.-Sept.), engrg. dept., (Western), C.P.R.; 1920-23 (summers), constrn. work, various jobs with contractor on rly. mtce.; 1924-26, supt. and engr. of constrn. work for Sask. district of C.P.R., done by Hurst Eng. & Constrn. Co. Ltd., Winnipeg, bridge, bldg. and track work; 1926, cost engr., paper mill constrn., International Paper Co., Three Rivers; 1927, cost engr., paper mill constrn., Gatineau, Que.; 1928 (Jan.-June), constrn. engr., fibre board mill constrn., Gatineau, Que.; 1928-29, constrn. engr., Frood Mine surface plant, Frood, Ont.; 1929 (Feb.-Aug.), constrn. engr., Port Colborne Refinery Constrn.; 1929-30, constrn. engr., Copper Cliff Smelter and Concentrator constrn.; 1931, constrn. engr., for Fraser Brace Engrg. Co. Ltd., Sudbury, Ont.

References: W. P. Wilgar, N. J. Kayser, W. H. Greene, J. H. Brace, A. I. Cunningham, J. R. C. Macredie.

PRICE—JOSEPH LEWIS EDGAR, of Montreal, Que., Born at Aberbeeg, Wales, Jan. 16th, 1889; Educ., 1903-06, Technical School Classes, concurrently with articled pupilage to architect and civil engineer, G. Cox-Hillard, Abertillery, Wales; 1907-08, asst. engr. with The Ebbw Vale Steel Iron & Coal Co., Wales; 1909-10, works mgr., The Ebbw Valley Construction Co., Engrg. Contractors, Wales; 1911-14, various engrg. capacities, latterly executive asst. engr., with C.P.R., Dept. Natural Resources, Calgary, Alta.; 1915-18, Lieut., C.E.F.; 1919-21, asst. to chief engr. and gen. mgr., during design and constrn. of Riordon Company's sulphite pulp mill and hydro-electric development at Temiskaming, Que.; 1922 to date, vice-president, George A. Fuller Company of Canada Limited, in sole charge of constrn. of such structures as the Royal Bank Building, Bell Telephone Building, Dominion Square Building, etc., etc.
References: S. J. Hungerford, J. W. Orrock, D. C. Tennant, H. R. Little, W. J. Armstrong, L. C. Jacobs, C. S. L. Hertzberg, A. H. Harkness.

ROGERS—HARRY GEORGE, of Montreal, Que., Born at Peterborough, Ont., Nov. 2nd, 1884; Educ., 1903-05, 1911-13, McGill Univ. Took three years but did not proceed; 1902-03, rodman, Canadian Niagara Power Co.; 1907-08, shop inspr., Dominion Bridge Co.; 1910 to date, with C.P.R., as follows: 1910-11, gen. inspr. on bridge work; 1911-14, bridge inspr.; 1925-28, constrn. inspr., detailing and supervising reinforcing steelwork for Toronto Terminals Rly. Station; 1928-29, supt., steel struct'l. work for Royal York Hotel; 1929, supt., steelwork and detailing changes for Palliser Hotel addition; 1930-31, in charge of replacement of all bridges in Ontario District; 1931, in charge of fabrication work for new bridges in Maine.
References: C. H. Mitchell, B. Ripley, G. H. Davis, W. H. B. Bevan, A. R. Ketterson, P. B. Motley, V. A. G. Dey.

RUNDLE—LEWIS PHILIP, of 28 Academy St., St. Catharines, Ont., Born near Lambeth, Ont., Dec. 10th, 1874; Educ., B.S. in Elec. Engrg., Case School of Applied Science, 1909; 1901-02, chief operator, municipal power, light and pumping plant, Goderich, Ont.; 1902 (summer), instr'man., on base and meridian line survey, Algoma District; 1909-10, sub-foreman, commercial test dept., Bulloch Electric Co., Cincinnati; 1910-12, designing dftsman on power plants, A.C. and D.C. machy., General Electric Co., Schenectady, N.Y.; 1912-14, design of power plants and switchboards, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; 1915-16, designer of machines and tools, Lenderman Co., Woodstock, Ont.; 1916-20, mech'l. and elect'l. design, Crocker Wheeler Co., St. Catharines, Ont.; 1920-21, design and estimating for electr'l. cranes and hoists, Herbert Morris Crane & Hoist Co., Niagara Falls, Ont.; 1921 to date, on the Welland Ship Canal, at present senior asst. engr. Engrg. works in connection with elect'l. design of power and control systems, transmission lines, bridges, pumping plants, lighting, hydro-electric plant, sub-stations, cable duct system, etc. Elect'l. specifications for power plant equipment, transformers, substations, control, gate lifter, etc. Directing elect'l. installations, tests and inspection.
References: A. J. Grant, E. G. Cameron, M. B. Atkinson, F. E. Sterns, A. L. Mudge, W. E. Ross, C. G. Moon.

THOMPSON—JOHN, of 62 Browning Ave., Toronto, Ont., Born at Murton, Durham, England, July 1898; Educ., Toronto Technical School, evening classes, Mech. Design Diploma. I.C.S. Civil Engrg. Course; 1914 (6 mos.), junior electr'n., Canadian Copper Co., Crean Hill Mine; 1914-16, steamfitting, Purdy Mansell, Toronto; 1916-18, dftsman., Canadian Ice Machine Co.; 1918 (4 mos.), tractor design, Hamilton Gear and Machine Co.; 1918 (3 mos.), munition shop management, Webber Machine Co.; 1919-20, chief dftsman., Canadian Ice Machine Co.; 1920-25, mech'l. design, and 1925 to date, charge of mech'l. design, H.E.P.C. of Ontario, covering mainly cooling water systems, lubrication, sanitary, ventilation, heating and transformer oil systems.
References: E. B. Dustan, W. Harland, S. W. B. Black, J. W. Falkner, H. E. Brandon.

TROWBRIDGE—CHARLES BARTLETT, of Montreal, Que., Born at Decatur, Mich., U.S.A., Jan. 16th, 1884; Educ., B.S., Rose Polytechnic Institute, Terre Haute, Indiana, 1905; 1905-09, dftsman., Illinois Steel Company; 1910-11, dftsman., American Bridge Co., Gary; 1912-31, chief dftsman., engr. and salesman, Mead-Morrison Mfg. Co., Chicago; July 1931 to date, sales manager, Canadian Mead-Morrison Co. Ltd., Montreal, Que.
References: S. Barr, H. M. Jaquays, F. W. Taylor-Bailey, O. E. Leger, R. E. Chadwick.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

CROSS—FREDERICK GEORGE, of Brooks, Alta., Born at Exeter, England, Sept. 2nd, 1881; Educ., Private tuition; 1906-09, location surveys and constrn. as rodman, instr'man. and timber inspr., C.P.R.; 1909-10, chief inspr., structure construction and field supervision, C.P.R., Irrigation Branch; 1911-12, asst. engr., Bassano Dam and Main Canal, etc., and 1912-14, gen. inspr. supervising concrete, steel and timber constrn., eastern section; 1915-19, overseas, Can. Rly. Troops, Major; 1919-25, canal supt., Eastern Section Irrigation Project, and from 1925 to date, asst. supt., operation and mtce., C.P.R., Dept. Natural Resources, Brooks, Alta. (*A.M 1912.*)
References: S. G. Porter, H. B. Muckleston, T. R. Loudon, A. Griffin, B. Ripley, H. A. Moore.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BOISVERT—CHARLES H., of Quebec, Que., Born at Montreal, Que., Feb. 2nd, 1904; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1925; 1924 (4 mos.), Topog'l. Survey; 1925-26, Student's training course, Shawinigan Water & Power Company; 1926-31, engr., and from Aug. 1931 to date, acting chief engr., Quebec Public Service Commission, Quebec, Que. (*Jr. 1927.*)
References: A. Lariviere, H. Cimon, R. H. Mather, J. L. T. Martin, A. Frigon, L. Beaudry, R. B. McDunnough, J. U. Archambault.

IRETON—JOSEPH MAURICE, of Calgary, Alta., Born at Moosomin, Sask., Sept. 23rd, 1898; Educ., B.Sc., Queen's Univ., 1928; 1919, dfting in C.P.R. shops, Winnipeg; 1925, inspr. for city engr., Regina; 1926, Massey Harris shops, Brantford; 1927, John Bertram & Sons, Dundas; 1928-29, asst. mech. supt., Central Spring Co., Oshawa; 1929, dftsman., Angus & Watson, Toronto; 1929 to date, head of maths. and dfting depts., Calgary Technical High School. (*Jr. 1929.*)
References: J. H. Ross, A. W. P. Lowrie, L. M. Arkley, L. T. Rutledge, D. A. R. McCannel, M. B. Watson.

TRUEMAN—JAMES COBDEN, of 1 Luxton Ave., Winnipeg, Man., Born at Kent, England, Nov. 28th, 1900; Educ., B.Sc. (C.E.), Univ. of Man., 1923. M. Sc., (Struct'l. Engrg.), McGill Univ., 1924; 1918, rodman, 1919, instr'man., C.P.R.; 1919-20, dftsman., E. D. Tuttle, architect; 1920, field dftsman., rly. location, C.P.R.; 1921, inspr., highway bridge constrn., Man. Good Roads; 1922, rodman, Great Falls power house, Fraser Brace Engrg. Co.; 1923, instr'man., mtce., Chicago, Milwaukee and St. Paul Rly.; 1924-25, struct'l. designer, U.S. Gypsum Co., Chicago; 1925-26, detailer, American Bridge Co., Gary, Ind.; 1926-27, chief dftsman., mainly struct'l. design, Kimberley Clark Co., Neenah, Wis.; 1927 to date, designing engr., Dominion Bridge Company, Ltd., Winnipeg, Man. (*Jr. 1924.*)
References: H. M. White, J. N. Finlayson, C. T. Barnes, R. D. Hannan, N. M. Hall.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

KAYE—JOHN ROBERT, of 8 Oxford St., Halifax, N.S. Born at Halifax, N.S., Sept. 13th. 1903; Educ., B.Sc. (Mech.), McGill Univ., 1924; 1921-23 (vacations), street paving work for City of Halifax; 1924 (3 mos.), erecting elect'l. equipment in pulp mill at Sheet Harbour for Canadian General Electric Co.; 1924 to 1928, employed by the Montreal Engineering Company, and assigned to the following: 1924-25, mtce. and constrn., Calgary Power Company; 1926-28, meter dept. and power distribution, Venezuela Power Co., Maracaibo, Venezuela; 1928 (8 mos.), manager of Barquisimeto divn., 1928-30, gen. supt., and 1930-31, manager Barquisimeto divn., Venezuela Power Co. Ltd., Maracaibo, Venezuela. (*S. 1924.*)
References: G. A. Gaherty, D. Stairs, J. T. Farmer, J. H. McLaren, R. W. Tassie, I. P. Macnab, H. W. L. Doane.

PRICE—FREDERICK AVERY, of Donnacona, Que., Born at Quebec, Que., Oct. 12th, 1904; Educ., B.Sc., Queen's Univ., 1929; With Price Bros. & Co. Ltd., as follows: Summers 1922-23-24, machine shop, paper machine erection, eng. records dept., Kenogami paper mill; Summer 1925, asst. erector, Riverbend paper mill; 1926-27 and summer 1928, design and dfting., engrg. dept., Quebec; 1929 to date, asst. plant engr., Donnacona Paper Company, Donnacona, Que. (*S. 1924.*)
References: W. G. Mitchell, A. A. MacDiarmid, J. S. Bates, C. A. Buchanan L. T. Rutledge, G. F. Layne, H. Cimon.

FOR TRANSFER FROM THE CLASS OF AFFILIATE

CUNNINGHAM—JOHN FERGUSON, of Winnipeg, Man., Born at Manchester, England, Oct. 12th, 1895; Educ., 1926, 1929-30, physical and inorganic chemistry, Univ. of Man. Physical metallurgical study for civil engrg. dept., 1909-11, C.P.R.; 1911-13, with Burnham Firth Electric Co., Edmonton; 1914-15 (seasons), with Dept. Public Works Canada; 1916-19, overseas, Can. Engrs.; 1919-21, mgr., Cunningham Bros., drilling and testing, Edmonton; Sessions 1921-22, 1922-23, 1923-24, asst. and mechanic in charge of civil engrg., mech'l. and hydraulic labs., Univ. of Man.; 1922-23-24 (seasons), engr. master of dredge "Plamondon," Lac la Biche, Alta.; 1927-28 (summers), inspr. on reinforced constrn. pavements and doctor's residence and nurses' home, St. Boniface Hospital, St. Boniface, Man.; 1924 to date, supt., engrg. labs., engr. of commercial tests and metallurgical examination. Research work and assistance to instruction of laboratories classes in materials testing, and mech'l. lab., Univ. of Manitoba, Winnipeg, Man. (*Affiliate 1928.*)
References: J. N. Finlayson, N. M. Hall, F. G. Goodspeed, L. R. Brereton, R. W. Moffatt, T. C. Main.

The Way to National Progress and Prosperity

Abstract from article by C. E. Grunsky appearing in the October, 1931, issue of Civil Engineering

The nation's spiritual and cultural advancement is of greater importance than provision for material well-being. Expenditures of public funds for such purposes, comparable with those spent for the safe-guarding of life and property, for the protection of health and for facilitating the exchange of products, would not be unreasonable, but there is fear of the tax burden.

Under a balanced programme, the nation should get vastly increased scientific research; expansion of educational opportunity and encouragement of art by the erection of monuments, the establishment of museums, art galleries, conservatories of music and opera houses, with maintenance of opera companies, in all centres of population. These expenditures would contribute to the spiritual uplift of the people and the progress of civilization. Provision for outdoor recreation should be made throughout the land on a scale never yet approached. Lands should be reserved and acquired so that those who go into the open can find suitable places to picnic and to camp. During periods of declining prices there should be also a speeding up of public works, according to a sane programme. Recourse to pick and shovel, instead of to modern appliances, is but a trifle better than the giving of a dole, with its encouragement of idleness and of a return to primitive conditions.

The basis of such a programme is a high rate of taxation; but any suggestion that the government spend more money, particularly in business depressions, is commonly frowned down. The fact is ignored that when capitalists close their purses, the government must spend to avert disaster. Objection should not be made to the magnitude of the sum to be raised, but to the prevailing unfair systems of apportioning the tax. If the burden were distributed commensurately with the ability to pay, there would be less dissatisfaction, and the public would soon learn that the greater the tax, the less the slump in the aggregate of the country's business.

Tax money thus put into circulation would create a volume of business that could readily bear the tax from year to year. To make this clear, let it be supposed that times are hard and money scarce, and that Jones has run up a bill of $100 at the grocer's. The grocer has gone into debt to a truck gardener for the same amount; the truck gardener owes the butcher $100; the butcher owes the baker; the baker owes the plumber and so on one hundred times. The total indebtedness is $10,000, with one hundred persons complaining of the difficulty of making collections. Jones finds employment and pays his grocery bill. The grocer pays the truck gardener with the $100 received from Jones, and so on until a single $100 in a few days may have reduced outstanding indebtedness by $10,000.

If money received from taxes, equitably levied, is economically spent at home, it will in passing from hand to hand create in the long run business for each taxpayer in substantially the proportion in which he has contributed. Each dollar thus expended by the government should create from $30 to $50 work of business in a year, with, of course, some annual shrinkage. There appears no reason, in theory, why taxes should not be welcomed.

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Situations Vacant

SALES REPRESENTATIVE for various Ontario districts required by manufacturer of established engineering product. Prefer engineer-salesman good connection in mining, building and general engineering field, who would consider part time or sideline arrangement on commission basis. Location available, eastern and western area, northern and Niagara peninsula. Apply to Box No. 787-V.

WANTED, a graduate in mechanical engineering, between ages of twenty-five and thirty, to enter employ of a manufacturing firm situated in Toronto, to learn and grow up with the business. Must be of good appearance and qualified to assume full responsibility. A man preferred who has been employed by an industrial manufacturing firm. Acquainted with supervision, costing and production. Must be satisfied to accept a low but increasing salary during period of indent. State all particulars. Give age, experience and qualifications. Box No. 788-V.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

MECHANICAL AND CIVIL ENGINEER, B.Sc. 1926 (Queen's Univ.), A.M.E.I.C. Ten years experience building construction. Last two years estimator and sales engineer in prov. of Quebec. Good connections with architects, engineers and contractors in Quebec. Available immediately. Apply to Box No. 166-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

DRAUGHTSMAN, experienced in design steam and ventilating plants, boiler layouts, hoisting and other machinery, and structural engineering. Good references. Present location Montreal. For interview apply Box No. 329-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing, or sales organization. Apply to Box No. 334-W.

Situations Wanted

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and moveable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, B.Sc., Jr.E.I.C., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.Q., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

Situations Wanted

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

CIVIL ENGINEER, B.A.Sc. Toronto '28. Experience, hydro-electric, building design, bridges and culverts, inspection and testing of materials. Married. Present location Montreal. Apply to Box No. 576-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

MECHANICAL ENGINEER, Jr.E.I.C., five years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

CIVIL AND MECHANICAL ENGINEER, experienced in design, layout, installation and selling. Sixteen years association with largest Canadian industries manufacturing equipment particularly relating to pulp, paper and lumber and five years design and construction of sulphite mill, including electrolytic bleachmaking from salt. Apply to Box No. 633-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes on year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door sub-station construction, as assistant engineer. Also geologival survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

ELECTRICAL GRADUATE, McGill '30, S.E.I.C., with thirteen months experience on General Electric test course, twelve months draughting and five months as instrumentman on power plant construction. Location immaterial. Apply to Box No. 644-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), extensive experience as executive and in charge of construction of complete water power developments, including transmission lines, harbour developments, including hydraulic, dredging and land reclamation, industrial plants and municipal works. Apply to Box No. 647-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, Jr.E.I.C., 1926 grad. of English Tech. Coll. Past two years inspector of communication apparatus; three years varied power and sub-station experience, including automatic sub-stations, on comprehensive training scheme. Age 24, single. Location immaterial. Available at once. References. Apply to Box No. 658-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931. N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; students test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

RADIO ENGINEER, with thorough general experience covering short wave, marine, broadcast, wire communication, and sound picture work. Capable of taking responsibility in engineering, operating, manufacturing or executive fields. University graduate; single; age 27. Apply to Box No. 667-W.

Situations Wanted

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

ELECTRICAL ENGINEER, B.Sc., McGill Univ. '23, Jr.E.I.C. Eight years experience as sales engineer in all classes of electrical machinery, also switching, mine hoists, steam and hydraulic turbine generator sets, street railway and railroad equipment. Good commercial experience. Highest references. Age 30. Single. Available immediately. Apply to Box No. 670-W.

CIVIL ENGINEER, graduate University of New Brunswick '31, in C.E. Experience consists of three seasons on a survey party. Available October 1st. Desires permanent position. Willing to go anywhere. Apply to Box No. 672-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

CIVIL ENGINEER, graduate, Jr.E.I.C., age 25, single. Experience includes mill construction, design and supervision. Also design of hydraulic structures, bridge foundation, rigid frames and caissons. Will go anywhere. Apply to to Box No. 677-W.

RADIO ENGINEER. Graduate McGill Applied Science '30. Experience includes the design, development and production of broadcast receivers, as well as general radio laboratory practice. Apply to Box No. 680-W.

ELECTRICAL ENGINEER, graduated 1914, desires position with engineering firm or electric utility. Experience in design and layout of power houses and sub-stations, including automatic and supervisory control equipment; design of switchboards and switching equipment; manufacturing, testing, erection and operating of electrical apparatus of all kinds. Anywhere in Canada. Permanent position preferred. Apply to Box No. 681-W.

OPERATING ENGINEER, A.M.E.I.C. Operating superintendent or assistant. Age 44, married. Twenty years experience in industrial manufacturing, steel mills, power plants and quarrying operations, both large and small. Very successful with labour problems, cost accounting, etc. Will take any position with view to betterment. Available immediately in any location. Apply to Box No. 682-W.

ELECTRICAL ENGINEER, B.Sc.E.E., University of Man. 1921, A.M.E.I.C., married. Two years Westinghouse test course, three years sales engineer, five years draughting and electrical design on hydro plants, transmission lines, etc. Apply to Box No. 687-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available on short notice. Apply to Box No. 692-W.

Situations Wanted

ELECTRICAL ENGINEER, S.E.I.C., B.A.Sc. '31. Age 21. Three months undergraduate experience in electric railway substation. Five and a half months Canadian General Electric test course on induction motors and industrial control apparatus. Available on short notice. Location immaterial. Apply to Box No. 700-W.

AERONAUTICAL ENGINEER, M.Sc. Mass. Inst. of Tech., B.Sc. Mech. Eng. Queen's Univ. '30. Capable of aircraft design work and stress analysis. Experience also in machine design, etc. Canadian, single, available immediately for position anywhere. Apply to Box No. 702-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in Western or Eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

MECHANICAL ENGINEER, Jr.E.I.C. Graduate Inst. Mech. Engrs. Age 25. Nine years practical experience, design and construction, air compressors, Diesel engines, elevating, transporting, stone and woodworking machinery. Three years at pulp and paper mill, design and construction of paper and board machinery, reinforced concrete construction. Available at once. Apply to Box No. 704-W.

ELECTRICAL ENGINEER, B.A.Sc., graduate '28. Test experience D.C. motor and generator design, and industrial electric heating design experience. Single. Location immaterial. Apply to Box No. 709-W.

CIVIL ENGINEER, A.M.E.I.C., P.E.Q. Experience includes design and superintending construction of large reinforced concrete and steel mill buildings. Available at once. Apply to Box No. 712-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draftsman on modern steam power plants. Experienced in publicity work. Well known throughout the West. Location, Winnipeg or the West. Available at once. Apply Box 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experience in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

Copper-Oxide Photoelectric Cell

Electric Energy from Sunlight

Photoelectric cells that are commonly known and widely used both in industry and in laboratories are elements which suffer a change in resistance when illuminated. Certain materials, such as selenium, and certain apparatus, such as the vacuum tubes containing an electrode made from one of the alkali metals, have the characteristics that their resistances are much reduced when they are illuminated.

If such a piece of apparatus is connected to a battery or other source of power, it will not allow a current to flow so long as it is dark, but will as soon as the sensitive part of the circuit is illuminated. This kind of photoelectric cell, therefore, serves as a switch or a relay in a circuit which contains a local source of power. That is the type of photoelectric phenomenon that was discovered by Heinrich Hertz in 1887. The small currents that can flow through these devices are multiplied by means of amplifiers or relays so that they can be made useful in experiments and in industry.

The photoelectric cell that is the subject of this narrative is different from this ordinary type of photoelectric cell in that it does not require a battery or other local source of power. It transforms the energy of the sun's rays directly into electrical energy.

A few years ago a copper-oxide rectifier (Narrative 178) was being used for measuring small alternating currents by means of a direct-current meter. Trouble was encountered on account of what seemed to be erratic behaviour of the rectifier-meter combination. Observation showed that when sunlight fell on the rectifier, it gave a low reading; when an observer happened to stand so that his shadow fell on the rectifier, it gave a much higher reading.

This was the first observation of a photoelectric effect in a copper-oxide rectifier. It was thought due to a change in reistance, but a little more experimentation traced it to an electromotive force produced in the rectifier when it was exposed to light. The copper oxide photocell is the result of discoveries made and laboratory work done by Dr. P. H. Geiger and the writer. Further experimentation in our laboratory and elsewhere has indicated that the source of the electric current is at the junction between the mother copper and the oxide formed on it, which is also the location of the rectifying action of the copper-oxide rectifier.

This photoelectric cell is interesting theoretically. No satisfactory detailed explanation has yet been given of its operation, although it seems evident that it must be due to the liberation of electrons in the oxide or at the boundary between the oxide and the copper. Professor W. Schottky and Dr. Lange of Berlin have worked on the characteristics of this cell.

This cell will be useful for the operation of relays and of instruments for measuring intensity of sunlight, and in other applications where the power requirement is small. It transforms radiant energy directly into the energy of an electric current.

The cell operates very quickly and has practically no time lag. It can therefore be used for the reproduction of sound by means of a beam of light. In its present form it is most sensitive in the red and infra-red portions of the spectrum. This is due to the fact that the light has to travel through cuprous oxide in order to arrive at the boundary where the photoelectric energy is produced.

One important characteristic is that the behaviour of the boundary, which is the source of the electric energy, is uniform over any desired area. The boundary surface is permanent, consistent in its performance, and can be used in series or parallel connections to any desired extent. This type of boundary distinguishes itself especially in this consistency and in distributed and additive action, from any of the temporary or superficial contacts made between different materials and used in electrical work before the discovery of the copper-oxide rectifier.

The copper-oxide photo cell produces a current in a circuit which is practically proportional to the intensity of the illumination, so that it can be used with a sensitive instrument for reading directly the intensity of sunlight or other illumination. Since it can be used for determining the intensity of illumination, it can also be used with a constant source of light to detect smoke or to determine the density of smoke. It can be connected with a recorder so that the density of smoke at any time during the day may be read from a permanent record.

It can be used to turn on lights when natural illumination is low in the evening or during the passing of heavy cloud, and to turn them off again when the natural illumination increases. By projecting a beam of light across a road upon one of these cells, it can be located so that a vehicle that passes throws a shadow on the cell and operates a counter. It can be used, then, for counting vehicles, and for controlling traffic lights when a driver on a light-traffic road wishes to cross. These are illustrations of the many possible applications in industry and in scientific work.—*L. D. Grendahl, Ph. D., in Research Narratives of The Engineering Foundation.*

Early History of Electric Lighting

Though the great discoveries of Faraday in 1831 pointed the way to the use of power for the development of powerful electric currents in connection with the operation of arc lamps, it was not until about a quarter of a century later that magneto-electric machines of the Holmes and Alliance types were used in some instances for lighthouses, Faraday himself serving as scientific adviser to Trinity House in official charge of the lighthouse service in Great Britain from 1837 to 1865. Although in very feeble health, he took a deep interest in the Ladd and Wilde developments for continuous currents. These machines may be regarded as the earliest embodiments of Faraday's dynamo principles involving commutation for direct currents.

At the Centennial Exposition, held in Philadelphia, Pennsylvania, in 1876, there were but two types of dynamo-electric machines shown, one being the then famous Gramme machine, for running a single arc light. Included in the exhibit, a similar machine was reversed and used as a motor to run a pump. The other type at the Exposition was a few machines of the so-called Wallace-Farmer type. The latter machines were shown as arc-light dynamos and were built at Ansonia, Connecticut, but only had a brief existence, owing to defects in design and low efficiency. A Gramme machine built at Cornell University, under the direction of Professor William A. Anthony (then the head of the Physics Department), completed the list of exhibited dynamo machines, meagre as it was.

During the Paris Exposition of 1878, the chief electrical feature was the illumination of the Avenue de l'Opéra and Place de l'Opéra by the comparatively short-lived Jablochkoff or "electric candle" system, run from a type of Gramme dynamos, with stationary armature coils and revolving fields, separately excited—an alternating current system. In the St. Lazare Railway station at Paris, in 1878, there was a lighting exhibit of Lontin apparatus and, as reported, eight arc lamps operated in series from one dynamo.

In 1875, the writer had personally made for his experiments a small dynamo which could also be used as a motor. It was provided with a Gramme-ring armature and also, for comparison, with a drum type, or Siemens, armature. This did not have the hollow drum of Siemens with a fixed iron armature within, but was a solidly wound structure characteristic of the later Siemens drum windings. This form was preferrred to the Gramme-ring, as being more readily wound, and the armature core could contain more iron. But so far as the writer was concerned, the fallacy of constructing any drum armature long in relation to its diameter, a practice usual with constructors in those early days and chosen for the purpose of avoiding so-called "idle-wire" over the ends, had long been an exploded notion, and all his designs were markedly free from that misconception.—Professor Elihu Thomson in *Engineering.*

A New Photoprinting Method

The necessity of reducing overhead expense has led to an increased use of detail paper instead of tracing cloth. Detail paper, however, does not stand the same strain as tracing cloth and the continued use of paper tracings for the making of photoprints results in rapid deterioration of the originals. Consequently the engineer is compelled either to prepare new duplicate tracings or to be satisfied with bad prints due to the deterioration of the original drawings.

An interesting development now enables the engineer to preserve his drawings in their original state and at the same time to have as many prints produced as necessary without even taking the original from the vault. This new process is called "Ozalid," and its outstanding feature is that it employs dry development, eliminating washing and drying entirely. This development is of an importance which will be readily appreciated as by its means indelible tracings on cloth, or on paper, can be inexpensively produced from ink or pencil drawings. By this means duplicate tracings can now be effected with speed and economy, and being absolute replicas of the originals, take the place of the latter for all purposes. Valuable original drawings, not needed any longer for printing purposes, can be kept in a safe place and preserved. Ozalid prints permit readable alterations and can be coloured or varnished.

These prints are positive and are therefore perfectly legible. Once fixed they resist the action of light, water, heat, cutting compounds, grease, soda or soap. They are therefore also suitable for record and filing purposes.

Ozalid materials, which are protected by world patents, have been adopted in Canada by various provincial governments, railways, mining companies, etc., and satisfaction with this process has been expressed.

Apart from Ozalid prints on the sensitized transparent materials, they can also be had on plain paper. The advantages of positive photoprints are well-known. In this connection it is of interest to note that positive prints are produced direct from original tracings without the aid of an intermediate original. This process is the only one employing dry developing and the absence of any moisture results in prints which are absolutely true-to-scale.

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The Hydro-Electric Power Development at High Falls and Masson on the Lièvre River

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—This paper presents a description of a reservoir dam and an hydro-electric power development recently completed, and an hydro-electric power development now under construction for the Maclaren-Quebec Power Company, all of which are located on the Lièvre river in the province of Quebec, Canada. The principal subjects treated are the (1) Cedar Rapids storage reservoir; (2) the High Falls hydro-electric power development; and (3) the Masson hydro-electric power development. The design (and model tests) of the intake passages for conducting the water into a tunnel 25 feet in diameter and more than a mile in length, and the surge tanks of unusual size, are the more interesting features of the Masson development.

Location

The Lièvre river flows from the north into the Ottawa river at a point about 14 miles east of the city of Ottawa. The principal places on the river to which reference will be made are Masson, which is located about one and one-half miles from its mouth; Buckingham, which is about three miles above Masson; High Falls, which is about 25 miles above Buckingham; and Cedar Rapids, which is about 25 miles above High Falls.

The Lièvre river has its source in the Laurentian mountains, in the same general vicinity as the headwaters of the St. Maurice and the Gatineau rivers, and flows in a general southerly direction. The upper reaches of the river are located in a rough, mountainous region which is well forested. Tributary to the upper river valley are many lakes which, together with the character of the topography, provide much natural storage.

Hydraulic Characteristics of the Lievre River

The Lièvre river has a drainage area above Masson of approximately 3,615 square miles. High Falls and Cedar Rapids respectively, receive the drainage from about 3,350 and 2,890 square miles of territory.

Rates of flow of the river, which have been recorded daily by the Department of Public Works since 1910, were used for estimating what rate of regulated flow can be sustained by the reservoir to be constructed and for determining the economic capacity of the power developments. It was estimated that with a storage dam at Cedar Rapids impounding 24.4 billion cubic feet of water, a rate of flow equalling or exceeding 4,000 second feet can be sustained at High Falls for at least 97 per cent of the time, and that for more than 40 per cent of the time the rate of flow will equal or exceed 5,000 second feet. Occasionally, a year of exceptionally low run-off will occur, throughout which a minimum rate of flow equalling 4,000 second feet cannot be maintained with the reservoir capacity mentioned; but over a long period of years the duration of these periods of deficiency will not aggregate more than three per cent of the time.

The principal falls in the river, with the corresponding head and tail water elevations established for the purpose of development, are as follows, the elevations being referred to the government datum, the zero of which is mean sea level.

	Normal Head Water	Normal Tail Water	Gross Head
Cedar Rapids	659.50		
High Falls	623.50	442.50	181 ft.
Buckingham	393.00	327.00	66 ft.
Masson	327.00	133.00	194 ft.

Objects of Power Development

The High Falls and Masson water powers are owned by the Maclaren-Quebec Power Company, a subsidiary of the James Maclaren Company Ltd. The latter company has engaged in logging and lumber operations and the manufacture of pulp on the Lièvre river for many years.

In the year 1928, the James Maclaren Company undertook the construction of a paper mill at Masson which has a daily capacity of 250 tons of newsprint. The development of the High Falls power site was begun at the same time, in order to supply the paper mill with power for general purposes, and with the object of selling power should a future demand arise.

It was decided then to install 60-cycle electrical equipment at High Falls, since the general demand in the immediate locality was for current of that frequency. In order to utilize the High Falls power until such time as it could be sold, an electrical steam generating station was installed to produce process steam for the paper mill.

Later, when the High Falls plant was completed, a contract was made calling for the sale of 25-cycle current

Fig. 1—General View of Cedar Rapids Storage Dam.

to the Ontario Hydro-Electric Commission. Since High Falls had already been developed as a 60-cycle plant, it was decided to proceed with the construction of a 25-cycle plant at Masson to produce power for fulfilling the contract with the Ontario Hydro-Electric Commission.

Existing Power Developments on the Lievre River

Until the year 1928, the only developed water powers on the Lièvre river were at Buckingham. Here the James Maclaren Company Ltd, had installed hydraulic turbines with a capacity of approximately 6,600 h.p. Two 5,650-h.p. turbines recently added bring the total installed capacity to nearly 18,000 h.p. The effective head on the above installation is about 64 feet, and the power is used for driving direct connected pulpwood grinders and for general electrical purposes in the groundwood pulp mill of the James Maclaren Company Ltd. Just above the Maclaren power site at Buckingham, the Electric Reduction Company has a development aggregating about 8,000 h.p. of installed capacity under a head of about 30 feet.

Cedar Rapids Storage Dam and Reservoir

As part of the plan for developing the High Falls and Masson power sites, a storage dam was planned at Cedar Rapids for the purpose of regulating the flow of the Lièvre river. With the water level above the Cedar Rapids dam raised to elevation 662.50, and a reservoir formed having an area of about 38 square miles, it proved possible to provide a storage capacity of 28.8 billion cubic feet of water. Although the dam was planned so that the water level might eventually be raised to elevation 662.50, the reservoir will be maintained for the present at elevation 559.50, at which height the storage capacity will be 24.4 billion cubic feet.

The site chosen for the dam was in a narrow channel with fairly flat banks, which offered ledge at a reasonable depth and made possible sufficient length of dam to provide for flood control facilities. The section of the dam is of the gravity type. Its length is 755 feet between the abutments and its height, where the foundation is deepest, is about 85 feet from bedrock to the floor of the bridge which crosses the dam. The dam includes a sluice gate section containing four 8-foot by 8-foot gates for regulating the discharge; a log-sluice section containing three gates each 10 feet wide, the sills of which are 15 feet, 22 feet and 29 feet, respectively, below extreme high water level; a Stoney gate section containing eight gates 24 feet wide by 20 feet high; and a stop-log section having six bays 17 feet wide by 15 feet high. The remainder of the structure consists of a gravity type, non-spilling section. A concrete gate house encloses the hoists for the flow regulating and log-sluice gates.

On account of the distance of the location from established transportation facilities, it was planned to have most of the construction plant and materials brought to the site during the winter of 1928-1929. The nearest railroad station is at Gracefield on a branch of the Canadian Pacific Railway which runs from Ottawa to Maniwaki. The highway between the site of the dam and Gracefield was improved for heavy winter travel and most of the materials and construction plant were hauled to the site before the spring of 1929. The hauling was done principally with tractors and sleds, although horses supplemented the mechanical equipment. The length of the haul was about 25 miles.

Fine and coarse concrete aggregates were found within a short distance from the dam. Many miles

Fig. 2—General View of High Falls Hydro-Electric Power Plant.

of new roads and several bridges had to be built to replace those to be flooded by the water in the new reservoir. It was necessary to construct a rock-filled dam at Lake Cauchon and an earth-filled dam at Lake Campion to prevent overflow into the Gatineau river watershed. Both of these were built according to the designs and specifications of the Quebec Streams Commission.

The Cedar Rapids storage dam was built under the supervision of the Quebec Streams Commission, which now owns and operates it. The work was commenced in October, 1928, and completed in June, 1930. The reservoir started filling in May, 1930.

High Falls Hydro-Electric Power Development

A natural power site existed at High Falls, where an abrupt fall in the river made possible a compact development. At the head of the falls an island divided the river into what was known as the north and south channels. This facilitated unwatering the bed of the stream for construction purposes, since each channel could be unwatered separately by means of an upstream coffer dam from the shore to the island, allowing the water to pass through the other channel.

A dam was built at High Falls about twenty years ago for improving log driving conditions on the river. On account of the greatly increased height to which it was planned to raise the water level for power development purposes, it was decided to demolish the old dam and build anew from bedrock.

As at Cedar Rapids, all materials except lumber and concrete aggregates had to be transported about 25 miles from the nearest railroad. In this case, however, materials were loaded on scows at Buckingham and towed up the river, which is navigable to within a short distance of the power house site. From the scow landing, a construction railway was run to the power house, which was located at the foot of the falls below the south channel with a branch up the hill to the dam. Materials brought in after the close of navigation were handled over the road from Buckingham with trucks and tractors.

The north channel dam has a gravity section and is designed to pass large amounts of water during flood times. It contains eleven Stoney gates 24 feet wide by 20 feet 6 inches high, and a trash gate 12 feet wide by 6 feet 6 inches high. The length of this dam is 375 feet between abutments.

A gravity dam and an intake structure were built in the south channel. The dam contained two waste gates 18 feet wide by 13 feet 6 inches high, an ice sluice 18 feet wide by 6 feet 6 inches high. The balance of the dam was constructed as an abutment type, non-spilling gravity section. The flood discharge capacity of the dam is about 65,000 cubic feet per second.

The balance of the south channel contained an intake structure for supplying water to the penstocks. The four intake gates are of the Stoney type, are 21 feet wide by 17 feet high and are operated by a 30-ton electric crane. Emergency gates of steel construction are provided to give access to the intake gates and to the screens in case repairs are necessary. The intake structure is covered with a building having steel framework and brick walls. Fig. 3 shows a cross section through the power house and intake at High Falls.

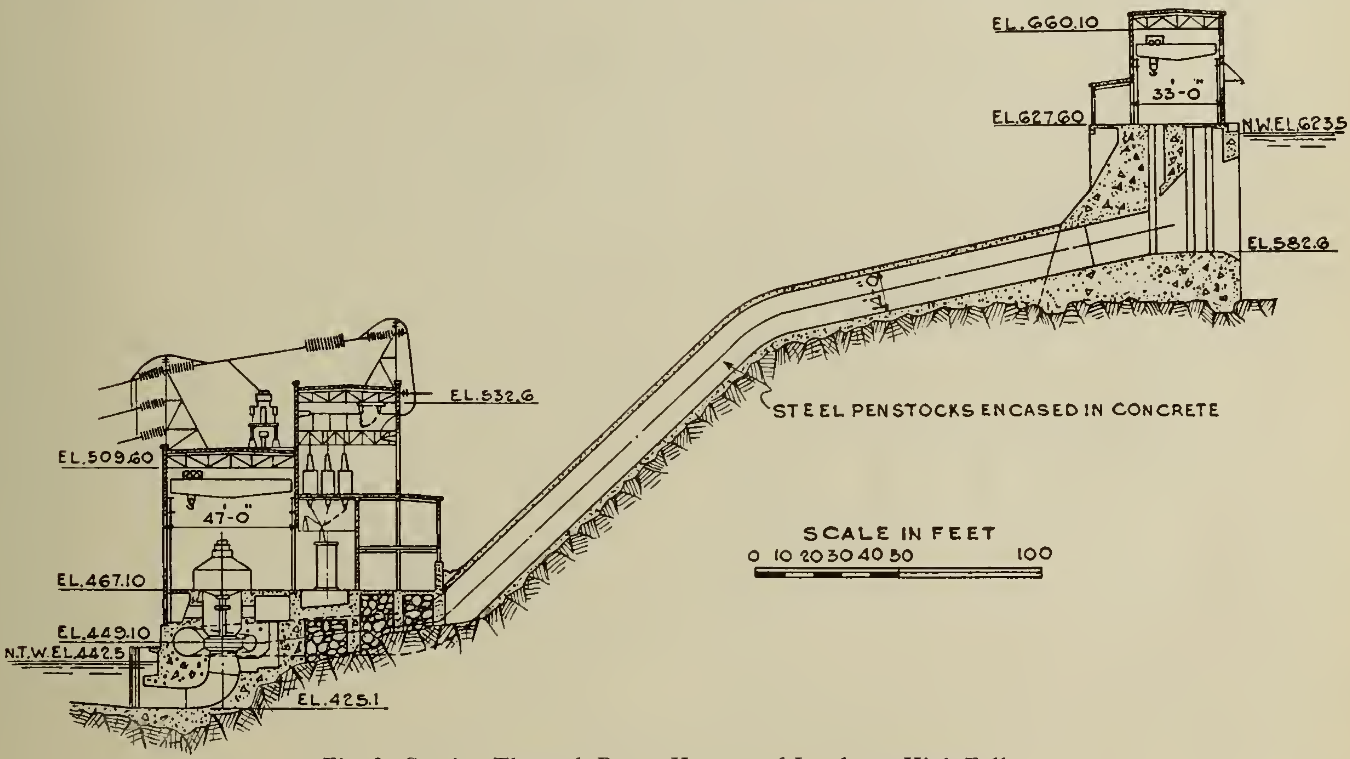

Fig. 3—Section Through Power House and Intake at High Falls.

The power house is located at the foot of the falls below the intake structure. Three steel plate penstocks 14 feet in diameter conduct the water from the intake to the turbines. The penstocks are anchored to the ledge at intervals and are enclosed with a protective covering of concrete having a minimum thickness of two feet. Individual tunnels were considered instead of penstocks, but it was decided that the extra cost of constructing them would not be warranted, and that with concrete protected penstocks the permanence of the installation would be assured.

The power house foundations are on solid ledge and contain the draft tubes for four vertical type hydraulic turbines, three of which are now installed. These turbines were built in Canada by the S. Morgan Smith-Inglis Company and are rated at 30,000 h.p. at full gate opening when operating under an effective head of 180 feet at 180 revolutions per minute. Three vertical type 3-phase, 60-

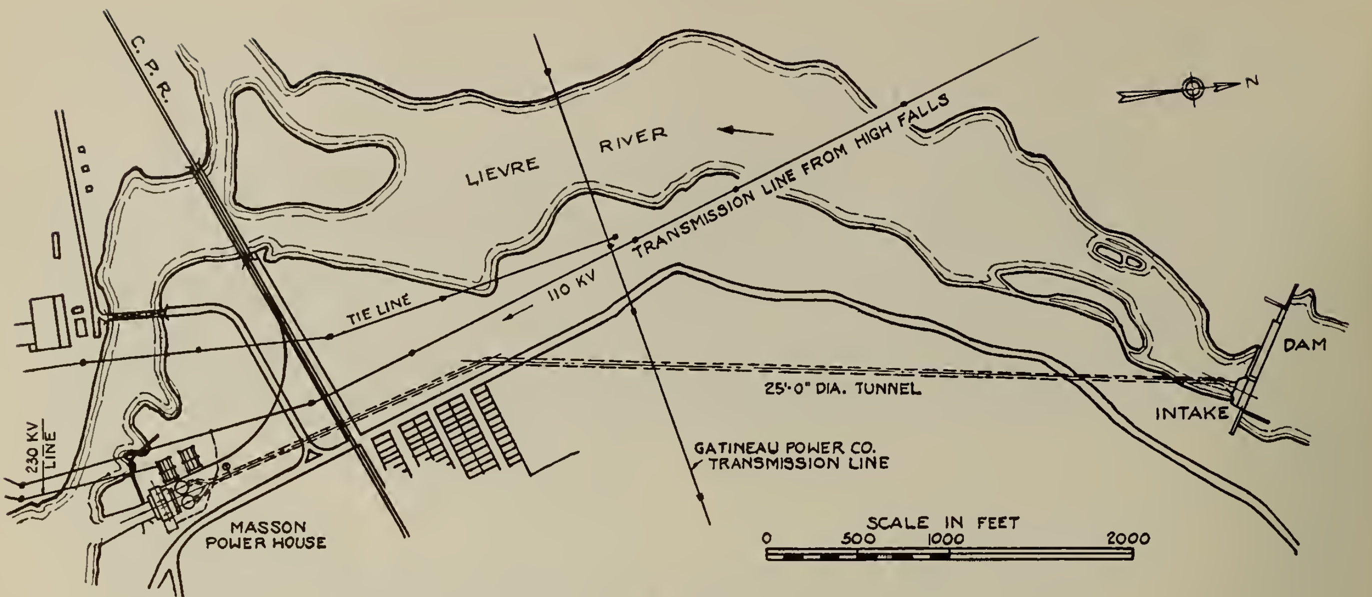

Fig. 4—Plan Showing Location of Intake, Tunnel and Power House at Masson.

cycle alternating current electric generators are connected directly to the turbines. These are rated at 25,000 kv.a. at 85 per cent power factor and current is generated at 13,200 volts. All provisions have been made in the power house as well as in the intake structure for the installation of a fourth unit. The generator room contains an electrically operated 150-ton crane for handling the turbine and generator parts.

The transformers are located in concrete compartments on the generator room floor level upstream from the units. There are seven 16,667 kv.a. single-phase, 60-cycle, oil immersed, water cooled transformers which step up the current from 13,200 volts to 110,000 volts. The transformers are arranged in two banks of three each with the seventh transformer serving as a spare for either bank.

High tension switching apparatus of the indoor type is located on the floor above the transformers and lightning arresters for protecting the indoor equipment are located on the generator room roof.

The building superstructure has a frame of structural steel, brick walls, and concrete floors. Comparatively little tailrace excavation was necessary to provide free discharge of the water from the draft tubes.

A 110,000-volt transmission line delivers the current from High Falls to a substation at the Masson paper mill. The line is about 25.5 miles in length and consists of two circuits of three 397,500 circular mils steel reinforced aluminum conductors and two 159,000 circular mils steel reinforced aluminum ground cables. Steel towers spaced about 700 feet apart support the conductors.

A log sluice gate, located at the south end of the intake structure, empties into a steel plate log sluice which runs down the hillside and discharges into the river a short distance below the power plant.

Since the High Falls plant has a pondage of considerable size amounting to an area of about 264,000,000 square feet, it will be possible to operate it as a peak load plant at low load factor. The construction of the High Falls development began in October 1928 and current was transmitted to the Masson substation in August 1930.

Masson Hydro-Electric Development

The construction of the hydro-electric development at Masson began early in 1931. The nature of the topography indicated that comparatively long conduits would be required for delivering water to the turbines if the total fall were to be developed in a single head since the natural drop in the river took place in a distance of more than a mile. In general, the dam was located as far downstream as the topography of the shores permitted, and at the same time raise the water level above the dam to that of the tail water at the Buckingham power. Fig. 4 is a plan showing the location of intake, tunnel, and power house at Masson.

Ledge was found at a reasonable depth at the site which was selected. The dam, which is located about 6,000 feet from the power house, consists of a gravity spillway section 78 feet 6 inches long with its crest four feet above average head water; eight flood control gates 24 feet wide by 20 feet 6 inches high operated by a travelling gantry crane; two waste gates 18 feet wide by 14 feet high; and a trash sluice gate 6 feet wide by 10 feet high. The main dam is 428 feet 6 inches long from the west abutment to the west end of the intake structure. The downstream wing wall of the west abutment is designed to include a log sluice. The calculated flood discharge capacity of the dam and gates is about 88,000 second feet when the head water is at elevation 334.0.

The hydro-electric plant at Masson will require 7,200 cubic feet of water per second when operating at full capacity. The intake structure is located at the east end of the dam near the shore line and is designed with a gravity section. Fig. 5 shows a plan and a cross section of the intake. The structure is 176 feet long and is divided into eight inlet openings 16 feet long by 22 feet high, which are provided with gates, screens and emergency gates. A 50-ton electrically operated bridge crane will be used to raise and lower the gates and screens.

Each pair of the eight gates opens into one of four closed passages which gradually changes in section from a rectangle to a circle with a diameter of 14 feet. Each outside passage joins an adjacent interior passage forming a symmetrical "Y," the stem of which is 18 feet in diameter. The two 18 feet diameter passages join and form another symmetrical "Y," the stem of which is 25 feet in diameter, the size of the conduit to the power house. The end passages are arranged symmetrically with the adjacent interior passages at points of relatively high velocities. The only unsymmetrical portions are just inside the gates where the velocities are relatively low.

Since the intake was required to deliver 7,200 cubic feet of water per second to the tunnel at maximum rate and in so doing, increase the velocity from about 2.5 to almost 15 feet per second in a comparatively short distance, and the design which was proposed represented a departure from ordinary practice, it was therefore decided to have a model test of the intake made at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute at Worcester, Massachusetts, under the direction of Professor C. M. Allen. The object of the test was to determine the loss of head in the intake; the relative rate of flow through the eight gate openings, and the variation in the rate of flow in any one gate opening from the average flow through the intake as a whole. The latter data were to be obtained for the purpose of studying the effect on the screens of the variation of flow in the section.

A model of the intake was built in the laboratory on a 1 to 24 ratio or at the scale of one-half inch to the foot. It included the eight gate openings, the two upper wyes, the lower wye, and a short section of the main conduit which slopes downward at an angle of 45 degrees. The tests showed that the loss in the intake as a whole will slightly exceed one foot of head when 7,500 cubic feet of water per second are being discharged. They further showed that the flow through any one of the four intake passages will not vary more than 1½ per cent from the mean intake discharge at rates of flow from 7,000 to 9,000 cubic feet of water per second. Changes in the shape of the end passages which would result in a more economical design were suggested during the tests. These changes were made in the model and were adopted in the final design since the hydraulic performance was not affected adversely.

By means of current-meter traverses, relative velocities were obtained across the section of each of the eight passages at the plane of the screens. The latter, however, were not duplicated in the model, since determinations of relative and not actual velocities were the object of the traverses. The mean velocity through the intake was determined by averaging all of the individual readings in a complete traverse of the intake. The maximum variation of relative velocity from the mean was found to be not more than 50 per cent at any point in the eight openings. This result was considered sufficient assurance that excessive velocities would not occur at localized spots on the screens. The relative uniformity of the flow in the intake will tend to prevent accumulations from building up on the screens, and should insure satisfactory operation of the headwork as a whole.

Various types of conduit for connecting the intake and the power house were considered and studied. Penstocks alone, and a combination of open canal and penstocks were studied. The distance to be covered, the large size of the penstocks, and the fact that a great proportion of the length of the penstocks would be subjected to high pressures, demonstrated that any scheme which would be worked out for surface conduits would be very expensive. When a single tunnel cut through solid rock was investigated, it proved to be less costly than any of the several surface conduits which had been considered, and offered a greater degree of permanence and reliability than the other schemes proposed. The decision to construct a tunnel was made only after the depth of the surface of bedrock had been determined, as well as the characteristics of the rock.

For the purpose of defining the bedrock surface quickly between the proposed dam site and power station, Schlumberger electrical prospecting methods was engaged to explore the east bank of the river over an area about 5,600 feet in length and 800 feet in width. This work was done during the last quarter of 1929. From the results of the electrical survey, a contour map of the surface of the bedrock was prepared. It then was possible to locate the line of the tunnel definitely with the assurance that it would traverse solid rock for its entire length. In order to determine the character of the bedrock along the line of the tunnel, diamond core drillings were made about 250 feet apart on the line of the tunnel, each hole extending to the invert of the tunnel as planned. The drillings indicated rock of such a nature that a tunnel could safely be driven through it. The drillings further served to check the bedrock contours which had previously been established by electrical prospecting and the agreement in contours as established by the two independent methods was remarkably close.

Samples of the rock cores from the drillings were submitted to a mineralogist for inspection, and were reported satisfactory for crushing for coarse concrete aggregate, enabling the tunnel contractor to use the spoil removed from the tunnel excavation, as long as the quality of the rock remained satisfactory.

A circular tunnel section, 25 feet in diameter, was adopted for hydraulic and structural reasons, even though it was estimated that it would cost slightly more than a horseshoe section of equivalent area. The water velocity in the tunnel when 7,200 cubic feet of water per second are being discharged, will be 14.7 feet per second. The tunnel will be lined with concrete nominally 22 inches thick, with a minimum thickness of 15 inches at small projections

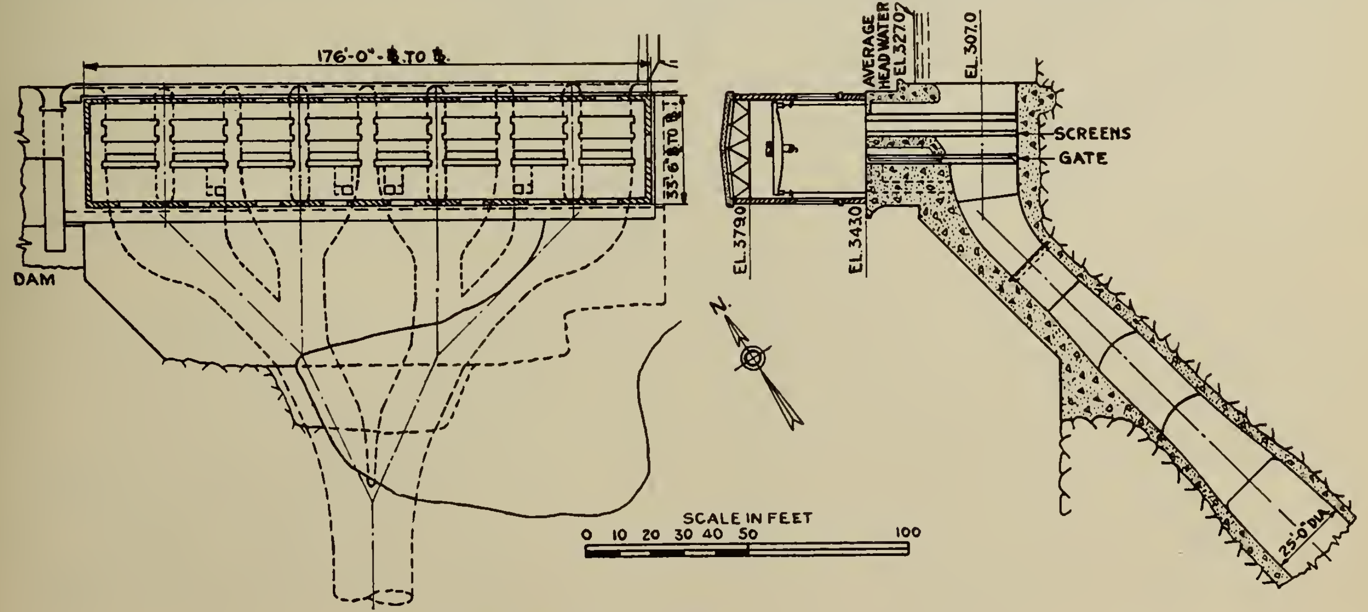

Fig. 5—Plan and Section Through the Intake at Masson.

in the ledge. No reinforcement will be necessary in the main tunnel since the weight of the rock above the horizontal axis of the section is sufficient to overbalance the water pressure within the conduit.

The tunnel slopes downward from the intake on an angle of 45 degrees to the horizontal to approximately centre line elevation 152. Here the direction changes, and having turned through a vertical curve, the tunnel extends a distance of about 5,600 feet on a downward grade of 3 per cent. At the low point of the tunnel near the power house end, a permanent concrete lined shaft is planned. This shaft is off the centre line of the tunnel. Pumps and the necessary connections for emptying the tunnel will be located in the permanent shaft, of sufficient capacity to pump out in 36 hours all the water which cannot be drained through the turbines. There will also be facilities for access to the tunnel from the permanent shaft for inspection purposes and for cleaning out sediment or whatever accumulations of foreign material may gather at the low point of the tunnel.

Beyond the permanent shaft, the tunnel divides into two branches 18 feet in diameter, each at a horizontal angle of 45 degrees to the axis of the main tunnel. Where the centres of the branches are 80 feet apart they turn upward toward the power house at a vertical angle of 45 degrees. Fig. 6, "Section Through Power House and Surge Tanks

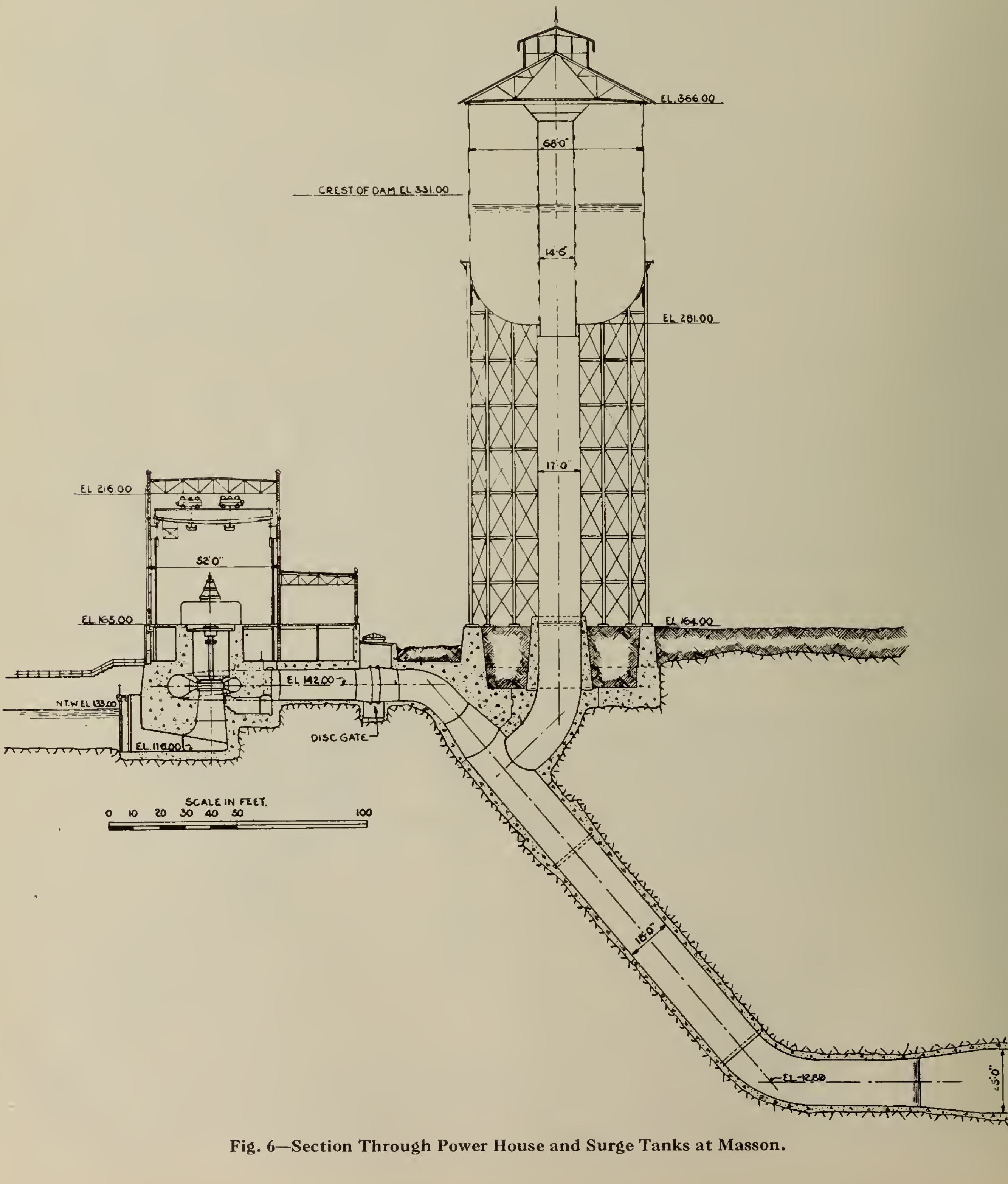

Fig. 6—Section Through Power House and Surge Tanks at Masson.

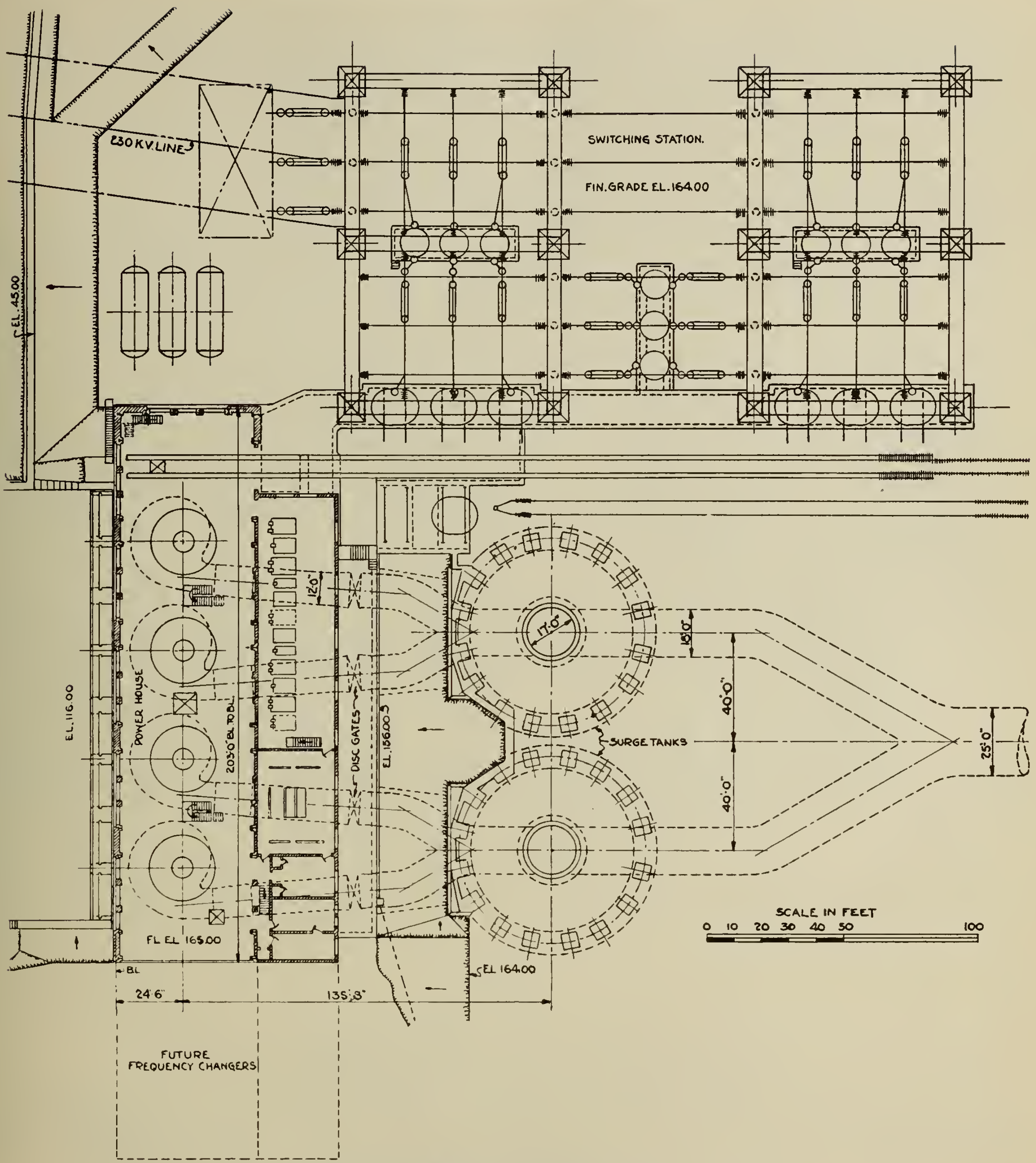

Fig. 7—Plan of Power House and Switching Station at Masson.

at Masson," shows the inclined branches. These are lined with steel penstocks which are designed to take the full water pressure. Anchorage rings are also provided to resist the full bulkhead pressure. Near the top of the inclined conduits, steel plate wyes divide them again into two branches, each 12 feet 9 inches in diameter, which turn through a vertical angle and connect with 14-foot butterfly valves in a chamber at the rear of the power house. Beyond the valves, 12-foot diameter penstocks deliver the water to the turbine scroll cases.

Two Johnson differential surge tanks are provided because of the length of the tunnel, to prevent excessive pressure changes in the tunnel and penstocks due to rapid opening and closing of the turbine gates. The connections to the surge tanks from the 18-foot diameter inclined tubes may be seen in Fig. 6. The external risers to the bottom of each tank are 17 feet in diameter. The cylindrical portion of the tank is 68 feet in diameter, and the height from the foundations to the roof eaves is 202 feet. Each tank is supported by sixteen 16-inch "H" columns weighing 342 pounds per foot. Each column is designed for a load of about 1,250,000 pounds. The interior riser in each tank is 14 feet 6 inches in diameter and extends from five feet below the bottom to within three feet of the top of the tank. Since no expansion joints were provided in the external risers, the design provides for torus shaped bottoms in which the expansion may be taken up. The external risers and the curved bottom of the tanks are to be insulated with rock cork to guard against freezing.

Structurally, the tanks present few innovations. Their chief appeal as an engineering work lies in their unusual size and the correspondingly heavy component parts which make up the whole. For instance, rods up to a maximum size of 2⅜ inches in diameter are used for cross bracing the main columns. This paper does not attempt to outline the hydraulic design of the tanks, since this subject is fully covered by papers already published by Mr. R. D. Johnson, hydraulic engineer of New York City,* who is responsible for the development of the differential surge tank, and who calculated the required dimensions of these tanks.

The Masson power house is designed for the installation of four hydro-electric units. The foundations are of mass concrete into which are built the draft tubes. A tailrace will be excavated for a length of about 300 feet, varying from 150 to 200 feet in width, through which the water will return to the Lièvre river.

The power house will be 203 feet long and about 82 feet wide. The west end of the structure is arranged so that heavy equipment may be delivered on standard railroad cars directly to the generator floor, where it may be unloaded and handled into place by means of a 170-ton electrically operated travelling crane. The four vertical type hydraulic turbines are being manufactured by Canadian Allis-Chalmers Limited, and are rated at 34,000 h.p. each when operating under an effective head of 185 feet at a speed of 166.7 revolutions per minute. Woodward type "A" governor actuators are to be used for the regulation of the turbines.

Four alternating current, vertical type, electric generators will be installed. They are being built by the Canadian Westinghouse Company Limited and are rated at 28,000 kv.a. when operating at 85 per cent power factor with a speed of 166.7 revolutions per minute. The current generated will be three-phase, 25-cycle, and the voltage 13,200. Station service equipment will be installed for using three-phase, 60-cycle, current, which can be delivered either from High Falls through the paper mill substation at Masson, or from Buckingham. The more important station service equipment at the Masson station will be duplicated so that 25-cycle current may be used, should the 60-cycle current not be available.

The superstructure of the Masson power station will have a structural steel frame, brick walls and concrete roofs

An outdoor high tension switching station will be located west of the power station. There will be two 25-cycle, 63,000-kv.a. banks of oil-immersed, water-cooled transformers, each consisting of three single-phase units. The low tension side will be 13,200 volts and the high tension side 230,000 volts. High tension switches and oil circuit breakers are provided between the transformers and the outgoing line.

It is planned to construct a single circuit 230,000-volt transmission line consisting of three 795,000 circular mils steel reinforced aluminum conductors. This line will cross the Lièvre and the Ottawa rivers and will tie in with the high tension lines of the Ontario Hydro-Electric Power Commission in the Province of Ontario. The Masson plant is scheduled to begin delivering 25-cycle current to the Ontario Hydro-Electric Power Commission in July, 1933. To insure delivery of the full amount of 25-cycle current called for in the contract, at times when low water will not permit the Masson plant to carry the entire load, it is planned eventually to install frequency changers at Masson. This will permit the 60-cycle current to be brought from High Falls and converted to 25-cycle current, when it may be sent out to supplement the Masson current. Should the High Falls plant be down, and the Masson plant running, it will be possible to convert the 25-cycle into 60-cycle current and supply the Masson and Buckingham mills.

*The Surge Tank in Water Power Plants, by Raymond D. Johnson, Transactions A.S.M.E., Vol. 30, 1908, and The Differential Surge Tank, by Raymond D. Johnson, Transactions A.S.C.E., Vol. 78, 1915.

The Central Heating Plant of the Toronto Terminals Railway Company, Toronto

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—This paper deals with the central heating plant at the foot of York street, Toronto, which supplies steam to the Union Station, Royal York Hotel and the roundhouses, coach yards and express buildings of both the railways, and the Dominion government customs house and post office. Steam is also supplied for car heating.

The total boiler capacity is over 5,000 h.p. rated, and the plant includes the necessary auxiliaries and an extensive distribution system, the annual production being about 500,000,000 pounds of steam.

Interesting features are a 1,350-ton coal bunker of special design, precautions for ensuring continuous operation and the water softening and steam distribution system.

Information is included in connection with the operation of the plant, the proportional costs and the record system employed.

An important feature arranged for in the building of the new passenger Union Railway Terminals at Toronto, is the supply of all steam for railway purposes as well as to the various public buildings surrounding the terminal, from one boiler plant. Briefly summarized, the main reasons leading to this action were the following:—

1. The elimination of boilers, with attendant noise and dust, from the various buildings, together with the trucking of coal and ashes. One plant replacing eight.
2. The saving of space in expensive locations for more remunerative undertakings, by eliminating boiler rooms and stacks.
3. The removal of smoke and gases from public areas.
4. A decrease of at least 25 per cent in the total fuel required, and a further reduction in cost by the use of a lower quality of coal.
5. Greater safety from fire.

In Fig. 1 are shown the favourable location of the plant at the foot of York street, the convenient siding for coal supply and ash removal, the various distributing lines of piping together with the approximate maximum horsepower of the various demands, which include the Union station, the Express building, roundhouse, coach yard of the Canadian National Railways, the Royal York hotel, the roundhouse and coach yard with buildings, also the Express building of the Canadian Pacific Railway, the Custom House and Post Office of the Dominion government, other minor buildings and all railway car heating at the terminal.

C.N.R. Garage	10 h.p.
Old Union Station	140 h.p.
Royal York Hotel	2,000 h.p.
T.T.R. Union Station	1,200 h.p.
Post Office	270 h.p.
Customs House	600 h.p.
Canadian Pacific Express	200 h.p.
Tracks Car Heating	650 h.p.
Can. Nat. Express	500 h.p.
C.P.R. Facilities	1,500 h.p.
C.N.R. Facilities	1,500 h.p.
Total	8,570 h.p.

Boiler Capacity
4—550 = 2,200 h.p.
4—819 = 3,276 h.p.

5,476 h.p. at normal rating
or 8,214 h.p. at 150 per cent rating.

A preliminary survey of the probable demand for steam was made in 1927 and preparation of the design was commenced in September of that year. The work of erection started in April 1928 and steam was supplied in August 1929.

In designing the plant the features aimed at in order of importance were—reliability, lowest possible cost, maximum efficiency under wide fluctuations of load (which were as shown in Fig. 2 and 2A for the load connected in 1930), also elimination of all smoke and dust, since the plant

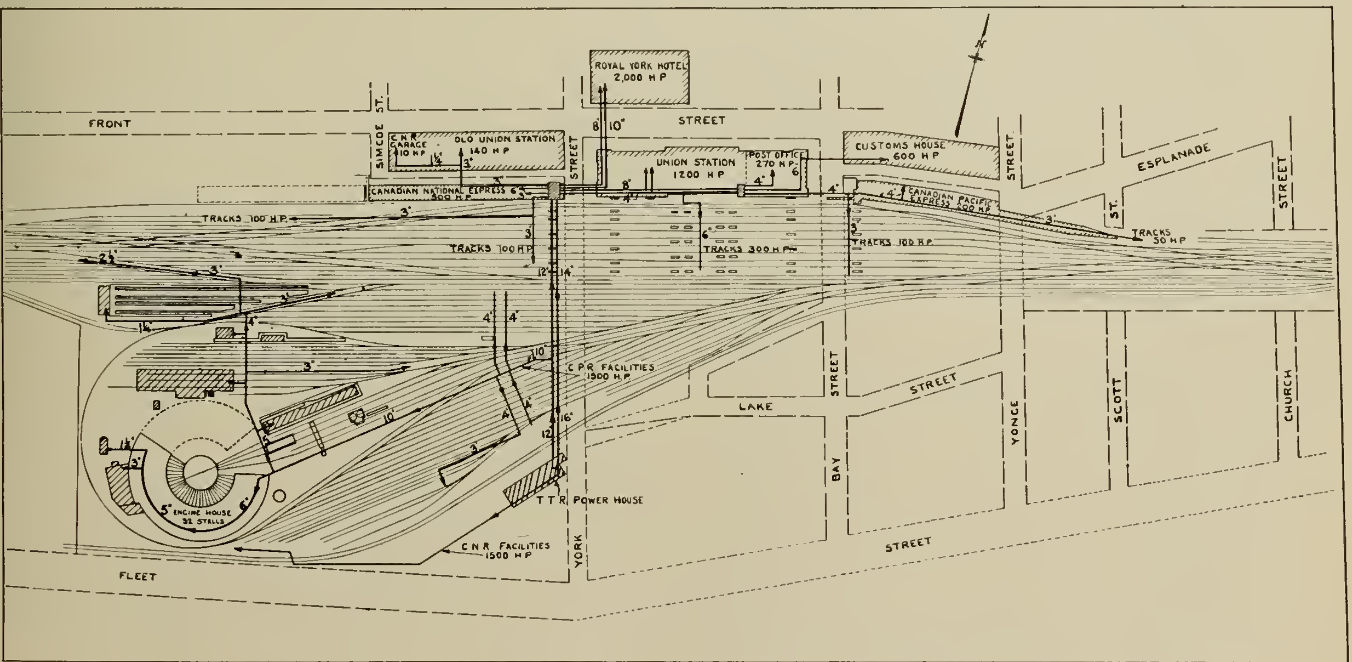


Fig. 1—Location of Power House Showing Distribution of Steam and Piping.

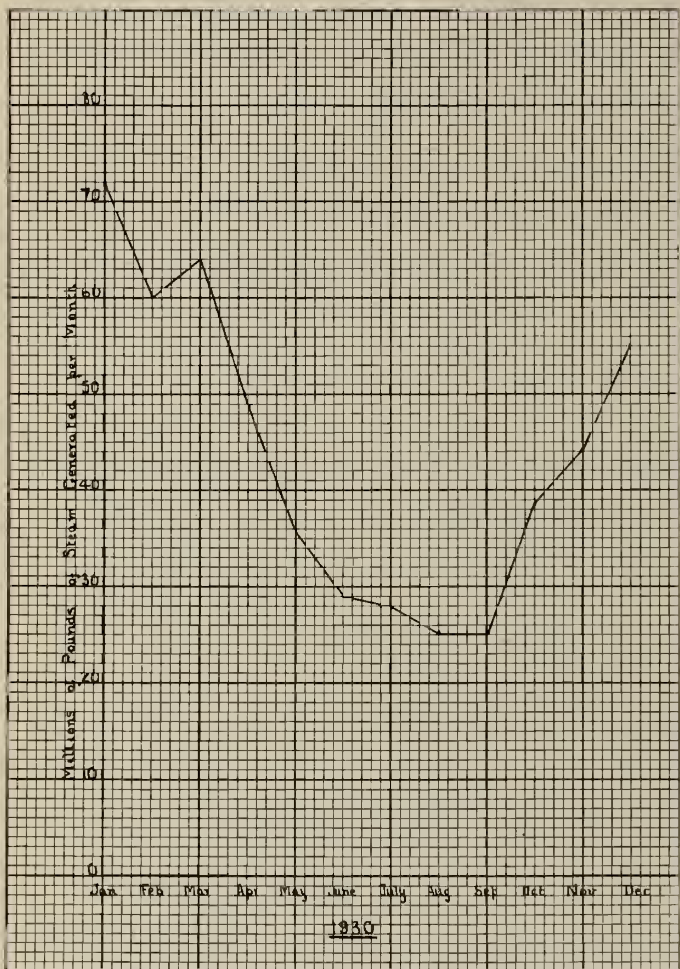


Fig. 2—Steam Generated per Month.

is in a very conspicuous position relative to the city. The use of a comparatively large number of small boiler units was decided upon, so as to give the greatest reliability with efficiency, and mechanical stokers to permit of a low initial and annual cost without danger of fly-dust. The skip type of hoist was adopted in conjunction with a travelling cable conveyor as this arrangement would give the greatest convenience in the handling of coal and ashes with minimum cost for installation, maintenance and labour. With the power plant operating at full load only two men on one shift daily are necessary for handling coal and ashes. The boiler setting was designed for 150 per cent of normal rating in continuous operation and 200 per cent with intermittent operation, as being within the limits of low first and annual cost, through eliminating the need for water-walls.

The accompanying plans show the main features of the installation and are as follows:

Fig. 3, general arrangement of boiler plant showing steam exhaust and blowdown piping.

Fig. 4, sectional elevation of boiler room.

An exterior view of the plant is shown in Fig. 5.

From Fig. 3 it will be noted that the boiler room contains eight units with provision for a ninth, and space has been arranged so that two more units could be added later by extending the building to the west. All are horizontal sectional water tube boilers of the Babcock-Wilcox and Goldie-McCulloch type. Four are of a rated capacity of 819 h.p. and contain three steam and water drums, which are 48 inches in diameter and 23 feet long. The tubes which form the heating element are 4 inches in diameter and 18 feet long, there being fourteen horizontal rows, each containing twenty-seven tubes. The other four boilers are rated at 550 h.p., and contain two 48-inch drums, with the heating element consisting of fourteen horizontal rows, each containing eighteen tubes. All are equipped with superheaters. The main boiler room is 200 feet long by 60 feet wide, with an engine room 50 feet by 60 feet, both buildings being 40 feet high with the exception of a 21-foot wide section in front of the boilers which is 65 feet in height, thus allowing space for a 1,350-ton coal bunker. A basement extends 12½ feet below the boiler room floor level and contains the ash handling equipment, steam mains, etc. The coal bunker and the 100-ton ash bunker were the first of their type to be installed in Canada, being made of cast iron sections. The coal bunker is supported from main longitudinal girders by a series of steel straps on 18-inch centres throughout its entire length of 193 feet 8 inches. The cast iron plates forming the sides, bottom and ends of the bunker overlap each other in such a manner as to prevent possible seepage from wet coal. The bolts securing the cast iron plates to the supporting steel fit into recesses on the outside of the plates, so that no bolt heads or nuts come in contact with the coal. The catenary form of construction provides the maximum capacity for a given span, and permits the necessary movement of the bunker for changed conditions of loading. The use of this design, it is hoped, will avoid all corrosion or erosion, which have been the main problems to contend with in the past with other forms of construction. The coal is not touched from the time it arrives at the station until the time it leaves as ash. An elevator has been erected to deal with both the coal and ash, the two operations taking place at the same time, and both being driven from the same winch. The coal elevator consists of a hopper which is filled with coal from dump cars. This feeds into a bucket of two tons capacity which is hoisted to the top of the elevator where it is automatically dumped into an auxiliary hopper ready for transporting to the coal bunker, by means of a three-ton cable operated car, where it can be dumped into any desired portion of this bunker. From here it is loaded into two lorries each of 5,000 pounds capacity. These are suspended from frames which run on an overhead track control of which is from the firing platform. From each lorry, the coal passes through a 400-pound automatic scale to the chute which delivers it to the hoppers of the stokers. By this means a record of the actual consumption of each individual boiler can be obtained. The ashes fall on the stoker dump plates

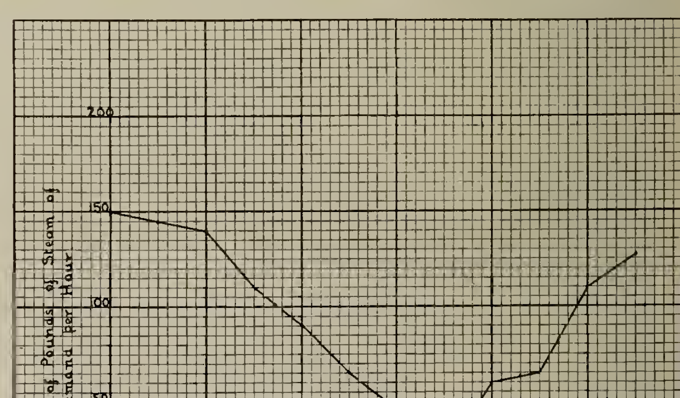


Fig. 2A—Maximum Steam Demand per Hour.

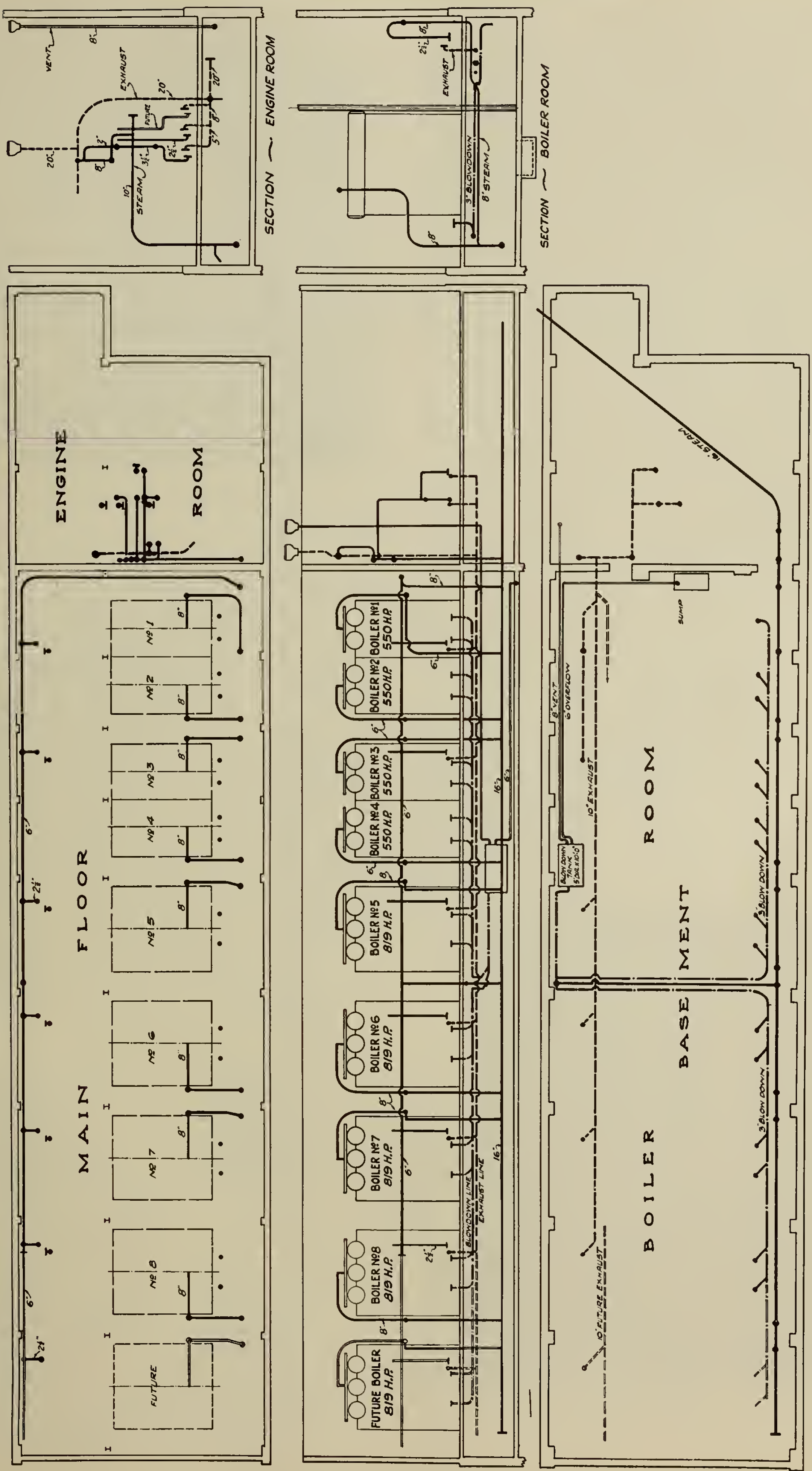


Fig. 3—Arrangement of Boiler Plant Showing Piping.

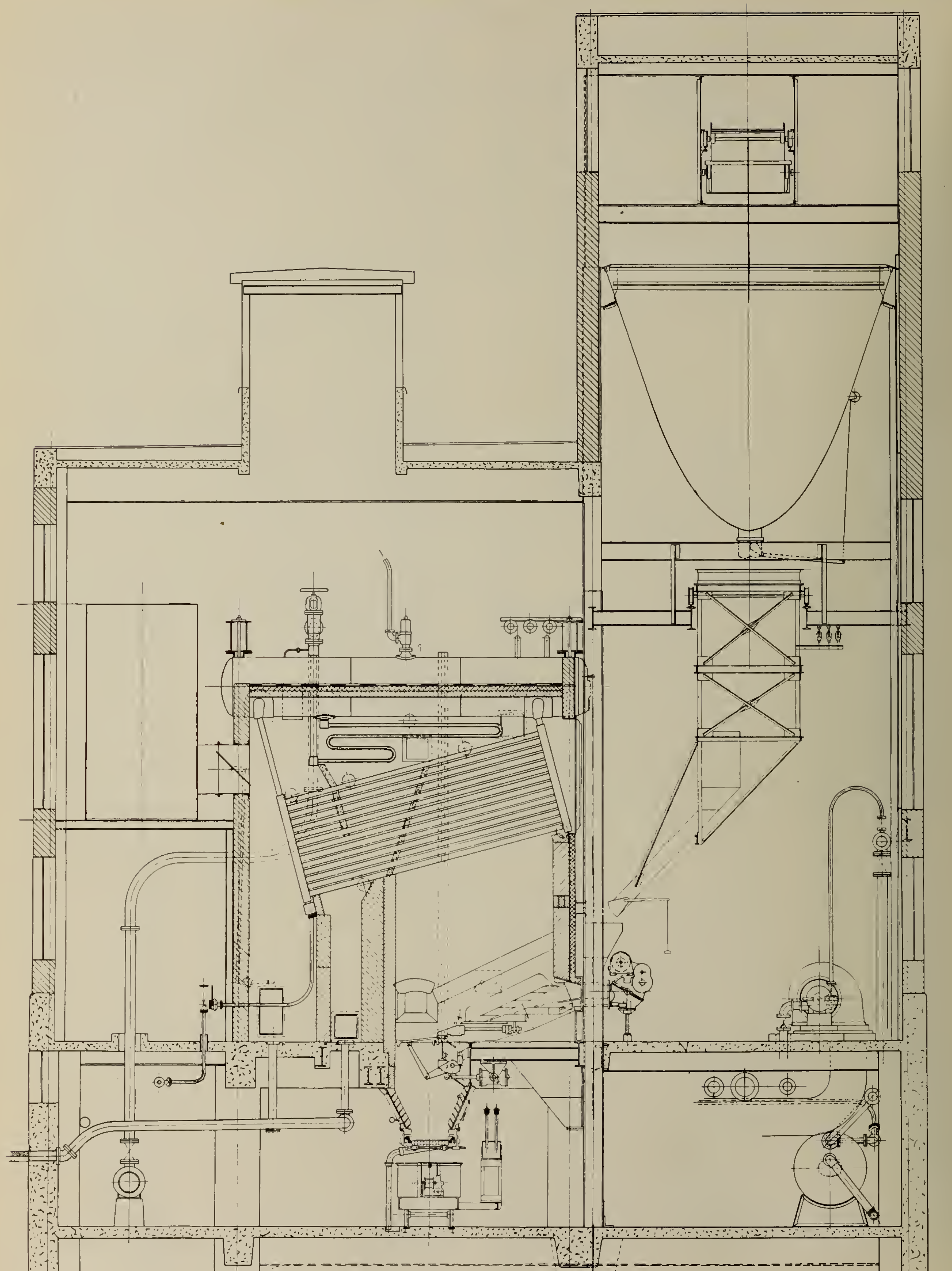


Fig. 4—Sectional Elevation of Boiler Room.

Fig. 5—Exterior View of the Plant.

at the rear of the boilers, where they are dropped into sectional cast iron refractory lined hoppers, fitted with water-collecting gates, one of the features of which is that the ash gate doors roll on inverted tracks which cannot collect dust or ashes. All excess water from the quenchers fitted in the side of each hopper is completely drained off through troughs across the end of each gate, thereby ensuring a clean and dry basement at all times. The ashes are transferred from the ash hopper under each boiler to an electric car. This has a capacity of 70 cubic feet and conveys the ashes to another hopper built on the side of the coal elevator, from which it is loaded into a bucket similar to the one used for hoisting coal. The drive of both the coal and ash buckets is such that while one is ascending with its load, the other is descending in readiness to be loaded. Situated directly over the railway track on which the coal is brought in, there is a sectional cast iron ash storage tank into which the ashes are deposited in readiness for loading into the cars. This tank has a capacity of 70 tons. The freezing of wet ashes in cold weather is prevented by piping live steam around the inside of the tank gates.

The two stacks are 232 feet high and are 12 feet inside diameter at the top with capacity for eleven boilers. Other details of plant equipment are given in a statement at the end of the paper.

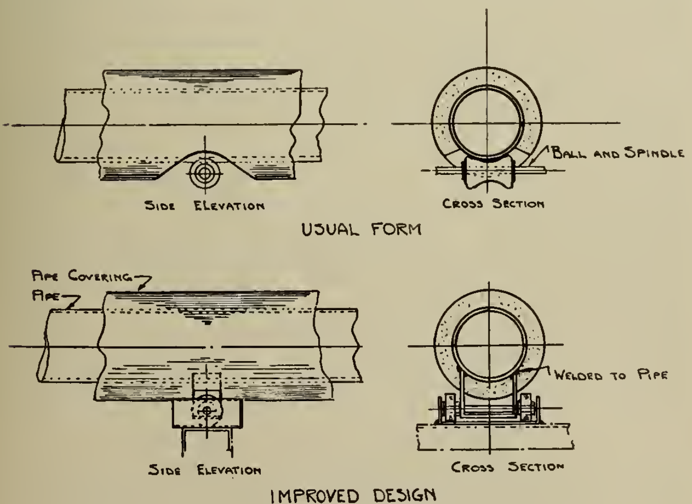


Fig. 6—Special Type of Welded Pipe Support.

In the basement there is a 16-inch steam main to which all boilers are connected through steel monel-mounted gate valves, the steam line from the larger boilers being 8 inches and from the smaller 6 inches in diameter. The steam mains, on leaving the power house by a short tunnel, connect into an 8-foot by 7-foot tunnel, built into the west wall of the York street subway, and thence pass by an underground tunnel below York and Front streets to the station and the hotel, the approximate length of this line being 1,500 feet. Two lines of piping are provided from the power house to delivery points, one for winter conditions and other for the lighter summer load, the latter having sufficient capacity to be used as an emergency line in winter, if necessary, with a slightly greater drop in steam pressure supply. The sizes of the pipe lines were proportioned to permit operating the boiler plant at 180 pounds with delivery at 160 pounds at the hotel, where steam is used in high-speed engine-generator sets.

In order to take full advantage of the highest efficiency in steam transmission, the boilers were equipped with superheaters to give an average superheat of 125 degrees F. or sufficient to ensure delivery of slightly superheated steam at the various premises. Readings taken daily show an average loss of 6 degrees F. per 100 feet of pipe line. Condensation in the pipe lines is extremely low. In this connection, it might be mentioned that the total steam delivered, as measured at the points of supply at the entrance to the various premises, during twelve months, has averaged 88 per cent of the total steam generated, the difference of 12 per cent including all losses and the steam used at the power house for the operation of all auxiliaries as well as for feed water heating.

When consideration was given to the design of the extensive pipe mains, it was decided that an improved form of pipe support was necessary to permit reducing radiation losses to as low a point as possible. In the commonly used pipe roller support, a section of uncovered pipe must be left above each roller to permit of the free movement of piping. This is especially necessary where the lines are long, with superheated steam and consequent large expansion movement. It is also to be noted that owing to the necessary cutting away of insulation on the portion of the pipe in contact with the rollers, the covering will sag in

Fig. 7—Front View of Boilers and Stokers.

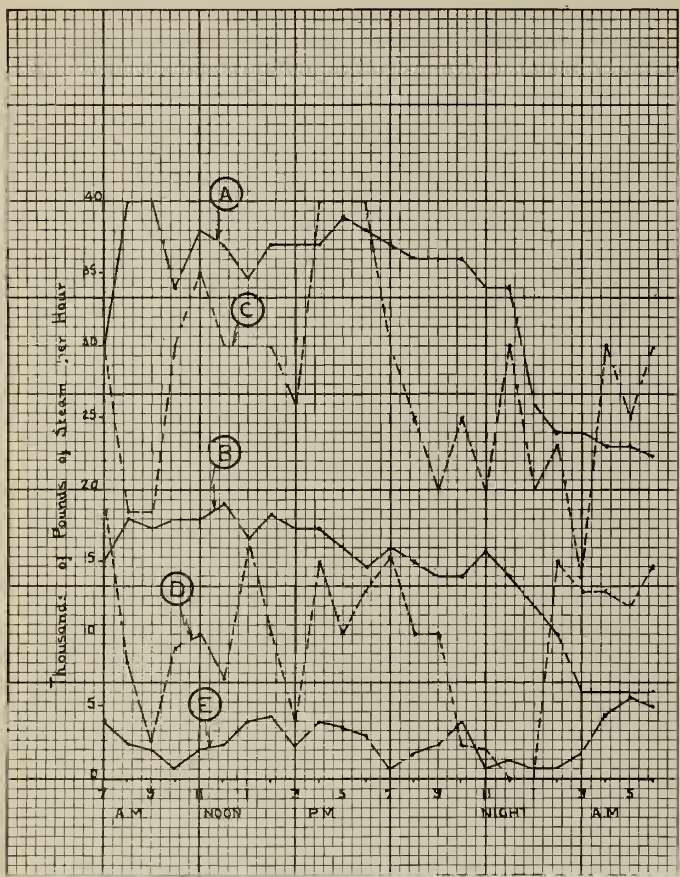


Fig. 8
A—Royal York Winter Load Feb. 1931.
B—Royal York Summer Load July 1931.
C—C.P.R. Yard Jan. 1931.
D—C.P.R. Roundhouse Aug. 1931.
E—Station Tracks March 1931.

time on either side adjacent to the bare section of piping, resulting in a comparatively large circulation of air around steam lines, thus creating additional losses in radiation and increasing the temperature of the tunnels. By the design of a special type of support welded to the pipe with two projecting legs carrying rollers, as shown in Fig. 6, it was possible to cover the piping completely and thus overcome the objectionable features in the older form of support. A noticeably lower temperature is found in the tunnels for this reason.

Fig. 9—Twelve-inch Electrically Operated Steam Valve.

An interesting feature in connection with the supply of steam to the Canadian Pacific locomotive roundhouse is the direct steaming installation. This, the first of its design in Canada, permits of the elimination of smoke jacks from the roundhouse in that the locomotives, when required for the road, are brought up to 170 pounds pressure by the central supply of steam, thirty to sixty minutes before being required for service. This results in a great improvement in the appearance of railway yards by allowing the dispatch of locomotives with little or no smoke. Each engine passes over the turntable from the roundhouse with the applied steam, and the coal on the grates which is put in when the engine enters the roundhouse, is ignited by an air-oil torch in 30 to 60 seconds; the engine then leaves for the trainshed. The line *D* in Fig. 8 shows the average daily demand of steam for this service in August 1931.

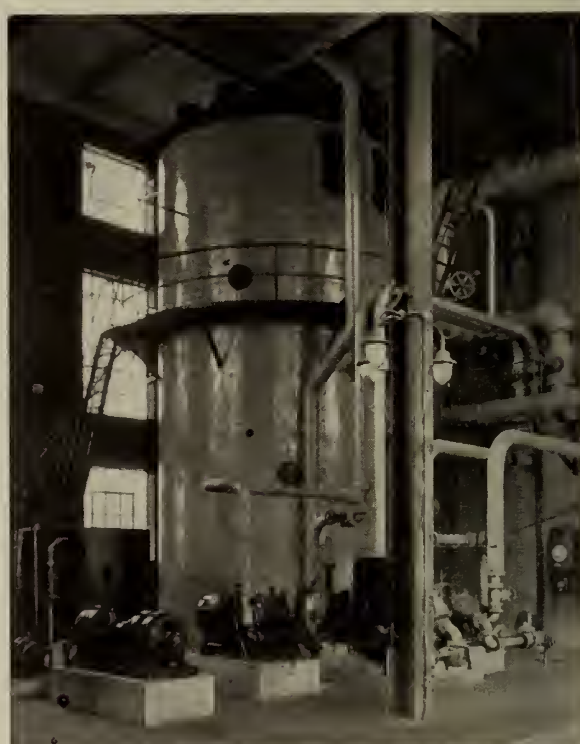


Fig. 10—Deaerating Heater and Water Softener.

Needless to mention the use of direct steaming converts a roundhouse into a much more attractive place, and permits perfect conditions for maintenance work.

Provision has been made to meet any emergency due to failure in the electric power supply of the Hydro by the installation of a 500 k.w. steam turbine unit which will permit of carrying all emergency lighting and power requirements of the station or power plant. This unit generates current at 2,200 volts which is transformed to 13,000 volts for transmission by underground cable to the transformer vault at the station. This emergency service is absolutely necessary, in order to meet the demands of the electrically operated slip switches and the signal system of the terminal, as well as the numerous express and baggage elevators in the elevated trainshed, and the lighting of all public areas.

The supply of feed water for the power house is taken from the city mains, and therefore is Lake Ontario water with an average of eight grains of solids per 1,000 gallons. A hot process soda-ash and lime treatment was installed owing

FORM 511

TORONTO TERMINALS RAILWAY COMPANY

CENTRAL HEATING PLANT

DAILY REPORT

Steam Generated		2,330,000	Lbs.
Coal Burned		242,000	Lbs.
Ashes Removed		33,628	Lbs.
Water Used		144,000	Gals.
Electric Power		200	KWH
Electric Power Demand		22	KW
Maximum Steam Demand Time	6/15 p.m.	125,000	Lbs.
Minimum Steam Demand Time	8.00 a.m.	68,000	Lbs.
Evaporation		10.87	Lbs. Water per Lbs. Coal
Boilers in Service	Nos.	6-7-8	
Boilers Banked	Nos.		
Boilers in Reserve	Nos.	1-2-3-5	
Boilers under Repair	Nos.	4	
Average Steam Pressure		161	
Average Feed Water Temperature		212	
Average Flue Gas Temperature		467	
Average Steam Temperature		530	
Average Condensate Temperature		160	
Average City Water Temperature		51	
Steam to C. P. R. High Level		469,000	Lbs.
Steam to C. N. R. Roundhouse			

Remarks:

Chief Engineer__________

Date March 2nd. 1930

Fig. 11—Typical Daily Report.

to the fact that only 40 per cent of the condensate is returned in winter and 60 per cent in summer, so that a considerable quantity of raw water is required. As a result of keeping the solids in the boiler water down to 125 grains per 1,000 gallons no scale has been deposited in the boilers, even after operation for several months at 150 to 200 per cent of rating. Condensate in winter is received at an average temperature of 160 degrees F. dropping to 140 degrees F. in summer. This water softener plant with de-aerating heater will soften and heat 20,000 gallons per hour of raw make-up water. The engine room is equipped with two centrifugal feed pumps driven by means of turbines of 90 h.p. capacity, 2,600 r.p.m., also a 15-k.w., d.c. generator set, driven by a 24-h.p., 1,400 r.p. turbine. In addition there is an emergency set in case the turbine should fail. This consists of a 25-h.p. motor driving a 15 k.w. compound wound d.c. generator. In both cases the current is generated at 125 volts.

The water entering the building is measured by means of a Trident 6-inch compound water gauge. The temperature and the rate of steam flow are measured by Bailey fluid meters. Foxboro meters register the temperature of the feed water, raw water, condensate and the pressure of the water service. Bailey boiler meters and draught gauges are located on each of the boilers, and on each steam line supplying the different buildings and services there is a Bailey recording and integrating flow-meter.

The cost of the plant is in the neighbourhood of $100 per boiler horsepower, based on the continuous operating capacity of the boilers, which figure will materially decrease when future boilers are installed, as certain expenditures had to be made to provide for possible extensions which are very likely to be required in the near future.

In arriving at the cost of steam, allowance is made for the complete investment, as each user is charged for steam as measured at point of delivery at the several premises by steam flow meters. The various items making up the total cost, with their percentage of the total are as follows:—

Fixed charges:

Interest at 5 per cent on total investment	24	per cent	
Depreciation at 2 per cent on structures	4	" "	
Depreciation at 4 per cent on equipment	10	" "	
Insurance	¼	" "	
Taxes	1	" "	
			39¼ per cent

Operating charges:

Fuel	43¼	per cent	
Labour	10¼	" "	
Water	4½	" "	
Power	½	" "	
Supplies	1½	" "	
Maintenance	¾	" "	
			60¾ per cent
		Total	100 per cent

The total steam delivered in 1930 was 466,500,000 pounds. During 1931 it is estimated that the demand will be 500,000,000 pounds and a further increase is expected in 1932.

The cost of steam has come well within the estimated cost made before the work was started and supplies steam to the several users at a cost below that at which any individual user could have generated his own supply. An allowance is made to the users from whom condensate is received, equivalent to the value of the water and the heat therein. It has only been found economical to install return lines where the return of condensate was continuous

Form 212

THE TORONTO TERMINALS RAILWAY CO.

CENTAL HEATING PLANT

REPORT FOR MONTH OF January

DATE Feb. 26th. 1931

TOTAL STEAM GENERATED	75,659,000	Lbs.
STEAM USED AT PLANT	11,039,000	Lbs.
CONDENSATION LOSSES	646,200	Lbs.
STEAM DISTRIBUTED	63,973,000	Lbs.

STEAM DISTRIBUTION

Royal York Hotel	22,300,902	Lbs.	Union Station	10,886,017	Lbs.
C. P. Coach Yard	15,448,000	Lbs.	Old Station	480,400	Lbs.
C. P. Express Bldg.	957,000	Lbs.	Station Tracks	4,507,418	Lbs.
Post Office	2,241,663	Lbs.	Trucking Areas	606,400	Lbs.
Customs House	2,507,000	Lbs.	C. N. Express	3,761,000	Lbs.
		Lbs.	C. N. Garage	278,000	Lbs.
		Lbs.	Total	63,973,800	Lbs.

COSTS		EVAPORATION		
Water		Steam Generated	75,659,000	Lbs.
Electric Power		Coal Burned	8,256,200	Lbs.
Labor		Lbs. Water per Lb. Coal	9.16	Lbs.
Coal				
Supplies				
Fixed Charges		COST OF DISTRIBUTED STEAM		
TOTAL				per 1000 Lbs.

Maximum Demand 140,000 Lbs at 4.30 P.M. Date Jan.14th. 1931

Signed__________

Title__________

Fig. 12—Typical Monthly Report.

throughout the year and in a fairly uniform quantity and where the distance is not too great. With the assistance of a complete set of records a comparatively high average evaporative and operating efficiency has been obtained. The record forms employed are given at the end of the paper and include a daily log-sheet, a daily summary to the supervising officer, and a monthly summary to the management. A yearly equivalent evaporative efficiency of 72 per cent was shown for the first two years' operation, with indications of an upward trend as the load on the plant is completed. Practically no repairs on the plant have yet been found necessary. The stacks are extremely prominent so that poor combustion can easily be checked, but every satisfaction has been obtained in this direction, due mainly to the extreme flexibility of the plant with the load.

Power House Equipment

Boilers—
Maker—Babcock-Wilcox and Goldie-McCulloch.
Size—4-819 h.p., and 4-550 h.p.
Steam pressure—200 pounds.
Drums (819 h.p.) 3-24 feet 6 inches long by 4 feet 0 inches dia.
(550 h.p.) 2-24 feet 6 inches long by 4 feet 0 inches dia.
Tubes (819 h.p.) 18 feet 0 inches long, 4 inches high.
27 wide, 14 high.
(550 h.p.) 18 feet 0 inches long 4 inches dia.
18 wide, 14 high.

Superheaters—
Babcock-Wilcox Co., double loop type for 150 degrees superheat at 200 per cent rating.

Boiler Settings—
14 feet from floor to lower header, walls 25-inch thickness made up of 9 inches of No. 1 grade firebrick—4½ inches of No. 2 grade firebrick and 4½ inches of insulating brick and red brick.

Steam Piping—
Extra heavy lap welded steel with Cranclap type joints with long hub steel flanges spot faced.

Insulation—
Johns-Manville sponge felt of 2-inch thickness.

Stokers—
Taylor multiple retort, underfeed power dump type.
(819 h.p.) 9 retorts wide, 21 tuyeres long.
(550 h.p.) 5 retorts wide, 21 tuyeres long.
Motors—Louis Allis 4 speed.

Soot Blowers—Diamond. Six per boiler.
Type—G9-B valve in head.

Forced Draft Fans—
Can. Blower and Forge Co.
Type—Conoidal.
Capacity—(4) 20,000 cu. ft. per min. at 60 degrees F.
(2) 27,000 cu. ft. per min. at 60 degrees F.
Driven by Moore steam turbines.

Boiler Feed Pumps—(2) LeCourtenay.
Type—Centrifugal.
Driven by Terry 90-h.p. 2,600-r.p.m. turbines, with Fisher regulators.

Feed Water Heaters—
Make—Cochrane.
Type—Hot process, lime and soda ash.
Capacity—20,000 g.p.h. condensate and 20,000 g.p.h. raw water, complete with chemical feed pumps.

Turbo Generator—
Make—Daniel Adamson.
Capacity—300 kilowatts.
Voltage—2,300.
Frequency—25 cycles.
Speed—1,200 r.p.m.

Steam Flow Meters—Bailey Meter Company.
Type—Mechanical.
No. in plant—10.
On lines — 8.

Coal Bunker—Allen-Sherman-Hoff Company.
Type—cast iron, catenary shaped.
Capacity—1,350 tons.

Weigh Lorries—Richardson.
Capacity—5,000 pounds.
Scales—400 pounds.

Coal and Ash Plant—
Combination double shaft skip hoist to permit raising coal and ash at same time with a horizontal travelling 3-ton coal car cable operated. Capacity 60 tons coal hourly. Installed by J. Inglis Co.

Ash Hoppers—
Make—Allen-Sherman-Hoff refractory lined sectional cast iron with type C.H. water collecting gates of 342-ton capacity, with ash quenching sprays.

The Train Ferry *Charlottetown*

Walter Lambert, M.I.N.A., M.E.I.C.,
Lambert and German, Naval Architects, Montreal.

Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—A history of the development of ferry traffic between Prince Edward Island and the mainland, culminating in the placing in service of the triple-screw steel ice-breaking train and auto ferry *Charlottetown*.

A description of difficulties involved in winter navigation and of interesting details of this vessel, one of the most powerful ice-breaking ferries in the world, and the first train ferry to provide for the transportation of automobiles on a separate deck, without prejudicing the efficiency of the equipment as a railroad unit.

Significant as being the most valuable shipbuilding contract ever placed in Canada, and one involving a special effort to ensure that, to the greatest possible extent, all materials and labour are Canadian—the balance being provided from within the Empire.

Island Origin and Development

History informs us that the first provision for winter communication between the mainland and Prince Edward Island was made by Lieutenant Governor Patterson in 1775, when a service was established between Wood Islands and Pictou, by means of birch bark canoes. This fragile equipment later developed into flat bottom dories operated by two men and having two runners attached underneath to allow of their being pulled over intervening pans of ice.

Further development ensued, after the visit of a business man from Prince Edward Island to Europe, who took particular notice of the peculiar shape of the Norwegian pram, which is a long low boat with a round bottom and turned up at each end. On his return home he suggested to the dorymen that they try a boat of this kind, with the result that for many years winter communication was carried on with an adaptation of the "Pram" type of boat, with a somewhat sharper bottom, having two hardwood runners shod with steel and its hull sheathed with tin as a protection against ice.

We are further informed that in 1827 the year's operating cost of this ferry service was £75, and that one mail in two weeks was considered adequate for the needs of the various settlements.

In 1832 the Steamer *Pocahontas* began to ply between Charlottetown and Pictou, making two trips per week for the carriage of mails and passengers, but the use of the "Pram" type of boat, or the "ice-boat" as it became known, continued up till 1916, being somewhat more dependable, even if of much less capacity, than the winter steamers. Fig. 1 shows the manner in which the ice-boats were taken over the shore ice. Nevertheless, transportation by ice-boat required much hardihood and involved considerable danger, passengers and crews having been lost on more than one occasion.

The first effort to place a steam vessel, designed as an ice-breaker, in the service resulted in the building of the wooden steamer *Northern Light*, an old cut of which is shown in Fig. 2. The conception of her designers was that she would push her way between the ice-floes until she became jammed, when with the aid of barrels of water placed on her deck, the crew would roll her until free. The scheme did not work very well, it being found that the ice was rather resistant to rolling.

The next real attempt to improve on the service emanated from the Dominion government, consequent to Confederation, and indeed the desire for transportation facilities within the island and improved communications with the mainland was largely instrumental in influencing the people of Prince Edward Island to modify their inherent antipathy to the idea of Confederation.

It would seem that with the Arcadian simplicity of sentiment, which until 1913 prohibited the use of automobiles on their roads, they could see little advantage in sharing the responsibilities of the mainland, and in the year 1866 their Assembly passed a resolution to the effect that "while union might benefit the other provinces, they could not admit it could ever be accomplished on terms that would prove advantageous to the interests and well-being of this island, *separated as it is and must ever remain from the neighbouring provinces by an immovable barrier of ice for many months of the year.*"

The latter portion of this resolution is somewhat significant, in that seven years later one of the conditions imposed in joining the Union of Provinces was that "efficient steam service for the conveyance of mails and passengers be established and maintained (by the Dominion government) between the island and the mainland of the Dominion, winter and summer, thus placing the island in continuous communication with the Intercolonial Railway and the railway system of the Dominion."

This condition of Confederation removed the onus of providing the ferry service from the islanders and placed it on the Federal authorities.

Federal Development

In 1888 the steel ice-breaking steamer *Stanley* was built by the Dominion government for this service, and was a great improvement over the *Northern Light*. The ice-breaking principle in her design contemplated that she would run up on the ice and break it down by virtue of her weight. With this object in view her draft forward was only two feet, while she drew seventeen feet six inches aft. This principle did not, however, conform to the ice conditions commonly met with in this service, and she frequently became landed on the top of large ice formations, necessitating laborious cutting out operations by her crew. At the best she could only make a one-way trip per day under winter conditions, so that in 1899 the steel ice-breaking steamer *Minto* was built and placed in commission, which enabled a daily service each way to be maintained with some degree of regularity, although interruptions to service were fairly frequent and sometimes long. In one year the island was without freight service for seven weeks, due to the *Stanley* becoming stranded on a pan of ice and the *Minto* breaking her propeller while going to her

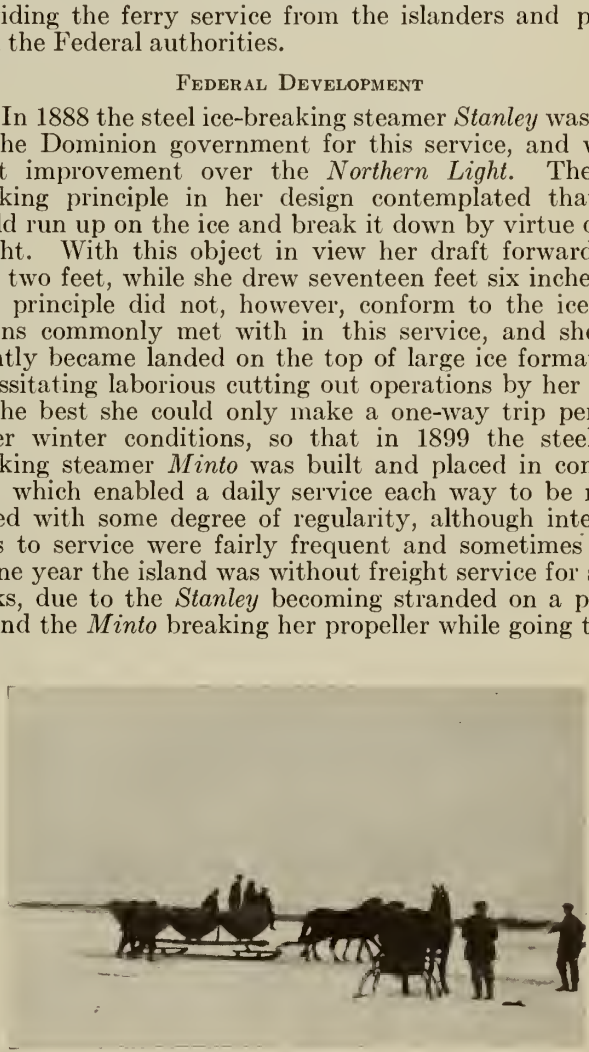


Fig. 1—Ice Dories Being Driven over Shore Pan Ice.

Fig. 2—Wooden Ice-Breaking Steamer *Northern Light.*

assistance. Both vessels were then out of commission until spring conditions released them, and on many similar occasions the Dominion government was required to compensate the island by the payment of considerable sums of money for losses incurred by failure to maintain continuous communication as guaranteed by terms of Confederation.

The somewhat ambiguous success attained with the *Stanley* and *Minto* resulted in another effort to improve the winter service, the steel ice-breaking steamer *Earl Grey* being built in 1909, and, although the same procedure of running up on the ice and breaking through was intended, rather fortunately, as it happened, it was found impracticable to trim the vessel by the stern sufficiently, and in part the greatly improved performance of the *Earl Grey* was attributable to the fact that she never became stranded on ice floes. She possessed much better manoeuvring ability in ice, due to her greater beam and the peculiar egg-shaped side which is now common to modern ice-breakers. The service provided by the *Earl Grey* was very reliable, and for the first time the equipment provided allowed of a strict interpretation of the letter of the requirement covering ferry service for "passengers and mails."

It now became apparent, however, that the service, excellent as it was, had little value insofar as the island's commerce or the marketing of its produce was concerned. Trade was still dormant during the winter months for the reason that almost all native produce, such as potatoes, turnips, eggs, cheese, etc., was of a perishable nature such as would not withstand transhipment in zero weather, while other frozen foodstuffs, such as meats, suffered by being placed in the heated holds of the ship. Consequently claims for spoiled shipments were frequent, due to some commodities becoming frozen and others being thawed out. The situation was further prejudiced by handling charges in and out of the ships and the short hauls involved which created excessive freight rates. It was therefore still advisable to anticipate as much as possible the crippling advent of winter and to provide suitable storage for goods of a perishable nature which could not be shipped prior to "close of navigation."

Car-Ferry Service Initiated

The ferry service, while now adequate insofar as the letter of the law was concerned, therefore fell far short of the ideal embodied in the consent of the island to Confederation, and the agitation which ensued, together with the degree of success attained by ice-breaking railroad ferries on the Great Lakes and in the Straits of Canso, determined the building of an ice-breaking train ferry, in accordance with the best practice then known. In 1912, Professor A. K. Kirkpatrick of Queen's University investigated and reported on "the establishment of the most suitable route for a car-ferry between Prince Edward Island and New Brunswick."

This comprehensive report covered no less than fifteen alternative routes, investigated with particular regard to ice conditions, depths of water, harbour protection, traffic requirements, mileage between principal towns, etc., and eventually the island terminal for the service was selected at Port Borden, and the New Brunswick terminal at Cape Tormentine, their distance apart being about eight miles.

Professor Kirkpatrick enumerated the principal particulars of nearly forty ice-breakers and car ferries in operation in many parts of the world, although this list was necessarily by no means comprehensive. For instance, in 1907 there were in service no less than 562 car ferries and car floats on the American continent alone, with capacity for 5,615 cars, while the average daily number of cars carried was 11,476, and the total ferry service mileage 1,360.

The report recommended that a vessel should be built having an ice-crushing bow; with bow propeller of nickel steel and forward engine of 2,000 indicated horsepower; with twin screws aft and engines of 2,500 indicated horsepower each; seacocks designed for encountering lolley ice; heavy ice-belt plating; two railway tracks to accommodate twelve freight cars, and to load and unload over the stern; with accommodation for passengers as well as crew. Suggested dimensions—length 280 feet, beam 50 feet, light draught 16 feet, loaded draught 18 feet.

Car Ferry *Prince Edward Island*

These recommendations formed the basis of the conception of the S.S. *Prince Edward Island* (shown in Fig. 3), which was designed and built in 1915 by the firm of Armstrong Whitworth & Company, Ltd., which firm had earned an enviable reputation for the building of large ice-breaking vessels for the Russian government.

The advent of the car ferry *Prince Edward Island* in conjunction with the building of the new shore terminals, and the changing of the Prince Edward Island Railway from narrow to standard gauge, marked a new era in the history of the island province insofar as its transportation facilities were concerned. The perishable products of Prince Edward Island could now reach the markets of North America without breaking bulk at any time of the year. This not only decreased the freight rates, but at the same time increased values; poultry could be shipped alive by the carload, dressed lambs and hogs could be hung up in refrigerator cars at Summerside or Charlottetown and delivered in Toronto, Montreal or New York without being handled. Business methods and values changed almost overnight. Under the old system of transportation the merchants had


Fig. 3—Car Ferry *Prince Edward Island.*

to lay in their winter's supply of coal and other commodities the preceding fall, with the result that the consumer had to pay interest, insurance and storage charges, but with the train ferry system, merchants were able to buy as their needs arose. The new vessel served her purpose admirably and maintained a regularity of service which was remarkable. Some interruptions to schedule were of course unavoidable, due to weather conditions. She has been as long as seventy-two hours in making a single crossing, and on another occasion when she was more than halfway inside the end of the pier at Borden, the ice pinched her stern with such force as to pull her out of the harbour and to carry her 12 miles down the strait before she could be got under control. On the other hand, she has broken her way out of Port Borden when the whole harbour was full of rafted ice, solid to the bottom. On this occasion 65 feet of progress required sixteen hours of strenuous effort. But such occasional service interruptions serve only to emphasize the onerous navigating conditions obtaining in the Northumberland Strait in the wintertime. When one remembers the somewhat resigned sentiments expressed in the Island's Assembly resolution of 1866, previously quoted, the successful maintenance of winter communication by the car-ferry *Prince Edward Island* is sufficiently obvious.

The service has been maintained by her for the past sixteen years, relief and assistance from S.S. *Scotia I* being obtained for several months in the summer time to permit of brief overhauls and reconditioning.

In recent years, however, it gradually became apparent that conditions were becoming more difficult, freight traffic was increasing, the vessel was getting older, the necessity for and urgency of more important repairs evidenced themselves and the vessel called upon to substitute temporarily in the service was not altogether suitable for the weather conditions. There arose the ever-increasing risk, accentuated by lack of opportunity for major repairs, that a breakdown of a serious nature might occur at any time, creating an interruption in communications of vital importance to the well-being of the Island.

The condition, however, which probably affected the efficiency of the equipment as a car-ferry to the greatest extent was due to the fact that when the *Prince Edward Island* was designed, no cognizance was taken of automobile traffic or its future development (see Table "A"), and, this traffic being confined to the summer period, it was apparently not recognized that a demand would arise for automobile transportation by the car-ferry. For many years a privately owned, but government subsidized, ferry service has operated in the summer months between Charlottetown and Pictou, but the car ferry had hardly entered into service before it was required to carry automobiles to the detriment of its efficiency as a transportation unit for railroad equipment.

Table "A"

Statement of Traffic Handled by Car Ferries between Prince Edward Island and the Mainland each year from 1923 to 1931, inclusive.

	To Prince Edward Island					From Prince Edward Island			
Year	Autos	Cars			Round Trips	Autos	Cars		
		Loaded	Empty	Pssgr.			Loaded	Empty	Pssgr.
1923	781	6372	1205	946	795	783	4381	3157	925
1924	1211	6430	959	1006	815	1184	4606	2783	964
1925	1713	7601	2031	1024	1013	1665	6005	3707	1010
1926	2219	9548	2357	1020	1241	2080	6773	4879	1053
1927	2960	11277	4051	1271	1579	2706	8760	6500	1270
1928	3855	13035	5124	1190	1836	3596	9804	8121	1241
1929	4311	12340	4095	1185	1782	4153	10205	6527	1198
1930	5111	15673	6107	1141	2085	4899	11276	9795	1151
1931	5706	11109	2435	1043	1299	5275	8445	5673	1045

The method evolved for dealing with this unlooked for contingency was to drive the automobiles on to flat cars, two to a car as a rule, at a siding adjacent to the terminals and to shunt them on to the ferry in the same way as normal railroad equipment. This kind of service was admittedly discouraging to the motorist, creating excessive delays and annoyances, but its most serious import was in its effect on the chief function of the ferry, in that not only did the flat cars laden with automobiles occupy space which would otherwise be occupied by freight or passenger cars, but the automobile traffic was mainly seasonal in direction and involved the carriage of many empty flat cars on the return voyages.

In spite of its inconvenience, automobile traffic, as was the case everywhere else, steadily increased, until it was largely instrumental in creating a situation necessitating the vessel being employed considerably beyond her normal schedule at times, and involving overtime rates on the vessel and at the terminals.

A survey of the automobile situation alone would indicate at this time the desirability of building a special automobile ferry to be operated in the summer months only, and probably this course may yet become necessary when the roads of Prince Edward Island are improved and tourist traffic encouraged thereby, but, taken in conjunction with the other factors mentioned, it was obvious that this alternative would not take care of that which remained the principal factor to be considered, namely, the maintenance of adequate winter communications, and it was evident that something had to be done to better serve both demands.

Various schemes received the consideration of the authorities. The feasibility of laying a tube across the strait along the bed of the ocean was examined. The provision of a tunnel received more detailed study, and a prominent British engineer, Sir Douglas Fox, was engaged to analyse and report upon its merit, who in 1891 estimated this cost at $11,262,500.

In 1929 a further estimate was made when its anticipated cost had grown to $38,178,000 if no air pressure was found necessary, but if air was required, as was expected, the cost would be well over $100,000,000. The building of a stone causeway with a navigating lock at one end was also suggested. All these ideas were eventually abandoned on account of the cost involved, but the agitations of the islanders continued, and in 1928 the Canadian government, acting upon the findings of the Duncan report, which recommended "that the situation should be considered from the point of view of placing at the disposal of the island such satisfactory means of communication as will ensure as regular and complete a service as can reasonably be made," decided to build another vessel to take up the brunt of the service, leaving the older vessel for emergencies, and to allow of reconditioning of the new vessel, as necessary from time to time, without detriment to the service.

Present Conditions Relative to the Service

It should be mentioned that while the maintenance of communications with the island is an obligation of the Dominion government, the service, on becoming a link in the general railroad system by the introduction of the car ferry system, was operated on behalf of the government by the Canadian National Railways, instead of by the Marine Department as formerly.

The decision of the government was therefore carried into effect by the railway company, S. J. Hungerford, M.E.I.C., vice-president, being the responsible officer, with H. T. Hazen, M.E.I.C., assistant chief engineer, as executive officer in charge of the work.

A study of the history of the service as outlined above indicated the desirability of increasing the length of track-

Fig. 4—Car Ferry *Charlottetown* before Launching.

Fig. 5—Car Ferry *Charlottetown* on Trial Trip.

age and the car capacity, with a view to taking care of increase in freight traffic already in effect and which could be reasonably anticipated within the useful life of the proposed new equipment.

It was also obviously desirable to provide a means for automobile transportation which would be more convenient to the motorist than the method then obtaining, and to provide it in such a way that ordinary railroad traffic would not be impeded or prejudiced.

Captain Read of the S.S. *Prince Edward Island*, a navigator of much experience in the winter service of the Strait of Northumberland and other parts of the world, was of the opinion that the new vessel should be much larger than the old one, but there were several material difficulties in the way. A considerably larger vessel would require correspondingly greater propelling power to provide for equal ice-breaking qualities. The extra weight of machinery and fuel so involved, together with the additional weight of cargo to be carried, would require an increase in draught, which would in turn necessitate expensive dredging at the terminals and the complete reconstruction of the landing piers. As the bottom at Port Borden is mainly rock, this would have meant a heavy capital expenditure, which prospect was received with much disfavour.

Any considerable increase in length was impracticable because the positions of the breakwaters and the restricted harbour areas necessitated very careful manoeuvring even with the existing vessel in bad weather or when ice conditions were difficult.

An increase in breadth could only be considered with caution, if complete reconstruction of landing piers was to be avoided, and owing to the necessity of terminals and aprons being suitable both for the new vessel and for the old vessel which would still require to use them on occasions when relief service would be necessary.

Contemporary Car Ferries

The principal particulars of a large number of modern car ferries were collated, and some of these are appended (see Table "B") as being more or less typical and suggestive.

Those in service on the Great Lakes were sufficiently alike to be classed as a standard type except for certain variations of propelling machinery. The largest and most attractive, from the point of view of car capacity, was the S.S. *Seatrain* in service at New Orleans, which carries no less than ninety cars, although it must be observed that comparisons based on car capacity are not necessarily exact, because car lengths vary considerably and the type of car carried is not always stated.

The *Seatrain* had the advantage of carrying cars on no less than four decks; the cars were lifted aboard by a powerful shore crane, being transferred to the several decks by means of an elevator. This type of vessel was not suited to the existing terminals at Borden and Tormentine; neither did the method of loading and discharging lend itself advantageously to such a short voyage.

There existed an undoubted tendency in favour of Diesel or Diesel-electric propulsion, and admittedly this type of machinery possessed definite attraction for the service in question. The severity of ice conditions—and there is no winter car ferry service where the ice problem is more real or persistent—the vital importance of maintaining scheduled time-table performance, and the fact that it was virtually an orphan vessel service, however, necessitated a most conservative choice of machinery being made, and required reliability being given priority over every other consideration.

It was further clear that if similar machinery to the S.S. *Prince Edward Island* was determined upon, the same engine room crew could operate either vessel as occasion demanded with no risk or anxiety occasioned by unfamiliarity with propelling machinery.

A mature study of such major considerations, and of many minor ones, finally determined the principal particulars of the new vessel, which was ordered by the Department of Railways and Canals, under authority of Dominion Order-in-Council passed March 8, 1930, to be built by the Davie Shipbuilding and Repairing Company, Ltd., of Lauzon, P.Q., who were the lowest tenderers, delivery being required at Port Borden after satisfactory trials by July 15, 1931.

Railroad and Automobile Ferry *Charlottetown*

The new vessel was named after the capital of the island province and a comparison of her principal particulars with those of the *Prince Edward Island* is attached. (See Table "C.") Figs. 4 and 5 show her just before launching, and on her trials.

Having regard to the objections previously noted to increasing the vessel's dimensions to any considerable extent, it should be observed that the principal factor which assisted in a favourable compromise being arrived at was the substitution of oil for coal fuel. It was almost essential to find some way of saving weight without prejudicing ice-breaking qualities, and the use of oil fuel with its lighter weight of about 300 tons, yet preserving the same steaming radius, was in fact the only means of doing so. An estimate of comparative operating costs revealed that the actual cost of coal and oil was approximately the same, presuming cost of oil at $1.57½ per barrel, plus handling charges. Actually the oil is costing only $1.05 per barrel including handling charges. The use of oil necessitated a rather considerable capital outlay for the provision of local

Table "B"
Particulars of Contemporary Car Ferries

Name	Service Locality	When Built	Speed	Dimensions	Draft	Rly. Cars	Tracks	Machinery	Horse Power	Propellers
City of Saginaw..........	Great Lakes	1930	18 miles	268′×57′×22.6′	18′	30	3	Turbo-Electric	7,200	2
Nyborg....................	Denmark	1931	14 knots	316′×58′×20′	13.1′	800 ft.	3	Diesel	4,000	2
Seatrain.................	New Orleans	1925	11 knots	316′×58′×20′	20.8′	90	16	Steam	3,500	1
Mommark.................	Denmark	1922	10 knots	140′×27′×14.5′	10′	4	1	Diesel	550	2
Pere Marquette 21 and 22.	Great Lakes	1924	14 miles	348′×56′×21.5′	16′	26	4	Steam	2,700	2
Leonard..................	Quebec	1913	12 knots	326′×65′×18′	15′	816 ft.	3	Steam	....	3
Schwerin.................	Germany	1926	15½ knots	328′×59′×19.7′	13′	7	2	Steam	4,500	2
Dolores de Urquiza.......	Argentine	1927	11½ knots	355′×57.5′×19.8′	12′	33	4	Diesel	1,800	2
Carmen Auellaneda......	Argentine	1930	11 knots	355′×57.5′×19.8′	12′	33	4	Diesel	1,400	2
Pere Marquette..........	Great Lakes	1930	18 miles	381.8′×57′×22.5′	16′	28	3	Turbo-Electric	7,200	2
Wabash..................	Great Lakes	1927	13½ miles	368′×57.5′×21.5′	16′	30	4	Steam	3,000	2
Ukoh Maru...............	Japan	1931	8.7 knots	150′×32′×8.5′	5.5′	12	2	Diesel	300	2
Cariddi and Scilla........	Str. of Messina	1931	15½ knots	359′×56.4′×20′	12.5′	790 ft.	3	Diesel-Electric	4,500	2

Note:—"Car capacities" is not exact criterion owing to different sizes of cars carried.

oil storage facilities, but this was in part offset by a reduction in firemen and trimmers personnel, and it was further estimated that a coal burning vessel of equal freight capacity would require to be about 20 per cent larger and over $400,000 more costly, besides necessitating the rebuilding of the landing slip and piers. Taking account of fixed charges due to increased capital cost of the larger vessel, and of difference in crew's wages, it was estimated that the oil burning vessel permitted an annual saving of nearly $70,000. From the operating point of view, oil fuel had very material attraction, allowing quick and easy adjustment of fires to meet the frequently changing demands of full steam and standby conditions.

The change also could not but prove beneficial to the important function of ice-breaking. The old ferry, being a coal burner and not having sufficient boiler capacity to permit the fires under one boiler being cleaned when working in heavy ice, could only work from two to three hours at full head of steam, by which time her fires became dirty and pressure gradually reduced till at the end of four or five hours it would be necessary to stop work and clean fires. Oil fuel not only obviates this condition but permits a rapid increase in steam pressure when ice conditions become suddenly more difficult.

The principal dimensional increase found to be permissible was in the beam, which was increased seven feet by cutting into the face of the spring fenders at both terminals. This increase allowed of a three track arrangement instead of two, and increased length of trackage proportionately except that it was still necessary to converge into two tracks at the after end of the vessel, where the cars enter and leave, in order to conform to existing terminal arrangements and to coincide with the track layout of the S.S. *Prince Edward Island* at this point of contact.

Provision for Carriage of Automobiles

The requirement that the vessel be adapted for service as an automobile ferry was one for which precedent offered no assistance, as this function was a novel one so far as railroad ferries were concerned. Some consideration was given to the possibility of laying a false deck at the height of top of rails, and using the car deck alternatively for railroad equipment and autos. Such an arrangement, however, could not but prejudice the vessel's ability for

Table "C"
Comparative Particulars of S.S. "Prince Edward Island" and "Charlottetown"

Particulars	*"Prince Edward Island"*	*"Charlottetown"*
Length between perpendiculars	285′	310′
Breadth	52′	59′
Depth	24′	25′
Draft	20′	19′ 3″
Displacement	4,900 tons	6,136 tons
Deadweight	775 tons	1,380 tons
Block Co-efficient	.58	.61
Freight Car Capacity	{12 Small 10 Large	16 large
Railroad Tracks	2	3
Automobile Capacity	none	40
Machinery	3 steam engines	3 steam engines
I.h.p.	7,000	8,000
R.p.m.	110	118
Boilers	6 Scotch	8 Scotch
Fuel	coal	oil
Bunker Capacity		450 tons
Speed	15 knots	15.3 knots
Propellers	3	3
Funnels	4	2

Fig. 6—Cape Tormentine Ferry Terminal Showing Inclined Bridge for Automobiles.

Fig. 7—*Charlottetown*—View from Docking Bridge looking forward showing Promenade Deck and Auto Runway.

her main purpose in the carrying of railroad cars, besides opening up possibilities of loss of time, damage to autos, and even danger to life involved in using common approaches and aprons for both classes of traffic.

The solution arrived at was a rather happy one, for the vessel, as built, permits all classes of traffic, namely, railroad equipment, foot passengers and automobiles to enter and leave the vessel by entirely separate routes, and even at different levels, thus preventing any one traffic conflicting with the others, avoiding loss of time and eliminating any attendant possibility of damage to life and property.

The largest single cargo carried by the *Charlottetown* to date is sixteen large freight cars and forty-nine automobiles. The largest cargo the *Prince Edward Island* is capable of is twelve old freight cars or ten modern with no automobiles, or twenty-four automobiles with no freight cars. Presuming she was laden on a fifty-fifty basis with cars and autos, she would have six freight cars and twelve autos, so that the increased capacity of the *Charlottetown* in the summer time may be placed at nearly three times that of the *Prince Edward Island* for freight cars and twice for automobiles. Actually the advantage is probably greater by reason of the enforced carriage of empty auto flat cars one way by the *Prince Edward Island.* In the winter time the increased capacity is in the proportion of 16 to 10 with an at present unknown factor compromising the problem, namely, the relative ice-breaking efficiencies of the two vessels.

In the case of the *Charlottetown,* the automobiles approach along a specially built inclined runway, shown in Fig. 6, and over a hinged gangway directly on to the deck aft, immediately over the railroad car space, which latter is two decks in height. They are driven all around the outer boundary of this deck, the main passenger saloons forming an oval-shaped island in its centre. Any possibility of misdirection is avoided by track fenders, and there is room for forty average size automobiles in single file, the gangways being so arranged that the first car on is automatically the first to leave the ship, and the rest following in single file.

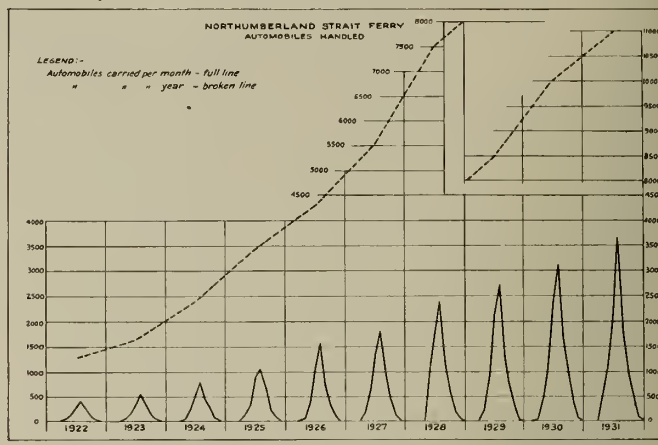


Fig. 8

The vessel construction in the vicinity of the auto space is entirely of steel, but to eliminate the possibility of an excessively hot auto fire during transit, causing the woodwork inside the steel house to catch fire, the space between the steel and the wood panelling is filled with insulating material. Incidentally this insulation has economic value in the winter time in reducing steam consumption to maintain appropriate temperatures inside the cabins. In order to deal promptly and effectively with isolated auto fires, a number of chemical fire extinguishers are also distributed in convenient positions.

Although the location for automobiles is really entirely safe, some apprehension was felt that nervous drivers might be a little alarmed at being expected to drive along the outside edge of a deck some 25 feet above the water. To provide a solid intervening bulwark was undesirable in that it would convert this long narrow driveway into a trap for snow accumulation in the winter time. Forged iron rails

Fig. 9—*Charlottetown*—View of Car Deck showing Three Tracks.

and stanchions of rather excessive height, and more than adequate weight, were therefore provided, and in order to further bolster up the confidence of a timorous driver if necessary, portable canvas weather cloths are fitted to remove the view and sense of undue elevation. In practice this apprehension appears to have been uncalled for and the travelling public is apparently of sterner metal than was anticipated. The automobile runway is shown in Fig. 7.

Passenger Accommodation

The motorist, on bringing his car to rest, steps out immediately on to a raised sidewalk which continues all around the centre saloons, and from which he has the option of passing into the main entrance saloon by either of four doors which are doubled to form an air-lock to isolate the saloon from excessive wind and extreme temperature. Alternatively he may proceed to the boat or promenade deck above by either one of three outside staircases.

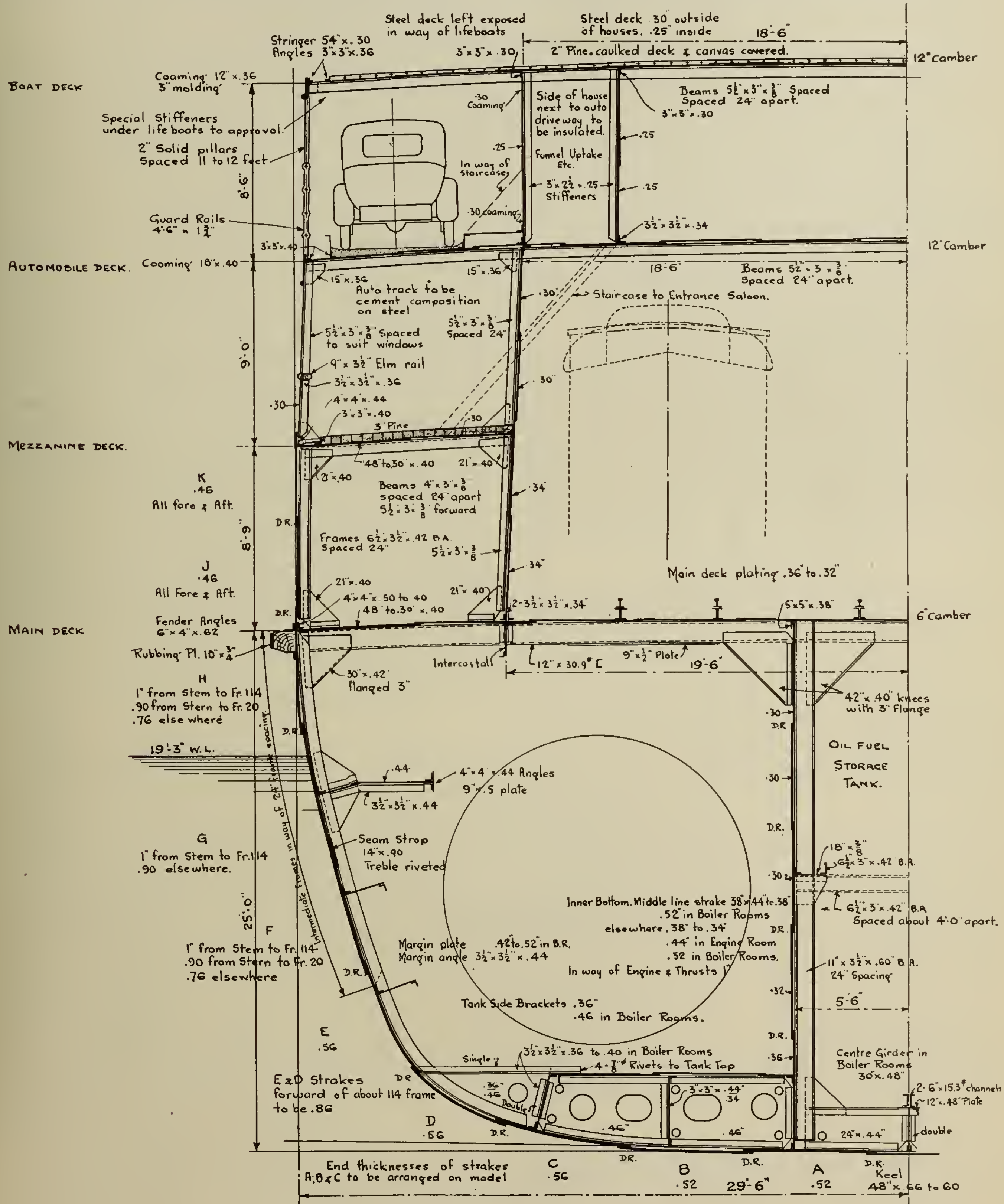


Fig. 10—Midship Section of *Charlottetown*.

On the same deck as the automobiles, and opening out of the entrance saloon, are the main lounge, news stand, ladies' drawing room and the restaurant. Four internal staircases lead from the entrance saloon down to the mezzanine or galley deck, and two internal staircases lead up to the smoking room, and to the observation saloon respectively, on the boat deck above. The staircase to the smoking room entrance is a handsome one of hammered Swedish iron and bronze, specially designed from records of early English ironwork made available by the Montreal Art Gallery.

The foot passengers board the vessel via combination hinged door-gangways on the mezzanine deck, which comprises a narrow gallery on each side of the ship at half height of the car-deck, and from which they may proceed to the main entrance saloon by the staircases aforementioned.

Provision for Carriage of Railroad Cars

The railroad equipment is shunted over the stern on to the main strength deck of the vessel, immediately over the machinery compartments, the procedure being reversed when discharging. While it is not the practice for passengers to be transported in passenger coaches, there are four staircases from this deck up to the mezzanine deck, so that train passengers, if still aboard the coaches, may proceed up to the principal passenger saloons.

Three sets of car-buffers are secured in place at the forward end of the car-deck, and arranged to take couplers of the standard type. Two powerful steam capstans are installed in an adjacent position and used in conjunction with a wire pennant and tackle attached to the after truck of the fourth car to hold the equipment up to the buffers. Air and hand brakes are also engaged, and when the weather requires it, sleepers are placed across the tracks behind the three after trucks, handy billies being attached to keep them snugged up to the wheels. Fig. 9 shows the car-deck.

Strength Problems

The constantly increasing weight of railroad equipment necessitated careful and exhaustive calculations being made to ensure that the main deck forming the working platform for railroad cars was adequately strong. For the purpose of these calculations it was assumed that the load would comprise freight cars weighing 210,000 pounds, having an overall length of 44 feet and mounted on two four-wheel trucks. To the weight was added 20 per cent for shock of impact, making a total weight of 252,000 pounds per car, and a wheel load to 31,500 pounds. The wheel centres were assumed to be 5 feet 6 inches apart, and the end axle three feet from the end of the cars. The determination of absolute stresses is approximate for such a structure, and the elastic support method of determining beam reactions was employed. Space will not permit the inclusion of details of these calculations, but it may be stated that the stresses amidships, that is, in way of the longest span, were considerably reduced by a rather novel arrangement of fuel bunkers. The customary arrangement of bunkers is to dispose them between the boilers and the side of the ship. In this instance they are located along the centre line of the ship between the two batteries of boilers. The strong containing oil-tight bulkheads of the fuel tanks, which extend from the bottom plating up to the main or car deck, thus afford a very rigid support to the middle portion of the beam span. This disposition also has value in maintaining a comparatively high temperature in the fuel tanks, thus saving steam in the heating coils, the tanks being virtually islands inside the heated boiler rooms, with only the comparatively small area of their bottom boundaries exposed to the cooling influence of the sea.

Similar calculations were made to ensure adequate deck strength under the automobiles. In this case the automobiles were assumed to weight 6,000 pounds each, plus 20 per cent for shock, giving a wheel load of 1,800 pounds. They were further assumed to have a wheel base of 108 inches, a tread of 56 inches, overall length of 120 inches, and to be touching in a fore and aft direction.

In practice it has been found that the scantlings incorporated in the structure (as shown in Fig. 10) are adequate for all stresses due to loading, there having indeed been only three tons of steel material added after the trials to overcome a moderate amount of vibration

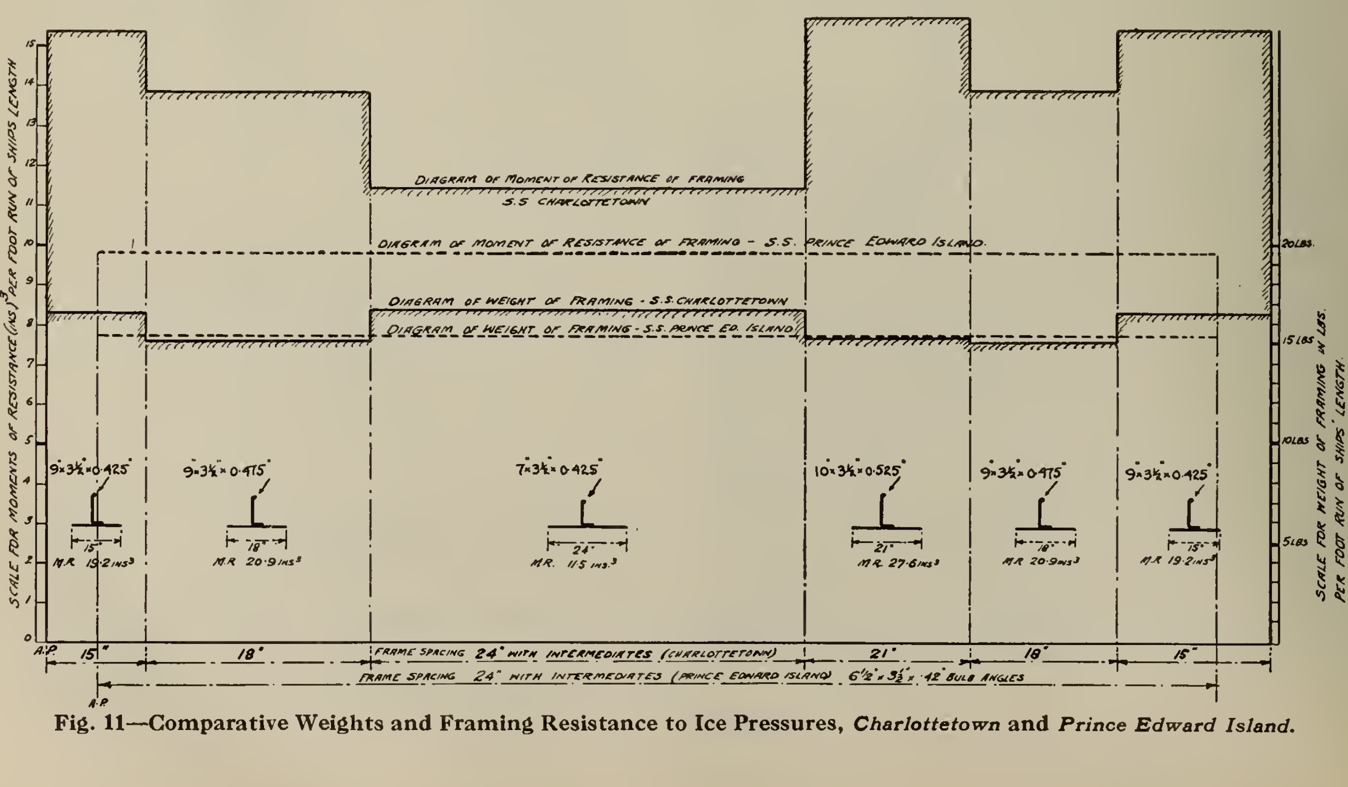


Fig. 11—Comparative Weights and Framing Resistance to Ice Pressures, *Charlottetown* and *Prince Edward Island.*

occurring in the deck over the car-well when vessel was being propelled at extreme full power.

The stem is a specially designed massive steel casting, of ram formation for ice crushing, being extremely solid in the vicinity of the waterline, but cut away sharply underneath to house the forward propeller. The stern frame, shaft brackets and rudder frame also are steel castings of heavy design, the latter being arranged to unship readily in dock or afloat, and connected to the 14-inch diameter upper stock by six 3½-inch diameter fitted bolts. In the region of the waterline is a belt of flush-seamed ice plating one inch thick, its width being increased towards the bow.

A problem which was given considerable study in the design stages had relation to the spacing of the transverse frames and web-frames. It is well known that for ordinary type cargo or passenger steamers, the various scantlings and frame spacings are usually determined by reference to the tables of the Classification Society to whose rules and class the vessel is to be built, which tables are based upon the principal proportional dimensions of the vessel. Ice-breakers are, however, a law unto themselves, their scantlings being very considerably in excess of Classification requirements, the weight and disposition of materials entering into their construction being subject to special experience with similar vessels, and the considered opinions or calculations of the designers. It can be readily appreciated that ice-breaker construction is not standardized to the extent that ordinary vessels are, and that a question such as that of frame spacing, instead of being automatically regulated without special consideration, becomes a matter for mature analysis.

An interesting and graphic comparison of the disposition of transverse strength members incorporated in the hulls of the car ferry *Prince Edward Island* and the car ferry *Charlottetown* is given in Fig. 11. It will be noted that a special feature of the structure of the *Charlottetown* is the variation in frame spacing, the intervals being much smaller towards the ends than in the region of amidships, on the theory that the pressures involved in cleaving the ice formation by the end wedges are greater than in way of the comparatively straight section amidships. This arrangement is excellent insofar as the lower part of the hull engaged in ice-breaking is concerned, but close spacing of frames at ends is somewhat obviously unnecessary and wasteful of weight insofar as the upper structure is concerned.

The study of this little problem resulted in a departure from established shipbuilding practice which finds expression for the first time in the *Charlottetown*, in that all transverse frames are not only cut at the main or car deck, but the frames above this deck have a uniform spacing of 24 inches from stem to stern, and no attempt has been made to arrange that the longitudinal position of the end frames shall coincide above and below the interrupting deck. There is accordingly a lack of continuity of transverse strength members at the ends and the hull up to the main deck is in a sense a separate entity, the part above this deck being virtually an erection upon the main lower hull.

It is contended that the system employed is more economical than the existing ferry, representing over twenty per cent less frames to shell riveting, with correspondingly decreased rivet repairs occasioned by ice damage. This arrangement also presents a stiffened shell to resist localized ice pressures, the moment of resistance of the framing forward being about forty-five per cent greater with no relative increase in structural weights.

Car-Deck Protection

The after end of the car-deck between the main and automobile deck levels is entirely open to permit the entry of railroad equipment, but as a means of preventing exposure to extreme temperatures in the winter when freight cars are left in the vessel at night, and with a view to discouraging pilferage, a large, vertical, sliding roller door is fitted in two sections at this point. It does not, however, function in keeping big seas out of the car-deck, which draws attention to perhaps the most common occasion for disaster to car ferries.

It is a very difficult matter to provide a barrier at the after end of such large area sufficiently strong to withstand the weight of exceptional seas, and more than one car ferry on the Great Lakes has been lost by seas sweeping up this rear opening and flooding the machinery spaces through the ventilating openings in the car deck, which, to avoid interference with cars, must necessarily be very low and which are customarily protected only by light steel non-watertight hinged covers.

The route over which the *Charlottetown* operates, while noteworthy for severe ice conditions in the winter time, is not sufficiently exposed to produce large enough seas to endanger a vessel of her size, while provision has been made for the fitting of a substantial breakwater on the few occasions when she will be called upon to proceed to Halifax or other ocean ports for dry docking.

As an additional precaution, however, advantage has been taken of a recently invented sliding steel hatch cover, which is as strong and watertight as the surrounding deck, can be quickly and easily operated by one man, and which is fitted to some twenty flush ventilator openings in the main deck in the car-well.

Reference to the sectional plan of the vessel discloses that in order to obtain the requisite clearances for three railroad tracks, very little space remains at the sides for funnel uptakes, stokehold fan vent casings, electric elevators and the various passenger staircases, etc., and indeed these narrow side erections cover a multitude of minor problems and occasioned many troublesome difficulties.

Crew's Accommodation

Due to the necessity of giving precedence to the special requirements of the service, the accommodation for the officers and crew of fifty-two is distributed in a rather scattered and unusual manner, albeit their quarters are to a high standard of comfort, privacy and sanitation. The seamen, firemen and stewards' personnel are berthed in the hull below the main deck, before and abaft the machinery spaces, and owing to the risk of ice damage which might be occasioned by port lights piercing the main hull comparatively close to the waterline, rather special arrangements to secure borrowed daylight to the crew's quarters were necessary.

In the narrow erections on both sides of the car deck are arranged the crew's galley, with cold stores, pantries and messrooms for firemen, seamen, petty officers and senior officers adjacent thereto; also their various and separate lavatories, drying rooms, stores, watchman's room, crew's reading room and cabin for the superintendent of ferries, etc.

On the mezzanine deck above are located cabins for deck and engine room officers, all of which are very comfortable and spacious.

The captain's quarters, comprising his day room, night room and bath room, are provided on the boat deck immediately abaft the wheelhouse, while the purser's and chief steward's rooms, with private bath, are entered from the main entrance saloon and are adjacent to the purser's office.

These executive officers, together with transient officials, are also fortunate in being provided with a separate dining saloon located on the same deck and entered from the restaurant. This dining saloon is served by an electric elevator from the crew's galley below on the main deck.

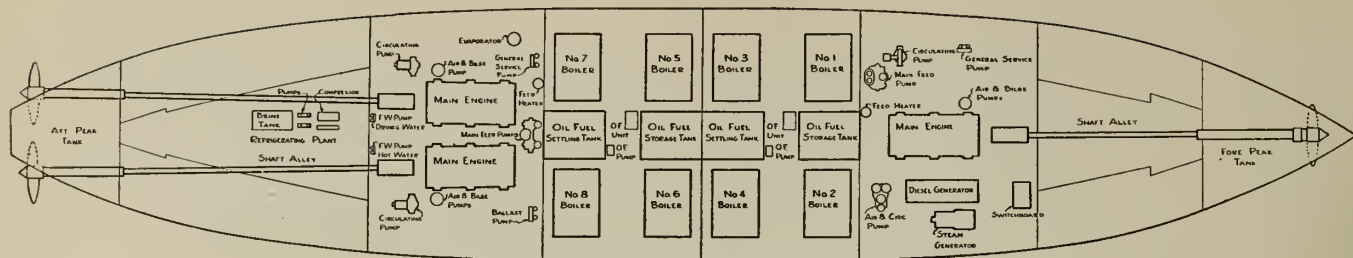


Fig. 12—Plan of Machinery Spaces, *Charlottetown*.

Public Rooms and Equipment

Space will not permit more than passing reference to the passengers' public saloons, and indeed a detailed description of them would be more appropriate to a gathering of interior decorators than to a representative body of engineers, but they are in a scale of substantial comfort and convenience, and are furnished in accordance with specially approved decorative schemes, which are rather superior for a vessel of this type. The hardwood panelling of these rooms, comprising mahogany, walnut, oak and sycamore, manufactured by Canadian Vickers Limited, is indeed a beautiful exemplification of the best in Canadian workmanship.

The restaurant is designed as a combination dining room and lunch counter, the forty-five minutes occupied in transit rendering it necessary to provide for specially quick service when a full complement of passengers is aboard. It is complete with appointments of the most modern character, and is served by its own electric kitchen, with complete outfit of culinary equipment for producing an excellent variety of food in the quickest possible time, and under the most sanitary conditions.

The public rooms as a whole provide inside seating accommodation for about two hundred and fifty passengers, which number could be easily increased if found desirable. Emergency sleeping accommodation, comprising portable folding cots, for one hundred passengers, is also provided in the event of the vessel being held in the ice for unusual periods.

The boat deck is quite spacious, affording ample promenading space for passengers in the summertime, and on this deck are berthed eight steel lifeboats, operated by Columbus mechanical davits, the falls of which are controlled by electric winches, assuring quick and easy lowering in an emergency. An interesting survival of past practice is evidenced in the carrying in addition, under davits, of two small ice-boats.

The navigation bridge is entirely enclosed by teak and glass for comfort during the winter months, one of the windows being equipped with a "Kent" clear view screen, an ingenious device of revolving glass, preventing the lodgment of snow, ice or water, and thus affording clarity of vision under all conditions of weather. The navigating equipment and instruments are of most modern calibre, including electric telegraphs, revolution indicators, steering pedestal, searchlight projectors of 25,000 candle-power, range finder, steering compass, gyro compass, and a 100-watt radio-telephone, the latter being the first marine installation in Canadian waters. All watertight doors allowing access between the various machinery spaces are operated hydraulically from the wheelhouse on the "Brunton" system.

A rather similar docking bridge is located at the after end of the ship, and equipped with duplicate electric telegraphs, etc., for convenience in controlling the vessel when backing into the terminals.

The two main funnels, placed athwartships, are connected near their top by a light steel lattice-work bridge on which are mounted two flood lights, which together with the search lights enable the vessel to be manoeuvered at night with the same facility as in the day time.

The steering gear is installed in a compartment aft, being directly connected to the rudder stock. It is of the Brown tiller type, controlled from the navigation bridge by telemotor gear, and is capable of withstanding shock when the vessel is backed into a solid mass of field ice.

A steam refrigerating plant of the ammonia type is installed for 750 cubic feet of cooling chambers on the main deck for the provision store. In addition a small branch refrigerator is fitted in the all-electric passengers' kitchen aforementioned.

Weights

The *Charlottetown* was launched on May 20, 1931, with considerable éclat, her sponsor being Mrs. Charles Dalton, wife of the Lieutenant Governor of Prince Edward Island, and the ceremony being attended by leaders in public life and business in the Maritime provinces, representatives of the Dominion cabinet and principal officials of the Canadian National Railways. The launching weight of nearly 4,500 tons was the heaviest ever launched from a Canadian shipbuilding berth.

The vessel was designed to carry a deadweight of 1,380 tons, comprised as follows:

Railroad load	1,000 tons
Automobiles	60 "
Fuel oil	250 "
Fresh water	35 "
Provisions and stores	15 "
Passengers and crew, effects and stores	20 "
Total deadweight	1,380 "

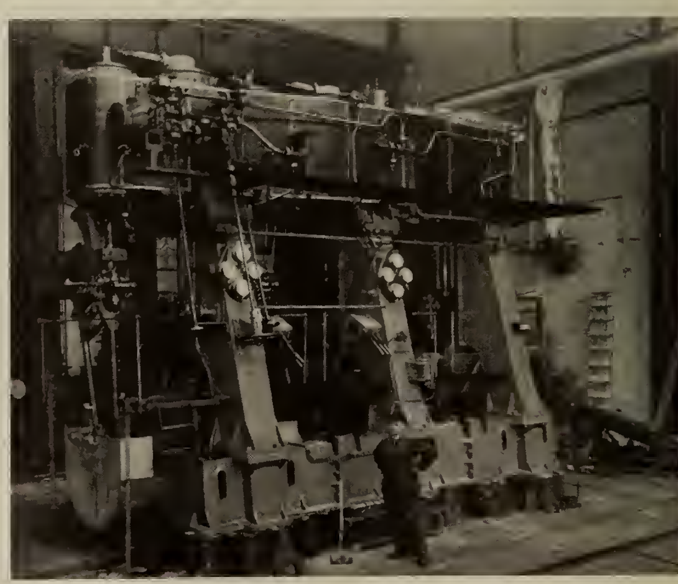


Fig. 13.—One Set of Main Propelling Engines, *Charlottetown*.

Table "D"

"Charlottetown"—List of Auxiliary Machinery

Description	Type	Size
Forward Engine Room		
Main Feed Water Pump	Weir Duplex	8″×10½″×22″
Auxiliary Feed Water Pump	Weir Simplex	7″×9½″×21″
General Service Pump	Carruthers and Darling Duplex	7½″×10″×12″
Main Circulating Pump	Allen Centrifugal 2,700 g.p.m.	7″×6″ engine
Auxiliary Condenser	Canadian Vickers	750 square feet.
Air and Circulating Pump	Weir—Air Pump 17″ Circ. Pump 20″	14″×15″ steam cyl.
Feed Water Heater	Caird and Rayner	Suitable for 2,700 I.h.p.
Feed Water Filter	Caird and Rayner	Suitable for 2,700 I.h.p.
Watertight Door Pump	Weir Duplex	4½″×9½″×7½″
After Engine Room		
Main Feed Water Pump	Weir Duplex	10″×13½″×24″
General Service Pump	Carruthers and Darling Duplex	7½″×10″×12″
Emergency Bilge Pump	Carruthers and Darling Duplex	8½″×8″×8″
Ballast Pump	Carruthers and Darling Duplex	12″×10″×12″
Sanitary Pump	Carruthers and Darling Duplex	5½″×5½″×6″
F. W. Pump, hot and cold	Carruthers and Darling Duplex	5½″×5½″6×″
Drinking Water Pump	Carruthers and Darling Duplex	5½″×5½″×6″
Two Main Circulating Pumps	Allen Centrifugal 2,700 g.p.m.	7″×6″ engines
Evaporator	Weir	30 tons per 24 hours.
Feed Water Filter	Caird and Raynor	Suitable for 5,400 I.h.p.
Feed Water Heater	Caird and Raynor	Suitable for 5,400 I.h.p
Calorifier for Hot Water	Robertson	....

Heavy penalties applied in the event of the vessel's draught exceeding 19 feet 3 inches with this load aboard, but on completion this condition of draught was met with two inches to spare.

Machinery

The propelling machinery, built as a sub-contract by Canadian Vickers Limited, is exceptional only from the point of view of strength, the working parts varying from 15 to 35 per cent in excess of Lloyd's requirements.

As in the *Prince Edward Island*, there are three propelling units, two aft and one forward. In the older vessel the two after engines are slightly more powerful than the single forward engine, but in the *Charlottetown* all three engines are to the same pattern and parts are therefore interchangeable.

Steam is generated in eight single ended Scotch boilers, working under forced draught, and having a working pressure of 180 pounds per square inch. The general arrangement of the propelling and auxiliary machinery is indicated in Fig. 12.

The oil-firing equipment is of the Wallsend-Howden type with air pre-heaters and generally the machinery installation is noteworthy, apart from its rugged design, from the fact that it is conservative and simple in character, all its features being considered largely from the aspect of dependability and suitability for operation by the ordinary class of marine engineer. Every effort has been made to obtain a good fuel economy consistent with this policy.

It is located in four main watertight compartments, all interconnected by watertight doors, two batteries each comprising four boilers, and constituting separate steam-raising units, being in two compartments amidships, with one engine in the forward end and two at the after end.

Fig. 13 shows a set of the main engines which are of the triple expansion, vertical inverted, surface condensing type, with cylinders 26 inches, 41 inches and 66 inches diameter, with 36-inch stroke. The collective designed power is 8,000 i.h.p. at about 118 revolutions per minute. The forward engine actuates the bow propeller, which when working in ice functions similarly to a centrifugal pump, tending to agitate the water under the ice and so allow the crushing action of the bow to exert maximum effect. A removable distance piece is inserted between the crankshaft and thrustshaft couplings to enable the forward shafting to be uncoupled and run freely should it be desired not to

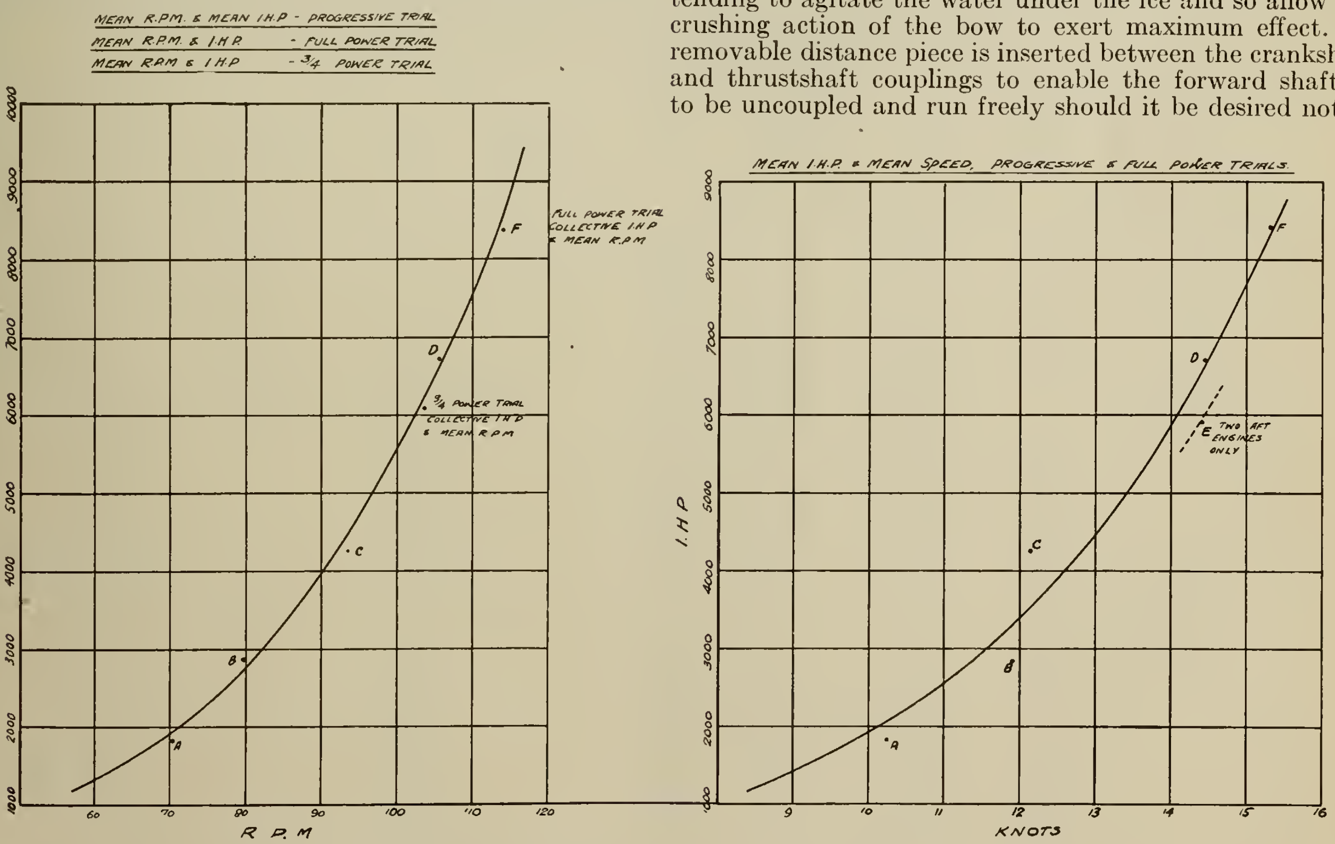


Fig. 14—Trial Data giving Power, Speed and Revolutions, *Charlottetown*.

operate the forward engine. The two after engines operate as in ordinary twin screw practice, driving two stern propellers. All three propellers are of the built up type, of very robust design, and made in Canada of cast nickel steel.

Auxiliary Machinery

Exceptional manoeuvring qualities being essential, the engines are fitted with direct-acting reversing engines, and all machinery is adequately chocked and stayed to withstand ice shock. Each engine has its individual surface condenser, having a total cooling surface of 3,484 square feet, and capable of maintaining a vacuum of 26 inches under normal conditions. The circulating pumps are three in number, of the direct driven centrifugal type, and draw from large compartments within the double bottom, which fill from the sea through perforations in the shell plating.

Two 85-kw. 220-volt, D.C. generating sets are provided, each being of sufficient capacity to carry the full electric load, although capable of running in parallel in the event of an overload. The make-up of load is approximately as follows:

Pantry and galley equipment	32 kw.
Radiophone and searchlights	10 kw.
Lighting	25 kw.
Forced draught fans, etc.	5 kw.
*Workshop motor	12 kw.
Total	84 kw.

*The workshop machinery specified to be installed on the vessel was later deleted.

In order that electric power may be readily available when the vessel is laid up and without steam, one of the generating sets is driven by a Petter Diesel engine of 144 b.h.p., the other being driven by a Howden compound steam engine. They operate at the same speed, the dynamos being by the Lancashire Dynamo Company, and their parts are interchangeable. Special provision is made for pumping from forepeak to afterpeak tanks, and vice versa, for assistance in ice-breaking.

Further itemized details of engine and boiler room auxiliaries are listed in the attached Table "D."

Stability and Trials

The three track arrangement incorporated in the design of the *Charlottetown*, as against two tracks on the *Prince Edward Island*, together with the increased deadweight loads above the main deck were factors which suggested the possibility of increased listing and decreased margin of stability. Preliminary calculations, however, established that the margin of stability in all stages of loading was more than ample to meet all requirements for initial stability, while the height of freeboard was such as to ensure an ample range.

When the vessel was approaching completion an inclining experiment was made when it was determined that the G.M. was 65 inches in light and 38 inches in loaded condition.

Of perhaps more practical importance, by reason of the small clearances at the terminals, and the almost vertical sides of the vessel, was the degree of list which would be occasioned by a load of cars and automobiles on one side only. Calculations showed that a list of 10 degrees might be expected, although hardly likely in actual practice, which necessitated sufficient flexibility in the terminal heights and clearances, plus allowance, due to rise and fall of tide.

The propelling machinery trials comprised a six-hour dock trial undertaken on June 25, 1931, followed by a six-hour official progressive trial at Murray Bay on June 29. On the next day a six-hour full power trial was made, including six timed runs on the measured mile followed by a seven-and-a-half-hour, three quarters power trial, all successfully completed without incident of major importance. The draughts at which the trials commenced were 16 feet 11 inches forward and 17 feet 4 inches aft, representing a displacement of 5,070 long tons. The mean full speed in the six runs was 15.32 knots, the mean collective

Table "E"

Trial Data of S.S. "Charlottetown"—Speed, Revolutions and Power

No. of Runs	Speed in Knots	Revs. Forward	Revs. Port	Revs. Starboard	Collective I.h.p.	Mean Speed	Mean R.p.m.	Mean I.h.p.	Point in Curve	Remarks
1	10.91	68.2	68.5	64.0	1617	10.23	70.35	1819	A	Progressive Trial 2 aft engines running
2	9.96	71.8	75.8	73.0	2021					
3	12.18	79.2	81.3	75.4	2978	11.9	79.95	2879	B	
4	11.61	79.6	82.8	81.5	2780					
5	12.52	98.0	91.0	89.5	4081	12.12	93.4	4270	C	
6	11.73	91.2	95.4	94.2	4458					
7	14.24	104.2	106.7	103.5	6672	14.42	105.75	6713	D	
8	14.60	105.5	108.4	105.5	6754					
9	14.02		114.5	110.0	5792	14.4	112.35	5933	E	
10	14.77		114.0	110.9	6074					
11		108.0	118.0	116.0	8737		114.			Full Power Trial
12		108.0	120.0	118.0	8786		115.3			
13		110.0	120.0	118.0	8649		116.			
14		110.0	120.0	118.0	8638		116.			
15		109.0	120.0	112.0	8432		113.6			
16	11.86	108.0	116.0	114.0	8253	15.32	112.6	8404	F	
17	19.72 / 11.82	109.0	120.0	116.0	8778		113.4			
18	18.81 / 12.02	108.0	120.0	114.0	8381		114.			
19	17.61	108.0	116.0	112.0	8206		112.			
20		107.0	116.0	114.0	8196		112.3			
21		108.0	118.0	112.0	8275		112.6			
22		98.0	106.0	110.0	6103		104.7			Three-Quarter Power Trial
23		100.0	106.0	102.0	6247		102.7			
24		98.0	108.0	104.0	6228		103.3			
25		98.0	108.0	104.0	6197		103.3			
26		98.0	108.0	104.0	5970		103.3			
27		98.0	108.0	104.0	5939		103.3			

horsepower being 8,404. The principal data obtained on these trials are set out in Table "E," while Fig. 14 shows these results graphically.

Made in Canada

Apart from the peculiar technical characteristics of the vessel, possibly the most interesting feature associated with the building of the *Charlottetown* was the requirement that to the greatest possible extent all material and equipment should emanate from Canadian sources, and that such as could not be so obtained should be produced within the Empire. This stipulation was rigidly enforced and to a certain extent increased the difficulties and responsibilities of the builders, in that instead of relying in many cases on the fully established reputation of British merchants in a particular item of marine equipment, they had perforce to take a chance on a Canadian made article which was not backed with the same degree of marine experience. It is to their credit that no attempt at evasion was made and that indeed no trouble was too much to them to obtain adherence so far as possible in letter and spirit to this somewhat onerous condition. In consequence, it may be stated that no vessel of any consequence has been built in Canada so consistently of Canadian materials, or with so much Canadian labour entering into its component parts, as has the *Charlottetown*. One-third of the steel was rolled it Canada, and the balance in Great Britain. Ninety per cent of the lumber came from Canada's forests and ten per cent, comprising mahogany from British Honduras and teakwood from India. All interior furnishings, with the exception of coverings not made in this country, were made by Canadian furniture companies. Electrical, plumbing, lighting and other fixtures were made in Canada, in some cases from British materials, and installed by Canadian workmen. Certain fittings for the *Charlottetown* were made in Canada for the first time, so that, by and large, the successful issue of such a large contract, the most valuable order ever given to a Canadian shipbuilding firm, is distinctly creditable to the Davie Shipbuilding and Repairing Company, Ltd., Canadian Vickers, Ltd., and the various other subcontractors.

Work of construction commenced with the laying of the keel on June 5, 1930, and carried through in the open during a very severe winter. In order to allow interior work to proceed, the upper decks and houses were pushed ahead before the heaviest snow storms, and a temporary heating system installed in the ship. The temperature at times reached a minimum of 30 degrees below zero. The delivery of the boilers commenced in November and they were installed through the ship's side before closing in. The three sets of engines and all auxiliaries were installed in similar manner, the last of the machinery being delivered in March 1931. The hull was closed in April and her complete light displacement was 4,647 tons. The actual number of working days occupied in building, from keel laying to delivery, was three hundred and twelve, and a total of seven hundred men were employed at the shipbuilding plant, with an approximately equal number on outside subcontracts. The total number of rivets in the vessel was 518,000, and 109,000 feet of wiring was used in the lighting and various electrical circuits; 29,500 feet of piping was used in the several piping systems, each being painted in distinctive colours, and as many as one hundred and twenty-two Canadian firms were fortunate enough to participate in supplying the miscellaneous materials required.

All the guarantees as to carrying capacity, developed horsepower, draught and fuel consumptions were met with some margin, and the only performance factor which at the time of writing these notes is undetermined is the vessel's ice-breaking qualities; the lines of the vessel were determined after careful study, full advantage being taken of Captain Read's extensive experience, so there is every reason to hope that the next few months will prove out this feature to the satisfaction of all concerned.

The *Charlottetown* left her builders' yard on July 14, and entered service a few days after arrival at Borden, releasing the *Prince Edward Island* for a much needed and overdue major overhaul.

Report of Council for the Year 1931

While the affairs of The Institute, like those of other public organizations, have been affected by the change in industrial and financial conditions during the past year, Council has been able to note with satisfaction that as regards the activities of The Institute and its Branches the work has been carried on with very slight recession. The year's results have, in fact, been more encouraging than was anticipated, and it is felt that the reports now submitted to the membership do not warrant any pessimistic attitude as to The Institute and the engineering profession in Canada.

The present has seemed to Council the proper time to take stock of The Institute's condition, policy and resources, and for this purpose a Committee on Development has been formed. Its report, which it is hoped will be presented at the next Plenary Meeting of Council, is expected to contain suggestions as to the measures which should be taken if The Institute is to increase its activity and usefulness in readiness for the development which will follow improvement in world conditions.

The interest in Institute affairs which has recently been shown on so many occasions by Branch officers and Executive committees, and the discussions on these matters which have taken place at Branch meetings, indicate that this course will receive general approval, and that the Committee on Development will be aided in its responsible task by comment and suggestion from our Branches and the membership generally.

The relations of The Institute with the several Associations of Professional Engineers have now been under consideration by Council and by the membership for some years. It is gratifying to note that as a result of the action of The Institute's committees dealing with this question, the eight Professional Associations have now taken the initial steps towards the co-ordination of their work. It is hoped that in this way means will soon be found for removing some of the divergencies now existing in their powers and policies and obtaining a reasonable measure of agreement as to qualifications for registration and conditions for mutual recognition of membership. These are matters of vital concern to all members of the engineering profession in Canada.

This year's records of our Employment Service Bureau, in contrast to the condition two years ago, indicate a considerable increase in the number of members looking for employment, and a marked decrease in the opportunities for employment. This situation has been more noticeable in connection with the construction industry than in other branches of engineering. Our list of members who are seeking positions and who have registered with the Bureau, however, has not exceeded six per cent of the total membership, and the average has been less than this, a condition which it is felt compares favourably with the state of affairs in many other lines of occupation.

During the year the work of the library and information service has shown a steady increase, many members taking advantage of our facilities for obtaining references to current information and copies of articles in the technical press.

No changes or amendments have been made in The Institute's By-laws during the year, the amendments proposed last year for Sections 66 and 67 having failed to secure the approval of the membership on ballot.

The Fifth Plenary Meeting of Council took place at Headquarters on September 21st, 22nd and 23rd, 1931, with an attendance of thirty-five members of Council. The proceedings of this meeting were reported in the November number of The Engineering Journal, pages 573 to 577.

The Forty-Fifth Annual General and General Professional Meeting was held in Montreal on February 4th, 5th and 6th, 1931, and was largely attended, its proceedings being reported in The Engineering Journal for March 1931, pages 176 to 192. One of the principal technical items at this meeting was the presentation of a series of papers on the engineering features of the new Sun Life building, Montreal.

At the Annual Dinner of The Institute the innovation was introduced of having ladies present, and on this occasion the prizes and medals of The Institute were presented, including the Sir John Kennedy Medal awarded to Past-President G. H. Duggan, M.E.I.C.

The Council has noted with satisfaction the success attained in connection with the working of the agreement concluded in 1930 with the Royal Aeronautical Society, and particularly the activity shown by the Aeronautical Section of the Ottawa Branch. Approval has been given to a somewhat similar arrangement in connection with Radio Sections as between The Engineering Institute of Canada and the Institution of Electrical Engineers (Great Britain). The organization needed for putting this second agreement in force is now under consideration and it is hoped that similarly satisfactory results will follow.

The Council has received with pleasure an intimation that The Institution of Mechanical Engineers will hold its summer meeting in Canada this year. The British party is expected to visit Quebec, Montreal, Ottawa, Toronto and Niagara, and The Institute has already been able to render them some assistance in making their arrangements. Council is confident that our Branches in the cities visited will do much to make the party's stay in Canada enjoyable and informative. The Institution's meeting will take place in August in Toronto.

A welcome has been extended by The Institute to The American Society of Mechanical Engineers which is holding a Canadian Summer Meeting at Bigwin, Ontario, in June next. Members of The Institute are invited to participate in this meeting, which will afford another opportunity to mark the friendly relations which have always existed between The Engineering Institute of Canada and the sister societies in the United States.

In June, The Institute was represented by Professor R. W. Angus, M.E.I.C., at the Seventy-Fifth Anniversary Meeting of the establishment of the Verein Deutscher Ingenieure held in Cologne; greetings from The Institute and other engineering societies throughout the world were received at this important convention, which was attended by over one thousand members and delegates.

Among the names of prominent members deceased during the past year may be noted those of F. C.Laberge, M.E.I.C., member of the Quebec Public Service Commission; George C. Mackenzie, M.E.I.C., secretary of The Canadian Institute of Mining and Metallurgy; two of our distinguished American members, E. W. Stern, M.E.I.C., and Professor G. F. Swain, M.E.I.C.; R. W. E. Loucks, A.M.E.I.C., and R. W. Downie, A.M.E.I.C., two members who served for many years as secretaries of the Saskatchewan and Niagara Peninsula Branches respectively, and two of our senior members who joined The Canadian Society of Civil Engineers in its early stages, L. G. Papineau, A.M.E.I.C. (1887), and H. E. Vautelet, M.E.I.C. (1888).

The report of the Committee on Classification and Remuneration, presented at the Annual Meeting of 1931, has been well received, and it is hoped will prove as useful to the profession as did that of the previous committee issued in 1922.

Your Council's attention having been drawn to the unsatisfactory conditions prescribed by the city of Oshawa in calling for competitive plans and tenders for a proposed sewage disposal plant, a letter was addressed to that city pointing out the objectionable features of their method of obtaining engineering services, and The Institute's membership was informed that in Council's opinion they would be well advised to refrain from competing under the conditions described in the city's advertisements.

The eleven Engineering Institute of Canada Prizes, instituted last year by Council for award to deserving students by the authorities of the principal engineering schools in Canada, were willingly accepted, and it is hoped will form an additional link between The Engineering Institute and the schools which are concerned with the education of our young engineers. In this connection it is noted with satisfaction that an educational conference has been arranged by The Institute's Committee on Engineering Education to take place in connection with the forthcoming Annual Meeting.

During the year The Institute has been honoured by His Excellency the Governor-General, who graciously permitted his name to be added to The Institute's list of distinguished Honorary Members.

Meetings

Annual General Meeting

The Forty-fifth Annual General Meeting of The Institute was held at Headquarters, in accordance with the By-laws, on Thursday, January 22nd, 1931, with Vice-President George R. MacLeod, M.E.I.C., in the chair. After the approval of the minutes of the Forty-fourth Annual General Meeting and the appointment of the scrutineers and auditors, the meeting was adjourned to reconvene at ten o'clock a.m. on Wednesday, February 4th, 1931, at the Windsor hotel, Montreal.

On February 4th the adjourned meeting was called to order by President A. J. Grant, M.E.I.C., who welcomed the members and guests present, particularly F. L. Stuart, M.E.I.C., President of the American Society of Civil Engineers, and W. S. Lee, M.E.I.C., President of the American Institute of Electrical Engineers.

The business transacted included the appointment of the Nominating Committee for 1931, the announcement of the recipients of the various prizes and medals of The Institute, and the consideration of the reports of Council and of The Institute's committees, and the reports from the Branches.

Considerable discussion took place on the report of the Committee on Membership, particularly as to the comparison between The Institute's educational requirements for admission and those exacted by the Professional Associations. The reports of the Branches were next considered.

During the afternoon session discussion took place on the report of the Committee on the Relations of The Institute with the Provincial Associations, and upon Council's proposals for amendments to by-laws, after which the retiring President delivered his address, dealing with the great ship canals of the world, with comments on their economic possibilities. The scrutineers' report was next presented, and the officers for 1931 were declared elected.

The newly elected President, S. G. Porter, M.E.I.C., was then conducted to the chair, and the Annual General Meeting terminated with votes of thanks to the retiring President and Council, the scrutineers and the Montreal Branch for their hospitality in connection with the meeting.

General Professional Meeting

The technical sessions of the General Professional Meeting took place on February 5th and 6th, when a series of papers were presented dealing with a wide range of engineering activities. The social features of the meeting included a very successful smoking concert, a reception and supper dance held on the evening of the 6th, and the Annual Dinner at which the principal speaker was Beaudry Leman, A.M.E.I.C., President of the Canadian Bankers Association.

Roll of The Institute

During the year 1931 two hundred and twenty-seven candidates were elected to various grades of The Institute. These were classified as follows:—one Honorary Member, five Members, forty-five Associate Members, twenty-nine Juniors, one hundred and forty-one Students, and six Affiliates. The elections during the year 1930 totalled two hundred and eighty-three.

Transfers from one grade to another were as follows:—Associate Member to Member, sixteen; Junior to Associate Member, thirty-six; Student to Associate Member, twenty-three; Student to Junior, thirty-seven; Student to Affiliate, two; a total of one hundred and fourteen.

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 membership roll during the year 1931, for non-payment of dues, and by resignation, thirty Members, one hundred and seven Associate Members, thirty-one Juniors, forty-six Students, and five Affiliates, a total of two hundred and nineteen.

Twenty-four reinstatements were effected, eight Life Memberships were granted, and ten members were placed on the Suspended list.

Deceased Members

During the year 1931 the deaths of thirty-five of The Institute's members have been reported as follows:—

Members

Andrus, Donald Allan
Astley, John W.
Bernasconi, Gustavus A.
Bryant, Orville Frank
Cameron, Donald
Evans, John Dunlop
Fellowes, Chas. L.
Hayward, Jos. Wm.
Laberge, Francois C.
Mackenzie, Geo. C.
Martin, Frank Henry
McLeod, Norman M.
Stern, Eugene W.
Swain, Geo. Fillmore
Vautelet, Henri Etienne
Volckman, Geo. W.
Welby, Adlard Edward

Associate Members

Anderson, Robert Jack
Bateman, Edward Fleming
Cairnie, Gordon F.
Cameron, E. Parke
Downie, Ralph Waldo
DuTremblay, P. P. V.
Fuller, Wm. Jackson
Gear, Sydney Stuart
Loucks, Roy Wm.
McLellan, Harold Elmer
Montgomerie, Robert
O'Sullivan, John Owen
Papineau, Louis G.
Paterson, Graham Ferguson
Rosenorn, Paul E. M.
Welsh, Dean Thos.

Junior

Olekshy, M. D.

Affiliate

Neilson, A. B.

Total Membership

The membership of The Institute as of January 1st, 1932, totals four thousand, seven hundred and fifteen. The corresponding number for 1930, was four thousand, six hundred and ninety-one. These figures do not include members who have been placed on the Suspended List or those who have not yet accepted election.

The details are as follows:—

1931		1930	
Honorary Members	10	Honorary Members	9
Members	1,080	Members	1,104
Associate Members	2,284	Associate Members	2,309
Juniors	445	Juniors	444

Students	840	Students	769
Affiliates	56	Affiliates	56
	4,715		4,691

Respectfully submitted on behalf of the Council,

S. G. PORTER, M.E.I.C., *President.*
R. J. DURLEY, M.E.I.C., *Secretary.*

Finance Committee

The President and Council,—

During the course of the year the Finance committee held regular meetings in order to carry out its functions as provided in the by-laws. At the commencement of the year a budget was prepared and submitted for the approval of Council, and recommendations made regarding the general policy for the administration of the financial affairs of The Institute. The committee passed upon all resignations, the status of members in arrears, and from time to time made recommendations to Council regarding removing members from the roll of The Institute for non-payment of dues, or placing them on a suspended list in those cases where there were extenuating circumstances. A member of the Finance committee also approved all vouchers for payment, and another member of the Finance committee signed all cheques drawn by The Institute.

One of the major expenditures of The Institute being for the printing of The Journal, and as the existing contract expired early in the year, tenders were invited from a number of responsible printing houses and the award finally made to the Modern Printing Company, who was the lowest tenderer, and who had previously given satisfaction in carrying out this work.

Arrears

In view of the number of members falling into arrears for two and more years, the Finance committee was requested by Council to investigate ways and means of dealing with this unsatisfactory situation, and after careful investigation the committee recommended to Council the changing of section 37 of The Institute by-laws so as to provide a procedure somewhat similar to other organizations, namely, that a member in arrears should be auto-

STATEMENT OF ASSETS AND LIABILITIES AS AT 31ST DECEMBER, 1931

Assets

PROPERTY			$ 89,041.64
FURNITURE:			
Balance as at 1st January, 1931	$5,117.56		
Additions during the year	950.91		
	6,068.47		
Less: Realized on furniture sold	81.90		
		$ 5,986.57	
Less: Depreciation 10%		598.65	
			5,387.92
LIBRARY		2,207.16	
Less: Depreciation 10%		220.71	
			1,986.45
STATIONERY—On hand			731.57
STAMPS—On hand			200.00
GOLD MEDAL			45.00
INVESTMENTS—At cost:			
$4,000 Dominion of Canada 4½%, 1959		4,090.71	
$6,000 Montreal Tramways Bonds, $5,000 5%, 1955		4,689.00	
$1,000 5%, 1941		950.30	
$100 Dominion of Canada 4½%, 1946		96.50	
$500 Province of Saskatchewan 5%, 1959		502.50	
Canada Permanent Mortgage, 2 shares par value $100 each		215.00	
$500 Title Trust & Guarantee Corp. Certificate		500.00	
40 shares Montreal Light, Heat & Power Cons. N.P.V.		324.50	
			11,368.51
ACCOUNTS RECEIVABLE:			
Sundry and *Journal* advertising		4,350.07	
Advances to Branches		410.00	
		4,760.07	
Less: Reserve for bad debts		252.64	
			4,507.43
J. F. PLOW—Advance Travelling Expenses			150.00
ARREARS OF FEES—Estimated			2,500.00
CASH:			
Canadian Bank of Commerce, Savings Account		191.31	
Petty Cash		100.00	
			291.31
UNEXPIRED INSURANCE			110.00
SPECIAL FUNDS:			
Investments		11,479.91	
Cash in Savings Bank		1,971.62	
			13,451.53
POST MASTER—Deposit			100.00
			$129,871.36

Liabilities

ACCOUNTS PAYABLE:		
Sundry	$ 2,666.13	
Canadian Bank of Commerce—Overdraft	2,495.98	
Amounts due to Branches	259.14	
Reserve for cost of Transactions	3,000.00	
Reserve for estimated cost of Year Book	2,000.00	
Library Deposits	10.00	
		$ 10,431.25
SPECIAL FUNDS:		
As per schedule attached		13,451.53
LIFE MEMBERSHIP FEES:		
For investment		300.00
SURPLUS:		
Balance as at 1st January, 1931	107,317.78	
Deduct: Deficit for the year ended 31st December, 1931	1,629.20	
		105,688.58
		$129,871.36

MONTREAL, 12TH JANUARY, 1932.

(Verified) RIDDELL, STEAD, GRAHAM & HUTCHINSON, C.A.
Auditors.

STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR ENDED 31st DECEMBER, 1931

Revenue

Membership Fees:		
Arrears	$ 3,361.56	
Current	27,446.21	
Advance	394.80	
Entrance	2,209.50	
		$33,412.07
Interest:		
On overdue fees	72.14	
" Victory Loan Bonds	224.50	
" Montreal Tramways Bonds	300.00	
" Savings Bank Account	110.51	
" Title Trust & Guarantee Corp. Certificate	30.00	
" Province of Saskatchewan Bond	25.00	
		762.15
U.S. Premium on Coupons		16.00
Dividends:		
Canada Permanent Mortgage Stock	24.00	
Montreal Light, Heat & Power Cons.	57.00	
		81.00
Publications:		
Journal subscriptions	7,958.10	
Journal advertising	28,861.49	
E-I-C News advertising	3,696.07	
Journal sales	89.65	
		40,605.31
Refund of Expenses of Hall		610.00
Certificates		108.90
Badges		36.30
Deficit:		
Excess of Expenditure over Revenue for the year ended 31st December, 1931		1,629.20
		$77,260.93

Expenditure

Building Expenses:			
Taxes, Property and Water		$2,374.27	
Fuel		474.66	
Insurance		116.62	
Light and Gas		321.28	
Caretaker's wages and service		1,270.80	
Repairs and expenses		777.53	
			$5,335.16
Office Expenses:			
Salaries—Secretary and staff		15,039.99	
Postage and telegrams		1,587.55	
Office supplies and stationery		881.24	
Audit		300.00	
Telephone		311.49	
Messenger and express		86.24	
Miscellaneous		257.57	
			18,464.08
Publications:			
**Journal*		26,837.21	
†*E-I-C News*		6,287.09	
Sundry printing		1,107.52	
Year Book—Reserve against estimated cost		2,000.00	
Transactions—Reserve against estimated cost		500.00	
Transactions paid on account		132.70	
			36,864.52
General Expenses:			
Annual and Professional Meetings		2,462.46	
Plenary Meeting of Council		1,842.80	
Committee on Remuneration		69.86	
Committee on Co-ordination		20.10	
Travelling—President and Vice-President		132.25	
Travelling—Secretary		448.16	
Branch stationery		256.53	
Students' Prizes		26.58	
‡Library expenses and magazines		3,364.50	
Depreciation on furniture and books, 10%		819.36	
Bank exchange and discount		110.53	
Examinations:			
Cost	$165.00		
Less: Collected	105.00		
		60.00	
			9,613.13
Gzowski Medal			30.00
E.I.C. Prizes			275.00
Rebates to Branches			6,679.04
			$77,260.93

* Includes $6,676.33 for salaries chargeable to this item.
† Includes $600 for salaries chargeable to this item.
‡ Includes $1,200 for salaries chargeable to this item.

Special Funds

Leonard Medal

Balance as at 1st January, 1931	$ 601.13	
Add: Bond interest	30.00	
Bank interest	2.55	
	633.68	
Less: Cost of Prizes	36.22	
		$ 597.46
Represented by:—		
Title Guarantee & Trust Corp.	500.00	
Balance in Bank	97.46	
	$597.46	

Plummer Medal

Balance as at 1st January, 1931	533.87	
Add: Bond interest	27.50	
Bank interest	1.21	
		562.58
Represented by:—		
Dom. of Canada 4½% 1959 Bond	500.00	
Balance in bank	62.58	
	$ 562.58	

Fund in Aid of Members' Families

Balance as at 1st January, 1931	2,044.57	
Add: Bond interest	77.50	
Bank interest	11.49	
		2,133.56
Represented by:		
$1,000 Province of Ontario 4½% 1964 Bond	1,022.17	
$1,000 Dom. of Canada 4½% 1959 Bond	972.97	
Balance in bank	138.42	
	$2,133.56	
Forward		$3,293.60

Special Funds—*Continued*

Brought Forward		$3,293.60

Past Presidents' and Prize Fund

Balance as at 1st January, 1931	$4,903.11	
Add: Bond interest	226.25	
Bank interest	17.52	
Cash received	100.00	
	5,246.88	
Less: Cost of Prizes	251.10	
		4,995.78
Represented by:—		
$500 Dom. of Canada 4½% 1946 Bond	515.43	
$2,500 Dom. of Canada C.N.R. 5% 1954 Bonds	2,489.55	
$1,500 Title Guarantee & Trust Corp. 1933 6%	1,500.00	
Balance in bank	490.80	
	$4,995.78	

War Memorial Fund

Balance as at 1st January, 1931	$4,930.99	
Add: Bond interest	210.00	
Bank interest	30.52	
	5,171.51	
Less: Payments out of Fund	9.36	
		5,162.15
Represented by:—		
$2,000 C.P.R. Collateral Trust 5% 1934 Bonds	1,979.79	
$2,000 Dom. of Canada 4½% 1959 Bonds	2,000.00	
Balance in bank	1,182.36	
	$5,162.15	
		$13,451.53

matically dropped from the roll at the end of the year, leaving, however, the possibility for Council to waive this requirement in special cases. The recommendations were approved by Council, and the proposed change in the by-law is now being submitted for the approval of the membership. It is felt that the proposed change will encourage members not to fall into arrears, and at the same time will very largely simplify the work of the Headquarters staff, of the Finance Committee, and of Council.

Revenue

The revenue for the year 1931 has fallen off $5,400 from the revenue of 1930, a drop of 6½ per cent, or $6,100 from the year 1929 in which the maximum revenue was obtained.

It will be noted from the financial statement that the bulk of The Institute revenue is obtained from membership fees (including subscriptions to The Journal), and advertising, in about equal proportions. The total drop in revenue for the year 1931 as compared with 1930 is made up of a loss of (in round figures) $1,300 in membership fees, including arrears, advance and entrance, a drop of $1,900 in Journal and E-I-C News advertising, the absence of year book advertising and a drop of nearly $800 in sales of special Journal numbers.

Of the foregoing items, the sale of advertising is the one feature over which The Institute has the greatest control. At the beginning of the year Council put into effect increased advertising rates, and while for a time there was every indication that there would be an increase in revenue therefrom, this did not turn out to be the case, as, owing to business conditions, there was considerable reduction in the latter part of the year in the sale of advertising space. It is hoped, however, that with improving business conditions during the current year the revenue from this source may be materially increased.

Expenditures

Great care has been exercised in keeping the expenditures of The Institute to the lowest possible point without sacrificing the essential services of The Institute, and it was possible to reduce the expenditures by over $6,000 as compared with 1930, a reduction of 7½ per cent. It will be noted from the financial statement that the greater part of this saving is due to a reduction in the cost of The Journal and E-I-C News. This reduction is due to a small extent to a more favourable printing contract, but also to the reduction in the numbers of advertisements and in reduction in the amount of reading matter in the body of the Journal. This item of the cost of publications is an item where great variations would be possible, and it is due to the care exercised by the Editor of The Journal that it has been kept down to a minimum.

Deficit

The financial statement indicates that there has been a deficit of over $1,600 on the year's operation, notwithstanding every effort that there should be no deficit this year. Attention might be drawn, however, to the fact that provision has been made in the financial statement for a reserve of $2,500 for the transactions and year book, which are now in the press, and will be paid for in 1932.

The following table gives the expenditures and revenues for the last ten years, and it will be noticed that there has been a deficit for the last four years:—

Year	*Expenditure*	*Revenue*	*Surplus or Deficit* (*)
1922	$71,512.56	$71,836.66	$2,324.10
1923	69,562.53	74,823.43	5,260.90
1924	78,536.67	80,451.67	1,915.00
1925	66,918.43	68,883.20	1,964.77
1926	69,273.36	72,094.54	2,821.18
1927	68,380.79	71,839.20	3,458.41
1928	74,719.17	73,342.14	*1,377.03
1929	84,859.23	81,751.62	*3,107.61
1930	83,594.81	81,081.34	*2,513.47
1931	77,260.93	75,631.73	*1,629.20

It was felt that steps should be taken to prevent the continuance of these annual deficits, and as there are no indications that The Institute's revenue for 1932 would be greater than that of 1931, and on the recommendation of the General Secretary, a reduction of ten per cent in the salaries of all members of The Institute staff was approved by Council and became effective on January 1st, 1932. Another feature which will be helpful in balancing the budget is that it should not be necessary, or even possible, to publish transactions or a year book during the year 1932, in view of the fact that these publications for the year 1931 are only now in the press. In order, however, that a balanced budget may be obtained for the year 1932, even with these economies and without sacrificing The Institute's service, the membership must help The Institute by paying their fees as promptly as possible and not permitting themselves to get into arrears.

While the outlook for the immediate future may be reasonably good, it is evident that in the coming year a balanced budget can only be obtained by exercising the greatest care in the expenditures of The Institute, and by forgoing the many services which have been recommended as being desirable.

Respectfully submitted,

J. L. Busfield, M.E.I.C., *Chairman.*

Nominating Committee, 1932

Appointments to the Nominating Committee for the year 1932 have been made by the various Branches, and the chairman has been appointed by Council, as shown on the following list, which is now presented for announcement at the Annual Meeting in accordance with the By-laws:—

Chairman: T. H. Hogg, M.E.I.C.

Branch	*Representative*
Halifax Branch	C. H. Wright, M.E.I.C.
Cape Breton Branch	W. C. Risley, M.E.I.C.
Saint John Branch	H. F. Morrisey, A.M.E.I.C.
Moncton Branch	F. L. West, M.E.I.C.
Saguenay Branch	G. F. Layne, A.M.E.I.C.
Quebec Branch	P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	J. A. Bernier, A.M.E.I.C.
Montreal Branch	E. A. Ryan, M.E.I.C.
Ottawa Branch	G. G. Gale, M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	Wm. Casey, M.E.I.C.
Toronto Branch	J. J. Spence, A.M.E.I.C.
Hamilton Branch	J. Stodart, M.E.I.C.
London Branch	F. C. Ball, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	O. Rolfson, A.M.E.I.C.
Sault Ste. Marie Branch	J. H. Jenkinson, A.M.E.I.C.
Lakehead Branch	F. C. Graham, A.M.E.I.C.
Winnipeg Branch	C. T. Barnes, A.M.E.I.C.
Saskatchewan Branch	W. G. Worcester, M.E.I.C.
Lethbridge Branch	G. S. Brown, A.M.E.I.C.
Edmonton Branch	R. W. Ross, A.M.E.I.C.
Calgary Branch	Thos. Lees, M.E.I.C.
Vancouver Branch	C. T. Hamilton, A.M.E.I.C.
Victoria Branch	A. L. Carruthers, M.E.I.C.

Past-Presidents' Prize Committee

The President and Council,—

Your committee has read the fifteen papers on the subject of Engineering Education submitted for the Past-Presidents' Prize for 1930-1931.

We have much pleasure in recommending that the prize be awarded to A. W. McQueen, A.M.E.I.C., of Niagara Falls, Ontario.

Of the papers submitted that of E. G. Cullwick, Jr.E.I.C., of Vancouver, B.C., is worthy of honourable mention.

Respectfully submitted,

Chas. M. McKergow, M.E.I.C., *Chairman.*

Gzowski Medal Committee

The President and Council,

Your committee, having studied all the papers eligible for consideration for the award of the Gzowski Medal for the prize year 1930-1931, has decided by a majority report to recommend that the award for this year be made to Mr. G. O. Vogan, A.M.E.I.C., for his paper on "The Design of the Chute à Caron Diversion Canal." A minority report (one member) recommends no award.

Respectfully submitted,

R. O. Wynne-Roberts, M.E.I.C., *Chairman.*

Plummer Medal Committee

The President and Council,—

At a meeting of the Plummer Medal committee it was decided to recommend that the medal for the year ending June, 1931, be awarded to Dr. G. S. Hume, for his paper entitled "Structure and Oil Prospects of the Eastern Foothills area, Alberta, between Highwood and Bow Rivers."

Respectfully submitted,

W. H. DeBlois, M.E.I.C., *Chairman*

Leonard Medal Committee

The President and Council,—

We award the Medal for the period 1st July 1930 to 30th June, 1931, to W. S. Dyer for his paper, "The Lignite Deposit at Onakawana, Moose River Basin."

Your committee has had regard in making its decision to a previous paper contributed by Dr. Dyer to the C.I.M. and M. Bulletin in 1928 on "The Mesozoic Clay Deposits of the Mattagami and Missinabi Rivers, Northern Ontario." This paper included a deduction as to the existence of "a lake of Lower Cretaceous or Upper Jurassic Age," and the possible northwest extension of the Blacksmith Rapids lignites, a constructive suggestion which led to the undertaking of drilling by the Ontario Department of Mines that, carried out under Dr. Dyer's direction, disclosed the presence of the lignite deposit at Onakawana, as reported by Dr. Dyer in the paper which your committee has selected for its award of the Leonard Medal.

Respectfully submitted,

F. W. Gray, M.E.I.C., *Chairman.*

Students' and Juniors' Prizes

The reports of the examiners appointed in the various zones to judge papers submitted for the prizes for Students and Juniors of The Institute, were approved by Council at its meeting on January 19th, 1932, and make the following announcements:

H. N. Ruttan Prize (Western Provinces)—No award; no papers received.

John Galbraith Prize (Province of Ontario)—To D. E. Bridge, S.E.I.C., for his paper on "Electric Furnaces as Applied to Industrial Heating."

Phelps Johnson Prize (Province of Quebec, English—To Eric G. Adams, S.E.I.C., for his paper on "Some Economic Problems Confronting the Wider Application of Railroad Electrification in America."

Ernest Marceau Prize (Province of Quebec, French)—No award; no papers received.

Martin Murphy Prize (Maritime Province)—To C. I. Bacon, S.E.I.C., for his paper on "Exhausting a Vacuum Tube."

Committee on Membership

The President and Council,—

Your Committee on Membership, originally appointed at the Plenary Council Meeting in September 1930, made a progress report to the Annual Meeting in February 1931. The report at that time recommended proceeding along lines by which the Branches were encouraged to increase the membership by efforts in their own areas and co-operation arrangements at Headquarters were outlined to aid them in their efforts. It was reported at that time that it was thought neither opportune nor desirable to organize a country wide membership campaign in any other manner.

Your committee still holding these same views reported again to the Plenary Council Meeting in September 1931 and from the experience gained by the Branch method of increasing membership recommended that it be continued again enlisting the hearty support of the Branches which indeed has been generously given. This method has consequently been continued.

In its report to Council of September 1931 the committee recommended amongst other features that:—

(1) Special concentration be made on obtaining new Junior and Student members. (2) Special care be taken that the prospect's qualifications be such as to ensure his election to the grade proposed. (3) Branches report as frequently as possible to General Headquarters the names and particulars of qualifications of all prospective members so as to keep Headquarters advised and enable a letter to go to the prospective member if thought desirable and (4) Branches pay special attention to their local press so as to secure attractive reports of meetings, etc. The report further contained recommendations looking toward assistance from General Headquarters by (5) Urging or assisting in the formation of Student Branches at universities, (6) the Council, through the President or General Secretary, frequently circularizing the Branches to assist and stimulate their efforts toward increasing membership and (7) Urging existing members to progress to a higher grade.

While the Council at its Plenary Meeting of September 1931 did not formally adopt this report, it inaugurated several steps in line with its recommendations. The Branches were further encouraged and more closely associated with Headquarters in this effort by correspondence and through efforts of the members of Council and the Membership committee. With this in view a special leaflet was prepared and issued by direction of the Plenary Council so drawn as to be an aid to members at all Branches in replying to inquiries as to the benefits of membership in The Institute.

It is well recognized, however, by Council and by the Membership Committee, and it must be evident to the members of The Institute generally, that the past year has been a most inopportune time in which to embark on increased membership. This needs no elaboration in view of the situation in engineering activity throughout the country. All that could be hoped for was to maintain the strength in membership without undue decrease. This, however, has not been found possible, and in the committee's report of last September the figures showed that despite the Branch efforts we were not maintaining the annual rate of 350 new members of all classes which is necessary to meet normal losses of deaths, resignations, etc. We are facing the possibility of increasing resignations due to the difficult times through which we are now passing. The committee, however, in its report of last September stated that it "views the past six months' work with a degree of satisfaction, placing the credit with the officers and members of the Branches, feeling that the Branches had succeeded very well under the difficulties." The committee still considers that for the present, at least, the best programme for maintaining the membership is to rely upon the interest and efforts of the Branch members.

Your committee, however, has encountered a very real difficulty in connection with the doubts which so frequently arise as to the qualifications and grading of prospective candidates for membership. In some cases prospects which are considered suitable have been deterred from applying and cases have arisen where they have been refused. These experiences are unfortunate and at times discouraging.

The experiences of the past year and the difficulties which have in this manner been disclosed as to the structure of our membership grading and qualifications, have emphasized the desirability of reviewing this whole question and the Membership committee was much interested and, in some respects, relieved to learn that the Council at its Plenary Session appointed a special Committee on Development to study and report on this difficult question. The Membership committee feels that if, arising out of this study, much needed changes in the membership structure can be brought about, the way will be open before long to increase the membership of The Institute very considerably.

Another feature of this present situation which has presented a problem and some difficulty in securing new members is concerned with the negotiations which have been proceeding with respect to arrangements with the Provincial Associations. If and when satisfactory working arrangements are made for some kind of affiliation, the whole membership question will be placed on a different basis. Your committee while realizing that these negotiations are naturally progressing slowly, considers that the extent to which the membership can be expanded is limited under the existing circumstances and hopes that these negotiations may be expedited.

In view of the foregoing, your Membership Committee can report only the progress indicated, limited though it is, and recommends that for the present the method of maintaining the membership by means of Branch effort be continued. This renewed recommendation is made in the hope that by means of the interest and loyalty of the thousands of members throughout the country the membership figures will not be allowed to diminish at this time.

Respectfully submitted,

C. H. Mitchell, M.E.I.C., *Chairman.*

Papers Committee

The President and Council,—

The Papers committee submitted a preliminary report to Council at its Plenary Meeting. This report was discussed at some length, and it and the discussion have been circulated to the Branches for their information. The present report is a continuation of the earlier report; it contains all of the information which the committee has been able to gather, and offers a number of suggestions of possible ways by which Branch meetings might be made more useful and interesting to the membership.

The Papers committee has this year been organized somewhat differently than in the past. It now consists of five members, one from each vice-presidential zone, except Zone A which, because of its size and the location of the Branches therein, has two representatives, one for the territory east of the Rockies and one for that west. Each zone member of this committee, is in turn the chairman of a Zone committee, the members of which are representatives appointed by the Branches in that zone. It is hoped by this set-up to provide machinery that can function quickly and that will be in closer touch with the problem of the individual Branches.

The membership of the Papers Committee and its Zone committees are as follows:—

Papers Committee

R. B. Young, M.E.I.C., *Chairman.*
- A. C. R. Yuill, M.E.I.C. .... Zone A, (British Columbia)
- R. S. Trowsdale, A.M.E.I.C. .... Zone A, (Prairie Provinces)
- H. A. Lumsden, M.E.I.C. .... Zone B, Ontario
- J. M. H. Cimon, M.E.I.C. .... Zone C, Quebec
- K. L. Dawson, M.E.I.C. .... Zone D, Maritime Provinces

Zone A (British Columbia)

A. C. R. Yuill, M.E.I.C., *Chairman.*
- J. E. McKenzie, A.M.E.I.C. .... Vancouver Branch

and a representative from the Victoria Branch, not yet appointed.

Zone A (Prairie Provinces)

R. S. Trowsdale, A.M.E.I.C., *Chairman.*
- C. D. Lill, A.M.E.I.C. .... Saskatchewan Branch
- J. B. de Hart, M.E.I.C. .... Lethbridge Branch
- H. J. McLean, A.M.E.I.C. .... Calgary Branch
- Dr. H. J. MacLeod, M.E.I.C. ...... Edmonton Branch

and a representative from the Winnipeg Branch, not yet appointed.

Zone B (Ontario)

Major H. A. Lumsden, M.E.I.C., *Chairman.*
- F. C. C. Lynch, A.M.E.I.C. .... Ottawa Branch
- H. R. Sills, Jr.E.I.C. .... Peterborough Branch
- L. F. Grant, M.E.I.C. .... Kingston Branch
- C. S. L. Hertzberg, M.E.I.C. .... Toronto Branch
- E. M. Coles, A.M.E.I.C. .... Hamilton Branch
- W. R. Smith, A.M.E.I.C. .... London Branch
- E. P. Murphy, A.M.E.I.C. .... Niagara Peninsula Branch
- H. J. Coulter, Jr.E.I.C. .... Border Cities Branch
- W. S. Wilson, A.M.E.I.C. .... Sault Ste. Marie Branch

and a representative from the Lakehead Branch, not yet appointed.

Zone C (Quebec)

J. M. H. Cimon, M.E.I.C., *Chairman.*
- Alex. Lariviere, A.M.E.I.C. .... Quebec Branch
- N. D. Paine, A.M.E.I.C. .... Saguenay Branch
- Ellwood Wilson, M.E.I.C. .... St. Maurice Valley Branch
- H. G. Thompson, A.M.E.I.C. .... Montreal Branch

Zone D (Maritime Provinces)

K. L. Dawson, M.E.I.C., *Chairman.*
- W. H. Noonan, A.M.E.I.C. .... Halifax Branch
- J. R. Morrison, A.M.E.I.C. .... Cape Breton Branch
- L. H. Robinson, M.E.I.C. .... Moncton Branch
- G. H. Thurber, A.M.E.I.C. .... St. John Branch

The Institute has twenty-five branches scattered from the Atlantic to the Pacific coasts and differing in the number of resident members all the way from thirty-four to eleven hundred and ninety-three. Therefore, the problem that the different branches face in providing the desired entertainment and instruction for their members is quite different with some than with others. In order that this phase of the problem could be studied, the Committee canvassed the various branches and from the twenty-one replies received has prepared a summary of the frequency and character of their meetings.

The smaller branch usually labours under severe handicaps; often its members are made up largely of men from one organization or industry who are in daily contact. They have, at best, only a few speakers available locally and the story these men have to tell is often well known to the other members. Many of them are isolated with respect to other branches or to engineering centres where speakers might be secured. Furthermore, they have very limited financial resources and cannot possibly help defray the expenses of any outside speaker they might induce to visit them.

It would seem that for those branches located in the smaller urban centres the most successful meeting is one that is both social and instructive and their problem is not to provide a series of lectures on technical subjects, but entertainment of a sufficiently wide appeal to bring out a large proportion of their limited membership.

The larger branches, situated in the bigger cities, have a distinctly different problem to face. The individual members feel little responsibility for the success of the Branch. They do not look to it for entertainment or as a leader in social activities, and their only bond is a common profession. They appear to prefer meetings in which the papers are on engineering, but not highly technical subjects, and these meetings have to be carefully organized to be successful. The larger branches have the advantage of considerable resources both in money and available speakers, and their membership is large enough so that they can approach prominent outside engineers without hesitancy.

The moderate sized branches have problems intermediate between those just outlined. They seldom have much money to spend on their meetings, but there are

Branch	No. of resident members	Frequency of meetings	Character
		Zone A	
Vancouver	246	Monthly during winter.	Both technical, non-technical and social, with occasional joint meetings with A.I.E.E. to plants or other places of common interest where there is some work of an educational nature.
Victoria	56		No reply.
Calgary	107	Every two weeks during fall and winter with special meetings where outstanding speakers are available.	Technical meetings covering a wide variety of subjects. Hold an Annual Ball and an Annual Dinner.
Edmonton	65		No reply.
Lethbridge	37	Fortnightly from October to March inclusive.	Partly social and partly technical, commencing with a dinner accompanied and followed by a musical programme, followed by a lecture. Prefer not too technical talks on engineering subjects. Using standard 35 mm. moving picture machine with government films which has increased attendance materially.
Saskatchewan	132	Monthly from October to April.	Technical papers on local or national projects and papers of general interest.
Winnipeg	253		No reply.
		Zone B	
Border Cities	98	Monthly from October to May.	Combined social and technical in the form of an informal dinner followed by a technical paper on a subject of general engineering interest. Excursions to construction jobs have been held when circumstances permit.
Hamilton	150	Monthly from September to May.	Technical meetings as a general rule with papers of general interest. Occasional meetings where subjects are of popular nature; ladies are invited and refreshments served.
Kingston	55 (Large proportion of students)	Five meetings and Annual Dinner.	Non-technical papers most popular. Usually have one technical paper during season. Co-operate closely with students' engineering society of Queens University.
Lakehead	34		No reply.
London	59	Monthly from October to June.	Both technical and non-technical meetings with an Annual Dinner and summer inspection trips to outside points of engineering interest.
Niagara Peninsula	103	Monthly, exclusive of summer months.	Take the form of an afternoon inspection trip to some manufacturing plant or construction work followed by a dinner and address. Annual Meeting is social with a dinner, followed by a speaker and dance. Also hold an Annual Dance and picnic, and special business meetings when necessary. Joint meetings held with other branches or other engineering societies.
Ottawa	409	Approximately every two weeks.	Majority are luncheon meetings with a few evening meetings. Inspection trips held which have proved popular. Lectures, largely technical on topics of general interest.
Peterborough	93	2nd and 4th Thursday from October to May except December.	Evening meetings and are strictly technical, but general rather than highly technical papers most popular. Usually preceded by an informal dinner to give speaker opportunity to meet some of their members.
Toronto	539	Twice a month from October to April.	Technical meetings, preceded by informal dinners where speaker is from out of city. Occasional joint meetings with other societies.
Sault Ste. Marie	95	Six to eight meetings a year.	Meetings are of technical nature with many papers of general interest.
		Zone C	
Montreal	1,193	Every Thursday from October 1st to April 30th.	Majority are technical, but a small proportion of what might be called a popular type, chosen however for their general interest to engineers. About three or four times a year light refreshments are served after the meeting with the idea of affording a better opportunity to the members for fraternizing.
Quebec	111	Fortnightly from December to May.	Mostly luncheon meetings at which an address of thirty to forty-five minutes is delivered. Speakers from various professions are invited and fifty per cent of addresses are non-technical. Members of Board of Trade and Service Clubs invited to some. Newspaper reporters always attend and good local publicity obtained.
Saguenay	38	Two to four meetings a year.	Technical and non-technical meetings. No social activity except occasional luncheon at the Annual Meeting.
St. Maurice	47	Four or five times a year.	Address and social evening. Prefer papers of general interest.
		Zone D	
Cape Breton	58	Monthly from September to April.	Mostly technical with an occasional non-technical. No social activities recently attempted on account of trade depression.
Halifax	183	Monthly from October to May.	Supper meetings at which some technical paper is read.
Moncton	69	Monthly from October to March.	Supper meetings, technical, with admission of one dollar. Advertised in press, and non-members invited. At least one meeting each year on a subject of general interest, open to public and admission free. Members broad in their interests and welcome papers on engineering subjects. No attempt has been made to hold so-called "social meetings."
Saint John	83	Monthly from October to May.	Technical evening meetings with two regular and occasional dinner meetings each season. Joint meetings held with Professional Engineers of New Brunswick, and the Engineering Society of the University of New Brunswick.

more local speakers available and their larger memberships make more attractive any invitations they extend to outside speakers. On the other hand there are a greater number of other activities competing for the time of their members, who in turn have less feeling of responsibility for the success of the branch than in smaller centres, and these difficulties increase with the size of the city in which the branch is situated. It seems that for them a certain amount of organized social activity is helpful and that they might well encourage their members to view them more as a club than as a lecture bureau, and govern their activities accordingly.

There is something to be learned from the individual experiences of several of the branches. Two of the smaller branches, Lethbridge and St. Maurice Valley, have solved their problems very successfully by holding meetings that are both instructive and social. Lethbridge owns standard 35 mm. moving picture equipment and shows films obtained gratis from various commercial and governmental bodies. They have found that this has added to the interest of the meetings and raised the average attendance.

The majority of meetings held by Quebec and Ottawa are luncheon meetings. Other branches hold occasional meetings of this type. Luncheon meetings have distinct possibilities in any branch where only a few of its members belong to service clubs, for many men will attend a luncheon meeting who will not turn out to an evening session.

Several branches hold evening meetings which are preceded by an informal dinner. This form of meeting seems to apply best where the membership is not too large. Such meetings are practically self-supporting, for each member pays for his own dinner and the caterer, usually an hotel, is glad to provide the meeting facilities free of charge.

Some of the larger Branches entertain visiting speakers at dinner prior to the meeting, to which are invited any members of the Branch who would be interested in meeting the speaker. This is not only a gracious thing to do, but it offers a Branch Executive an opportunity to get out inactive members to the meetings, for few men will refuse a direct invitation to a dinner of this kind, and many only need a little encouragement to get them into the habit of regular attendance at the Branch meetings.

A number of Branches hold excursions to points of engineering interest. Calgary holds an Annual Ball which ranks with the most important social functions of their city. Niagara Peninsula too holds a very successful Annual Dance, and also an Annual Picnic. Several hold Annual Dinners.

Four Branches at least hold joint meetings with sister organizations. Niagara Peninsula Branch has met with the Buffalo Engineering Society, with the American Institute of Electrical Engineers, and with the Hamilton Branch. Several report joint meetings held with their Provincial Associations. The Institute has much to gain through friendly gestures of this sort and they offer excellent opportunities for good local publicity. Similar contacts might well be established with other professional bodies such as the doctors and lawyers and with the local Boards of Trade and Business Men's Associations by inviting their active participation in meetings where subjects of mutual interest were being discussed.

The use of motion pictures by Lethbridge has already been noted. A wide range of films in both the standard 35 mm. and the amateur 16 mm. sizes are available free to any Branch who cares to avail itself of the opportunity. Both the Canadian transcontinental railways have such films showing the points of interest along their lines and in the different countries touched by their associated steamship companies. Several of the provinces have films for loan showing their natural resources, industries and scenic attractions. Many commercial organizations have films covering their particular operations and products and while this type of film is frankly promotional they are seldom objectionable and usually interesting. If one cares to go further afield there are the very fine films and lantern slides of such United States government departments as the Department of Agriculture and the Bureau of Roads, covering all manner of subjects which undoubtedly could be obtained if desired. In addition to these, there are quite a variety of educational and comic films in the 16 mm. size which can be rented from the different agencies handling amateur moving picture equipment. The charge for the use of these films is nominal and they add variety to a programme.

The majority of Branches seem to favour papers on engineering subjects which are not highly technical. A few non-technical papers of general interest may well be included in any year's programmes, but the experience of some Branches would indicate that too many of this type will likely lose membership support. The most popular paper with the average audience is one that treats the subject somewhat popularly, and is not too long. A few lantern slides are helpful, but too many are tiresome. Extemporaneous speaking, if well done, is best, but a read paper is better than a rambling speaker. Time should be allowed for discussion and some discussion should be deliberately arranged for. In fact, the successful meeting is the one that has been thoroughly organized and not left to chance, and a study of the data submitted by the various Branches indicates that the success or failure of the branch to function actively is as often a matter of local organization as a lack of members, funds or opportunity.

Many valuable suggestions have been received by the committee, but space will not allow them to be considered in detail. A number have to do with the greater participation of the Branches in the solution of municipal, provincial and national problems of an engineering nature. A pertinent suggestion made by several is that the Branches should organize some work for the common good as do the doctors and lawyers, who, instead of trying to interest the public in their technical discussions, get out and interest themselves in public affairs such as education and health, and thus keep their profession in the public eye. Such activities would help to promote solidarity and increase interest in the Branch, would give it good publicity, and would offer a chance to put more of the membership to work. This last is particularly important, for it is a fact, demonstrated by the experience of the most successful societies, that the more men an organization can get actively serving in some capacity, the more successful it will be.

Another re-occurring suggestion is that an attempt be made to get a greater number to take part in the meetings. Organizing the discussion helps in this respect. Meetings in which the programme is divided between several speakers, in which the speakers are chosen from the younger men, or which are entirely organized and run by them, and meetings where the programme takes the form of a symposium made up of several brief papers on different phases of a common subject are some of the suggestions as to how this problem might be solved.

Another group of suggestions hinged on the possibility of exchanging or circulating interesting papers between the Branches. The idea has possibilities and the Papers committee is studying the suggestion and will try to work out some practical means for accomplishing it.

The problem of the Papers Committee is the problem of how best to help the Branches help themselves. The committee has received many helpful suggestions on this also, and it would appear that it might be of considerable assistance in collecting and disseminating information as to subjects and speakers that might be available to the

Branches, in securing information on movie and projection equipment and sources of films, in acting as a clearing house of information on how the different Branches are handling their individual problems and in promoting joint activities.

The Papers Committee views its purpose as that of an adviser to the Branches in the conduct of their meetings, and it is with this concept in mind that the foregoing report has been prepared. The committee hopes that the different Branch executives, through their local representatives, will keep the committee advised of their activities and of their problems, with the thought in mind that by so doing the combined experience of all Branches can be brought to the solution of their individual difficulties and the whole Institute thereby benefit.

Respectfully submitted,

R. B. Young, M.E.I.C., *Chairman.*

Publication Committee

The President and Council,—

The Publication committee has studied the papers, which were presented at the General Professional Meeting or at meetings of the various Branches and which were printed in The Journal during the year 1931, and recommends that the following be published in the next Volume of Transactions:

1. Train Ferry Landing at Port Mulgrave and Point Tupper, N.S. by D. B. Armstrong, A.M.E.I.C., and W. Chase Thomson, M.E.I.C.—pages 3-14 inclusive. Discussion on above—pages 340-342 inclusive.
2. Structure and Oil Prospects of the Eastern Foot Hills Area, Alberta, Between the Highwood and Bow Rivers by Dr. G. S. Hume—pages 15-18 inclusive.
   Discussion on above—pages 343-347 inclusive.
3. The Technique of Placing Concrete on Steep Slopes Without Forms by I. E. Burks—pages 160-162 inclusive.
   Discussion on above—page 350.
4. Power System Stability by F. A. Hamilton, Jr.—pages 227-242.
5. Direct Method for Normal Thrust and Moment Influence Lines for Fixed Arches by Alfred Gordon —pages 243-249 inclusive.
   Discussion on above—pages 249 and 250 and page 296.
6. Some Problems Connected With Fluid Motion by J. J. Green, A.R.C.Sc., Ph.D., B.Sc., D.I.C.—pages 351-357 inclusive.
7. Practical Application of the Microscope in Railway Service by Frederick H. Williams, M.Sc.—pages 558-563 inclusive.
   Discussion on above—page 608.
8. The Electrification of Canadian Copper Refineries Plant, Montreal East, Que. by A. D. Ross, A.M.E.I.C.—pages 593-599 inclusive. Supplementary to the above—Arc Welding of High Conductivity Joints in Copper by T. C. Stewart—pages 600 and 601.
9. Montreal Incinerators by H. A. Gibeau, A.M.E.I.C. —pages 601-607 inclusive.
10. The Design and Construction of Metal Hulls for Boat Sea Planes by R. J. Moffett, A.F.R.Ae.S.—pages 609-615.

As in the past your committee has been guided in the selection of papers for publication by the principle that purely descriptive articles unless of unusual interest from an historical or engineering standpoint, should not be included. For this reason we have not recommended the inclusion of the four papers presented before the General Professional Meeting on various features of the Sun Life building nor the papers which were presented either at the General Professional Meeting or at Branch meetings during the year, dealing with hydro-electric developments. Of the latter there were four, the most interesting of which being that presented by the late F. H. Martin, M.E.I.C., before the Winnipeg Branch, dealing with the Seven Sisters development.

A number of worth-while papers were contributed to The Journal during the year. Owing to the fact that these papers were not presented before any of the Branches, your committee is in doubt as to whether they can properly be classed as transactions of The Institute. If they may be so classed, they should be published in this volume of Transactions. The papers in this category are as follows:

1. On the Determination of Stringing Tensions for Transmission Lines and Cables by J. W. Campbell —pages 477-481 inclusive.
2. Type Testing of Air Craft, Flying Officer A. L. James, R.C.A.F., A.F.R.Ae.S.—pages 488-493 inclusive.
3. The Elimination of Taste in Water Passing Through Creosoted Wood Stave Pipe by J. F. Harkom, A.M.E.I.C., and C. Greaves—pages 515-517 inclusive.
4. Riveted Tension Members by T. R. Loudon, M.E.I.C.—pages 554-557 inclusive.

The papers recommended for publication together with their discussions will occupy about 91 pages of the Transactions. The four papers of interest which were published in The Journal but which were not presented before any Branch occupy about 18 pages in The Journal.

Respectfully submitted,

J. A. McCrory, M.E.I.C., *Chairman.*

Library and House Committee

The President and Council,—

In your committee's opinion the publicity given to the Library and Information Service during the year in The Journal and the E-I-C News has been effective, for the work at Headquarters has shown a marked increase, many more members than heretofore having taken advantage of the library facilities both as regards borrowing books and obtaining technical information. Some fifty bibliographies have been compiled, and nearly six hundred photostats have been mailed to members requiring copies of technical articles. The Engineering Index Service has proved of increasing importance in this connection.

Accessions to the library during the past twelve months number 788, while fifty-one technical books were presented by the publishers for review. All the presentations to the library have been duly acknowledged.

As regards The Institute's premises, substantial expenditure has been necessary during the past year, covering repairs to the front steps, a considerable amount of interior painting, additional precautions as regards fire protection, and the replacement of a portion of the chairs in the auditorium. These items have required an outlay of approximately one thousand dollars.

Respectfully submitted,

D. C. Tennant, M.E.I.C., *Chairman.*

Legislation Committee

The President and Council,—

In compliance with your instructions, your committee considered and reported upon the changes proposed to be made in Section 37 of the By-laws, in order to give effect to the recommendations of the Finance committee, with a view to preventing members from becoming in arrears for more than one year.

The paragraph of this section dealing with Life Membership was also reviewed and amendments thereto were recommended in line with the expressions of opinion voiced at the Fifth Plenary Meeting of Council.

Your committee also studied the whole question of rebates to Branches, according to your direction, but, for various reasons, they felt that a revision of the present scale of rebates should not be recommended at this time and that no amendments to Section 56 of the By-laws should therefore be considered.

No questions regarding legislation were referred to your committee during the past year.

Respectfully submitted,

J. M. Hector Cimon, m.e.i.c., *Chairman.*

Report of the E.I.C. Members of the Main Committee of the Canadian Engineering Standards Association

The President and Council,—

The Institute nominees on the Main Committee of the Canadian Engineering Standards Association are now as follows:—

Dean C. M. Mackenzie, m.e.i.c., retires March, 1932.
Mr. J. M. Oxley, m.e.i.c., retires March, 1933.
Mr. P. L. Pratley, m.e.i.c., retires March, 1934.

While no new committees have been formed during the year, the membership of the Association has increased and now stands at six hundred and nine. Sustaining memberships have also increased, the total membership being eighty-two. Eight new firms or associations took out membership for 1931, and the total amount received from membership fees was $6,900, an increase of $300 over 1930. This is particularly gratifying in a year of industrial depression.

Addresses given by the Secretary at sessions of various clubs, institutions and associations were well received and closer co-operation between many of these bodies with the Canadian Engineering Standards Association has resulted. Special mention may be made of the Canadian Purchasing Agents Association, Canadian Lumbermen's Association, Radio Manufacturers' Association, Dominion Fire Prevention Association, Canadian Good Roads Association, National Fire Protection Association, Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities, whose meetings the Secretary attended and with whom useful contacts were made.

Valuable publicity has been given by the technical press and newspapers, and comments on the Association's Year Book and Quarterly Bulletin have been quite generous. The mailing list for these two publications (which are sent free on request) has steadily increased, and the sale of the Association's specifications has been satisfactory. A list of the Association's published specifications is attached.

Work in Progress

Civil Engineering and Construction

Wood Pile and Pile Driving. Valuable data on the available sizes of piling timber have been received from the different lumber dealers and the Forest Products Laboratories, and these are now being consolidated for the purpose of preparing a table in the proposed specification. Information is also being gathered with reference to different methods of preservative treatment, and a glossary covering trade terms and definitions of different timber defects is also being prepared.

Building Materials. The Royal Architectural Institute of Canada has sent in a request to the Association to consider the preparation of simplified practice standards covering building materials, and a conference of representatives of interested organizations will be held shortly.

In connection with lumber, the Association has been in contact with the Canadian Lumbermen's Association with reference to the preparation of lumber standards, but as yet nothing definite has been done.

In connection with paint, an attempt has been made to initiate work on a paint specification on a durability basis, and at the suggestion of the Association, the Canadian Paint, Oil and Varnish Association is arranging to appoint a special committee to consult with the C.E.S.A. committee. One of the features of this specification will be provision for an accelerated paint test by the use of a machine which simulates weather conditions.

Mechanical Engineering

Screw Products. The drafts covering established lists for cap and set screws and studs, also machine, carriage and plough bolts, are now in galley form and have been checked by the chairmen of the respective panels which prepared them. Arrangements have been made for an early meeting of the Committee on Screw Products to consider these drafts, also drafts covering machine screws and nuts, and binder head screws. It is also proposed to consider the preparation of similar lists covering wood screws.

Blade Punching for Road Grading Machinery. The first draft of dimensions has been generally approved, and a condensed diagram is being prepared for final approval.

Colour Scheme for the Identification of Piping Systems. Comments on the first draft have now been received from members of the special Panel, and a meeting will shortly be called to prepare a report for presentation to the Committee.

Electrical Work

Canadian Electrical Code. The Code has now been adopted in New Brunswick, under an act which was approved by the Provincial Legislature on March 26th. The Code is now officially approved in all the provinces but Manitoba and Prince Edward Island.

A meeting of the Committee on Canadian Electrical Code was held in Toronto in September, at which many of the revisions proposed by the different committees and other interests were approved. It was at first suggested that a supplement to the Code be issued at once, but it was finally decided to abandon this suggestion and publish a complete new edition of the Code early in 1933. The organization of a special committee to consider revisions to the Code was approved at the meeting, and this committee is now being organized. Recommendations made by the Code Committee in regard to revisions, will be published in the C.E.S.A. Bulletin, for the guidance of provincial and municipal inspection departments.

In connection with Part II of the Code, dealing with specifications for electrical apparatus, the specification for Power-Operated Radio Devices has been approved by the Panel on Specifications and the Code Committee, and is now before the Sectional Committee on Electrical Work. Specifications for Electrical Signs, Electric Equipment for Oil Burners, and Enclosed Switches, have been prepared and have been sent out for comment to the Panel on Specifications and interested manufacturers. Several other specifications are in preparation.

In connection with Part III, dealing with Outside Wiring Rules, great difficulty has been experienced in putting the draft rules in proper form, but every effort is being made to attain this objective.

Power Transformers. A meeting of the Committee was held in September to consider final revisions to the draft specification. The revised draft has been submitted to a special panel for consideration, and on receipt of a report from this panel it will be circulated to the Committee for final approval, if possible.

A report from the panel on transformer bushings was presented, and it is believed that an agreement will now be obtained on five classes of transformers of 44,000 volts and under. When agreement has been reached, it is proposed to design a C.E.S.A. transformer bushing which will be submitted to the bushing manufacturers for their comment.

Transformer and Switch Oils. A meeting was held in September, at which agreement was reached on the complete draft specification, which has now been sent out to the Committee for final approval, if possible.

Watthour Meters. Reports from the meter committee of the Canadian Electrical Association have been received, and a revised draft specification for alternating-current watthour meters and for demand meters has been sent out to the Committee for comment. Arrangements will be made for a meeting of the Committee on Watthour Meters in the near future.

Insulated Power Cable. The Committee held its first meeting in September, and it was decided at the meeting to cover all types of insulated cable and not confine the specification to lead-covered paper-insulated cable, as at present suggested. A panel was appointed at the meeting to prepare a draft specification which will be sent out to the Committee for comment.

The Association has co-operated closely with the British Engineering Standards Association (now British Standards Institution) and the Standards Assocation of Australia, and draft specifications are sent to us for comment by our committees before publication. Monthly reports are received from the South African Branch of the B.E.S.A. Regular exchange of publications is continued between the C.E.S.A. and other national standardizing bodies.

Respectfully submitted,

P. L. PRATLEY, M.E.I.C., *Chairman.*

Honour Roll and War Trophies Committee

The President and Council,—

During the year 1931 your committee was able to complete the verification of the names of members which will appear on the War Memorial Tablet of The Engineering Institute.

Tenders for the construction and erection of this bronze Memorial were called for from firms of high reputation and the lowest tender was accepted.

The Memorial should be ready for unveiling by February, 1932.

The names for the Honour Roll (in bronze), which number approximately one thousand, have been carefully checked for confirmation and it is expected that your committee will be in a position to call for tenders for this tablet very shortly.

Respectfully submitted,

CHARLES J. ARMSTRONG, M.E.I.C., *Chairman.*

Board of Examiners and Education

The President and Council,—

The results of the examinations held during 1931 for admission to The Institute are as follows:

	Examined	Passed	Failed
Examined under Schedule A (Student)	1	1	..
Examined under Schedule B (Junior)	5	2	3
Examined under Schedule C (Associate Member):			
Electrical Engineering	2	1	1
Structural Engineering	4	2	2
Mechanical Engineering	1	1	..
	13	7	6

The considerable proportion of candidates who fail in The Institute's examinations usually do so from lack of fundamental training in mathematics, physics, chemistry, strength of materials and applied mechanics. As pointed out in your Board's report last year the facilities for obtaining instruction of this kind on the part of men who are earning their livings during the day are lacking in Canadian cities. Candidates for our examinations, in too many cases, have the idea that an evening course in elementary machine drawing or building construction, or a course taken with one of the correspondence schools is all that is necessary to enable them to satisfy the examiners, and they are often disappointed to find that this is not the case. If The Institute can do anything to remove this difficulty a great service will be rendered to a number of deserving young men who are endeavouring to fit themselves for the engineering profession.

Respectfully submitted,

C. M. McKERGOW, M.E.I.C., *Chairman.*

Committee on Biographies

The President and Council,—

Since the appointment of the Committee on Biographies, initiated on February 17th last, a good deal of work has been done, but as this has been largely in the nature of organization and preparation for the future, definite results in the form of biographies appearing in The Journal of The Institute have not, as yet, appeared.

Upon its formation the committee became possessed of a considerable amount of biographical information but, for the most part, incomplete and requiring a good deal of further work before the biographies might be in a condition suitable for publication. The amount of work and the difficulties foreseen by the committee were considerable, but these were faced because of the feeling that when a member of some outstanding ability passes on it should be one of the first duties of The Institute to see that a suitable record of professional attainments should be recorded for future generations by way of an official biography published in The Institute's Journal.

The committee has outlined a method of procedure which should produce consistent and effective results in the future. This policy was submitted to the last Plenary Meeting of Council, and there approved with a qualification which seemed necessary with reference to the matter of financial expense. As the plan recorded by the committee would involve some additional work in the office of the General Secretary at Montreal, it is probable that the commencement of this work on a really sound basis may have to be deferred for a period until the finances of The Institute are in such a condition that the small expense which would be involved may be approved by The Institute's Committee on Finance.

The committee intends to carry on with its work and make such progress as may be possible, and with the hope that when the next Annual Report is submitted it may be possible to submit some more definite progress.

Respectfully submitted,

F. H. PETERS, M.E.I.C., *Chairman.*

Employment Service Bureau

The President and Council,—

The diminution in the number of positions available for members registered with our Employment Service Bureau, which was noted last year, has continued during 1931, and in common with other employment bureaux the number of applications for employment has largely exceeded the number of positions available. The activities of the Employment Service Bureau during 1931 are shown by the following records:—

	1931	*1930*
Number of registrations during year—Members	139	127
Number of registrations during year—Non-Members	37	180
Number of members advertising for positions	130	160
Replies received from employers	76	70
Vacant positions registered	122	180
Vacancies advertised	47	103
Replies received to advertised vacancies	240	754
Men notified of vacancies	97	114
Men's records forwarded to prospective employers	397	190
Placements—definitely known	33	57

The above does not disclose all of The Institute's activities in this connection, for we have hundreds of personal calls from applicants who, in many cases, are not willing to register or file their complete professional records. In these instances it is, of course, more difficult to give assistance and a great deal of time is taken up. Our files actually contain information regarding only a small proportion of our membership, and those members who do register are apt to be neglectful in keeping their records up to date. Thus any estimate of the number of members of The Institute who are unemployed at any given moment can only be a very approximate one. As far as is known at the present time the number of our members registed with the bureau who are actually unemployed is 125, but it is probable that this figure gives only a proportion of those who need employment, as many who register are engaged in temporary or part time work. Similarly our figures as to the number of placements are considerably below the actual number, for in the majority of cases we are not notified when a position is secured. It is interesting to note that during the past year most of the positions of which we were advised were exceedingly difficult to fill, as very definite experience and requirements were insisted upon.

As pointed out in the report of last year, the principal need of this service is greater opportunity for personal contact with prospective employers. The work is really of sufficient importance to require the undivided attention of one man, which is, of course, quite impossible under present conditions.

In connection with the proposal made at the Plenary Meeting of Council for discontinuing the E-I-C News, attention should be drawn to the pressing need for a weekly publication of this kind, if the work of the Employment Service Bureau is to be continued effectively when conditions improve.

Respectfully submitted,

R. J. Durley, *Secretary.*

Branch Reports

Border Cities Branch

The President and Council,—

The work of this Branch has been carried on during 1931 by the following committees:—

Papers and Entertainment..........H. J. Coulter, Jr.E.I.C.
Reception..........R. C. Leslie, A.M.E.I.C.
Membership..........C. G. R. Armstrong, A.M.E.I.C.
By-laws..........Orville Rolfson, A.M.E.I.C.
Publicity..........R. J. Desmarais, A.M.E.I.C.
Advertising..........J. D. Cumming, A.M.E.I.C.
Auditor and Representative on the Directorate of the Border Chamber of Commerce..........L. McGill Allan, A.M.E.I.C.
Branch News Editor and Assistant Secretary until October..........H. E. Bushlen, S.E.I.C.

The following meetings were held:—

Jan. 16.—Capt. A. F. Ingram of the Canadian Airways spoke on **Commercial Aviation in Canada.**

Feb. 20.—Messrs. W. C. Irwin and T. F. Stockslager of the Harbison Walker Co. spoke on **Refractory Materials.**

Mar. 20.—R. C. Manning, A.M.E.I.C., of the Canadian Institute of Steel Construction, spoke on **The Place of Steel in the World Today.**

Apr. 10.—Mr. F. R. Frost of the American Cyanamid Co. of Niagara Falls, Ontario, spoke on **Cyanamid and Its Derivatives.**

May 15.—Mr. C. E. Macdonald of the International Nickel Co. of Canada spoke on **New Developments at Copper Cliff and the Frood Mine.**

Oct. 16.—Mr. Paul Martin, of the legal firm McTague Clarke & Racine spoke on **The League of Nations and the Present Economic Crisis.**

Nov. 13.—Mr. A. H. Harkness, M.E.I.C., President, and Mr. H. Hellmuth, Organizer, of the Association of Professional Engineers of Ontario spoke on **The Professional Engineers' Act.**

Dec. 11.—Annual Meeting. Also Detective James Wilkinson of the Windsor Police Department spoke on **Finger Printing.**

Attendance at Meetings

January meeting	22	May meeting	35
February "	18	June "	19
March "	27	November meeting	36
April "	26	December "	16

Average.......... 24.88

Averages for other years:—

1926	*1927*	*1928*	*1929*	*1930*
31	20	38	34	28

In closing this report appreciation should be expressed of the work done by H. E. Bushlen, S.E.I.C., while assistant secretary. It is unfortunate that our present economic instability has lost to the Branch his valued services.

Financial Statement
(For year ending December 31st, 1931)

Receipts

Balance on hand from 1931	$234.41	
Receipts—Rebates from Headquarters, November	181.20	
Branch News	21.08	
Advertising	20.34	
Paid dinners	155.00	
		$612.03

Expenditures

Printing	$ 38.76	
Stamps and Telegrams	7.91	
Typing	15.00	
Meals	176.25	
Cigars	24.40	
Miscellaneous	154.00	
		$416.32
Cash in Bank		180.17
Rebates due from fees and advertising for December		15.54
		$612.03

Respectfully submitted,

Harold J. A. Chambers, A.M.E.I.C., *Secretary-Treasurer.*
C. G. R. Armstrong, A.M.E.I.C., *Chairman.*

Calgary Branch

The President and Council,—

On behalf of the Executive committee we beg to submit the following report of the activities of the Calgary Branch for the calendar year of 1931:—

Officers

Chairman..........R. C. Harris, M.E.I.C.
Vice-Chairman..........F. M. Steel, M.E.I.C.
Past-Chairman..........B. Russell, M.E.I.C.
Secretary-Treasurer..........A. W. P. Lowrie, A.M.E.I.C.
Executive (Elected)..........H. J. McLean, A.M.E.I.C.
F. N. Rhodes, A.M.E.I.C.
L. A. B. Hutton, A.M.E.I.C.
(*Ex-officio*)..........S. G. Porter, M.E.I.C.
R. S. Trowsdale, A.M.E.I.C.
T. Lees, M.E.I.C.
Auditors..........W. H. Broughton, A.M.E.I.C.
K. Moodie, M.E.I.C.
Branch Editor..........W. H. Broughton, A.M.E.I.C.

L. A. B. Hutton, A.M.E.I.C., during the year transferred his residence to Winnipeg and M. W. Jennings, A.M.E.I.C., was chosen to replace him on the Executive.

Membership

	Dec. 31, 1930		
	Resident	*Non-Resident*	*Total*
Members	20	7	27
Associate Members	46	19	65
Juniors	5	2	7
Students	7	1	8
Branch Affiliates	12	..	12
Totals	90	29	119

	Dec. 31, 1931		
	Resident	*Non-Resident*	*Total*
Members	23	7	30
Associate Members	55	20	75
Juniors	4	1	5
Students	4	1	5
Branch Affiliates	12	..	12
Totals	98	29	127

Meetings

The Executive met eleven times during the year to deal with the various questions which arose.

The committee in charge of the Annual Ball met three times and the work of this committee resulted in a very successful ball being held at the Palliser hotel on Thursday, November 19th.

Nine general meetings were held with a very fair attendance. The subjects chosen for the various papers presented were varied and of great interest.

Details of the meetings and speakers follow:—

Jan. 9.—Vice President, C. J. Mackenzie, M.E.I.C., Dean of Engineering, University of Saskatchewan. Subject: **Estimating Rural Populations in Western Canada.** Attendance, 35.

Jan. 16.—D. V. Canning, Jr.E.I.C., designing engineer, Peterborough, Ontario. Subject: **Automatic Stations and Supervisory Control.** Attendance, 68.

Jan. 23.—M. H. Marshall, M.E.I.C., Calgary. Subject: **The Churchill River Power Co's Plant at Island Falls.** Attendance, 58.

Feb. 19.—Kenneth Moodie, M.E.I.C., Calgary. Subject: **Refrigeration.** Attendance, 42.

Mar. 7.—Annual Dinner and reception to S. G. Porter, M.E.I.C., President of The Engineering Institute of Canada. Attendance, 87.

Mar. 14.—Annual Meeting. Attendance, 18.

Aug. 29.—Golf Tournament Attendance, 18.

Oct. 3.—Visit to Glenmore Dam. Attendance, 42.

Oct. 22.—Mr. H. G. Nolan, M.A., barrister, of Calgary. Subject: **The St. Lawrence Waterways Project.** Attendance, 65.

Nov. 7.—R. S. Trowsdale, A.M.E.I.C., Councillor of the Branch. Subject: **The Plenary Meeting.** Attendance, 18.

Nov. 16.—C. D. Howe, M.E.I.C., of Port Arthur. Subject: **Terminal Elevators.**

Dec. 10.—Dr. W. G. Carpenter, Principal of the Institute of Technology and Art, Calgary. Subject: **The Mid-North.** Attendance, 40.

Financial Statement

(For the year ending December 31st, 1931)

Assets

Cash in bank		$ 201.43	
Value of bonds		909.43	
New issue D. of C. loan subscribed for		200.00	
Dues collectable from Affiliates		30.00	
Cash account		9.35	
Rebates due, telegram, Jan. 2		8.10	
			$1,358.31

Liabilities

Accounts outstanding:—			
R. White, stenographer	$12.00		
Stanley Henderson	12.00		
S. Burnand	10.92		
E. Broughton	2.55		
Deposits of applicants for Membership	21.00		
		$ 58.47	
Net value of assets, December 31, 1931		1,299.84	
			$1,358.31

Revenue

Bank balance at Jan. 1, 1931	$219.11		
Coupons deposited Jan. 5, 1931	26.45		
Cash account	22.55		
Rebates due	3.30		
		$271.41	
Int. on bonds and savings	53.99		
Less rent on safety deposit box	3.00		
		50.99	
Redemption of D. of C. bonds	200.00		
Less purchase of new D. of C. bonds	198.91		
		1.09	
Rebates from Headquarters		232.08	
Amount due on rebates to Dec. 31, 1931		8.10	
Branch News		47.66	
Branch Affiliates and applicants	43.00		
Less amount applicants deposits	21.00		
		22.00	
			$633.33

Expenditure

Expense of meetings		$225.45	
Stenographic	$ 17.65		
Accounts outstanding	14.55		
		32.20	
Stamps, printing, etc	121.40		
Account outstanding	10.92		
		132.32	
Miscellaneous		71.10	
Annual Ball	0.15		
Less account outstanding	12.00		
		11.85	
Cash in bank, Jan. 2, 1932	201.43		
Cash account (Secretary)	9.35		
Amount due on rebates	8.10		
Less applicants deposits	21.00		
Less accounts outstanding	37.47		
		160.41	
			$633.33

C. C. Richards, M.E.I.C.
W. H. Broughton, A.M.E.I.C. } Auditors.

Respectfully submitted,

R. C. Harris, M.E.I.C., *Chairman.*
A. W. P. Lowrie, A.M.E.I.C., *Secretary-Treasurer.*

Cape Breton Branch

The President and Council,—

During the past year the Cape Breton Branch has held ten meetings as follows:—

Mar. 11—**St. Lawrence Waterways** by C. H. Wright, M.E.I.C.

April 14.—**Labrador** by J. A. Wightman.

May 19.—**Manufacture of Refractory Brick**—five reels of film lent by Harbison-Walker Refractories Co. General discussion of subject.

Sept. 14.—**Story of Steel**—five reels of film lent by United States Bureau of Mines.

Sept. 16 to 22.—**Concrete.** A series of six lectures on the design and control of concrete mixtures by J. M. Portugais, A.M.E.I.C., and S. Boyd of the Canada Cement Co.

The average attendance at these meetings, of which two were largely attended by the general public, was 81. The success of any meeting can best be gauged by the discussion provoked, and this, in all the meetings of the past year, was most encouraging. Unfortunately meetings scheduled for January and February had to be called off due to the inability of the speakers to attend.

Financial Statement

Receipts

Balance from 1930	$ 95.42	
Rebates from H.Q	144.06	
Banquet tickets	87.50	
		$326.98

Expenditures

Annual meeting and banquet	$117.55	
Ordinary meetings	13.00	
Printing	6.54	
Telegrams	1.30	
Rental of films, lantern	14.28	
Postage	2.60	
Balance on hand	171.71	
		$326.98

Respectfully submitted,

A. P. Theuerkauf, M.E.I.C., *Chairman.*
Sydney C. Mifflen, M.E.I.C., *Secretary.*

Edmonton Branch

The President and Council,—

The Executive committee of the Edmonton Branch begs to submit the following report on the activities of the Branch during the year 1931.

Officers

January to May

Chairman	J. Garrett, A.M.E.I.C.
Vice-Chairman	C. A. Robb, M.E.I.C.
Secretary-Treasurer	W. E. Cornish, Jr.E.I.C.
Committee	T. W. Brown, A.M.E.I.C.
	R. W. Dingwall, A.M.E.I.C.
	R. J. Gibb, M.E.I.C.
	H. J. MacLeod, M.E.I.C.
Ex-officio	R. W. Ross, A.M.E.I.C.
	E. Stansfield, M.E.I.C.

May to December

Chairman	R. J. Gibb, M.E.I.C.
Vice-Chairman	H. J. MacLeod, M.E.I.C.
Secretary-Treasurer	W. E. Cornish, Jr.E.I.C.
Committee	H. H. Tripp, A.M.E.I.C.
	W. J. Cunningham, A.M.E.I.C.
	T. W. Brown, A.M.E.I.C.
	R. M. Dingwall, A.M.E.I.C.
Ex-officio	J. Garrett, A.M.E.I.C.
	R. W. Ross, A.M.E.I.C.

MEETINGS

Lectures and papers given before the Branch during the year were as follows:—

Jan. 8—**Predicting Future Population in Urban and Rural Centres in Western Canada** by C. J. Mackenzie, M.E.I.C., Dean of Engineering, University of Saskatchewan.

Feb. 3.—**Planning for Sunlight** by H. L. Seymour, M.E.I.C., Director of Town Planning.

Mar. 27.—Observations at the Road Show and Road Builders Convention held in St. Louis, by E. Skarin, supt. of The Crown Paving Co.

April 30.—**World Minerals and World Problems** by Dr. R. C. Wallace, President of the University of Alberta. This was a Joint Meeting with The Canadian Institute of Mining and Metallurgy.

Nov. 4.—Report of Plenary Meeting of Council, Sept. 1931, by R. W. Ross, A.M.E.I.C., Councillor, Edmonton Branch.

Nov. 20.—**St. Lawrence Waterway Scheme** by H. J. Nolan of the firm of Bennett Hannah and Sanford at Calgary. Joint Meeting with The Canadian Institute of Mining and Metallurgy.

Dec. 22.—**Mineral Development at Great Bear Lake** by Dr. A. E. Cameron, Mining Dept., University of Alberta. Joint Meeting with The Canadian Institute of Mining and Metallurgy.

MEMBERSHIP

The Branch membership is now as follows:—

	Resident	*Non-Resident*
Members	15	1
Associate Members	25	6
Junior Members	5	1
Student Members	18	..
	63	8

FINANCIAL STATEMENT

Receipts

Balance on hand Jan. 1st, 1931	$254.06	
June 6th—Rebates from Headquarters	97.80	
Sept. 14th—Rebates from Headquarters	14.10	
Dec. 21st—Rebates from Headquarters	5.85	
Dec. 31st—Rebates from Headquarters	.60	
		$372.41

Expenditures

Expenses meetings and speakers	$ 22.45	
Printing, postage, etc	26.77	
Filing cabinet for Institute records	7.07	
Honorarium to Sec.-Treas	50.00	
Membership fee, National Highways Assoc	10.00	
Balance on hand, Dec. 31st, 1931	256.12	
		$372.41

Respectfully submitted,
R. J. GIBB, M.E.I.C., *Chairman.*
W. E. CORNISH, Jr.E.I.C., *Secretary-Treasurer.*

Halifax Branch

The President and Council,—

On behalf of the chairman and Executive committee the following report on the activities of the Halifax Branch for the year 1931 is submitted:—

Including the Annual Meeting there have been seven regular meetings of the Branch during the past year and eight meetings of the Executive.

The regular meetings were as follows:—

January.—Annual Banquet in conjunction with the Nova Scotia Association of Professional Engineers.

March.—Meeting addressed by Mr. James Govan, M.R.A.I.C., of Toronto, Ont., on **Modern Construction of Buildings.** Attendance, 35.

April.—Captain G. R. Chetwynd, M.C., D.C.M., R.C.E., on **The History of the Royal Engineers.** Attendance, 30.

September.—President S. G. Porter, M.E.I.C., visited the Branch and after discussing the affairs of The Institute and making some valuable suggestions as to the general conduct of the Branch activities, read a very interesting paper on **The Duties and Responsibilities of Engineers** and their relation to the present world problem. Attendance, 33.

October.—Regular Student's meeting at the Nova Scotia Technical College, at which H. W. L. Doane, M.E.I.C., read a paper on **The Construction of Hot-Mix Asphalt Pavements.** Attendance, 175.

November.—Meeting was addressed by Professor W. P. Copp, M.E.I.C., who reported on the Plenary Meeting of Council held in Montreal in September. Attendance, 10.

December.—The Annual Meeting which was held at the Nova Scotian Hotel on Thursday, December 17th, and was addressed by C. H. Wright, M.E.I.C., on **The Hudson Bay Railway and Mining Development in Western Canada.**

The following officers were elected for the year 1932:—

Chairman	A. F. Dyer, A.M.E.I.C.
Vice-Chairman	H. S. Johnston, M.E.I.C.
Executive	W. J. DeWolfe, M.E.I.C.
	J. D. Fraser, A.M.E.I.C.
	K. L. Dawson, M.E.I.C.
	H. S. Johnston, M.E.I.C.
	A. Scott, A.M.E.I.C.
	J. B. Hayes, A.M.E.I.C.
	S. L. Fultz, A.M.E.I.C.
	J. H. Clark, A.M.E.I.C.
	J. F. C. Wightman, A.M.E.I.C.
	J. F. F. McKenzie, A.M.E.I.C.
Ex-officio (Ex-Chairman)	J. L. Allan, M.E.I.C.
(Councillor)	W. P. Copp, M.E.I.C.
(Vice-President)	F. R. Faulkner, M.E.I.C.
Auditors	F. R. Faulkner, M.E.I.C.
	G. H. Burchell, A.M.E.I.C.
H.Q. Nominating Committee	C. H. Wright, M.E.I.C.

The attendance record at meetings is equal to that of previous years, and the total membership shows little change except a large increase in the number of student members. It is to be regretted that during the past year a number of members have been dropped for non-payment of dues and a number are still in arrears.

It is with regret we record the death of two members of the Branch, C. E. W. Dodwell, M.E.I.C., and G. A. Bernasconi, M.E.I.C.

The finances of the Branch are in very good shape, all indebtedness has been paid, but rebates are due from Headquarters for the last quarter of this year.

FINANCIAL STATEMENT

Receipts

Cash on hand, Jan. 1, 1931	$283.86	
Rebates	250.00	
Branch News	15.39	
Bank interest	9.25	
Miscellaneous	12.00	
		$570.50

Expenditures

Meetings	$130.19	
Secretary's office	67.00	
Pictures	39.75	
Flowers	8.00	
Mailing list	3.50	
Miscellaneous	21.70	
Balance on hand	300.36	
		$570.50

Showing a net gain for the year of $16.50

Respectfully submitted,
J. L. ALLAN, M.E.I.C., *Chairman.*
R. R. MURRAY, A.M.E.I.C., *Secretary-Treasurer.*

Hamilton Branch

The President and Council,—

The Executive committee of the Hamilton Branch submits the following report for the year 1931.

The Branch year dates from June 1st, so that two Executive committees were in office during the calendar year as follows:—

January to May

Chairman	W. F. McLaren, M.E.I.C.
Vice-Chairman	F. P. Adams, A.M.E.I.C.
Committee	J. B. Carswell, M.E.I.C.
	H. S. Philips, M.E.I.C.
	E. M. Coles, A.M.E.I.C.
	G. A. Colhoun, A.M.E.I.C.
Secretary-Treasurer	J. R. Dunbar, A.M.E.I.C.
Councillor	E. H. Darling, M.E.I.C.
Past-Chairman	H. A. Lumsden, M.E.I.C.
News Editor	J. A. M. Galilee, Affil.E.I.C.

June to December

Chairman	E. P. Muntz, M.E.I.C.
Vice-Chairman	H. B. Stuart, A.M.E.I.C.
Committee	E. M. Coles, A.M.E.I.C.
	G. A. Colhoun, A.M.E.I.C.
	J. Stodart, M.E.I.C.
	W. A. T. Gilmour, Jr.E.I.C.
Secretary-Treasurer	J. R. Dunbar, A.M.E.I.C.
Councillor	E. H. Darling, M.E.I.C.
Past-Chairman	W. F. McLaren, M.E.I.C.
News Editor	J. A. M. Galilee, Affil.E.I.C.

MEMBERSHIP

	Dec. 31st, 1930 Resident	Non-Resident	Total
Members	25	5	30
Associate Members	46	9	55
Juniors	11	4	15
Students	28	3	31
Affiliates E.I.C	3	0	3
Branch Affiliates	20	0	20
	133	21	154

	Dec. 31st, 1931 Resident	Non-Resident	Total
Members	25	5	30
Associate Members	49	9	58
Juniors	14	3	17
Students	32	1	33
Affiliates E.I.C	3	0	3
Branch Affiliates	18	0	18
	141	18	159

MEETINGS

The following meetings were held during the year:—

Jan. 13.—**Railway Construction Through the Yellowhead Pass** by W. R. Smith. Attendance, 45.

Feb. 11.—**Construction and Operation of Oil Electric Rail Cars** by H. F. Finnemore, A.M.E.I.C. Attendance, 75.

Mar. 10.—Students' Meeting: **A Brief Resume of the Development of the Air Brake and Its Relation to Transportation** by P. R. Adams, S.E.I.C. **Electric Furnaces as Applied to Industrial Heating** by D. E. Bridge, S.E.I.C. **The Power Supply of Southern Vancouver Island** by H. W. Blackett, Jr.E.I.C. Attendance, 25.

April 2.—**Steam Storage** by J. P. Wys. This was a joint meeting with the Ontario and Buffalo Sections A.S.M.E. and Niagara Peninsula Branch of The Institute. In the afternoon visits were paid to Works of the Canadian Westinghouse Company Ltd., Steel Company of Canada, Firestone Tire and Rubber Company, and Dominion Glass Company. After dinner, Japanese Research films were shown. Members of the Buffalo Section A.S.M.E. explained the films. Attendance: 100 at dinner; 120 at evening meeting.

April 24.—**Interesting Developments and Problems in Central Station Engineering** by R. E. Powers. This was the annual joint meeting with the Toronto Section A.I.E.E. Attendance, 240.

May 6.—Annual Branch meeting. Attendance, 20.

Sept. 17.—**Engineering of the Ancients** by W. P. Wilgar, M.E.I.C. Dinner meeting. Attendance, 32.

Oct. 6.—**Lighter than Air Transportation** by W. C. Young. The Hamilton Branch were the guests of the Niagara Peninsula branch at this meeting. Attendance, 81, including 18 from Hamilton.

Oct. 30.—**Mechanical Industries and the Chemical Engineer** by J. W. Bain. Joint meeting with Ontario Section, A.S.M.E Attendance, 41.

Nov. 17.—**Recent Progress in Bridge Engineering** by C. R. Young, M.E.I.C. **Proposed Amendments to the Professional Engineers' Act** by A. H. Harkness, M.E.I.C., and H. Hellmuth. Attendance, 66.

Dec. 3.—**Some Problems in Canadian Transportation** by W. T. Jackman. The Hamilton Chamber of Commerce and the Hamilton Traffic Club were guests of the Branch at this meeting. Attendance, 95.

Dec. 16.—**Arc Welding** by A. M. Candy. Attendance, 180.

Our meetings in general may be said to assist in the acquirement and interchange of professional knowledge among the members. We have endeavoured to enhance the usefulness of the profession to the public by holding meetings of interest to the general public and by inviting them to the meetings. In this connection the meeting of December 16th may be mentioned in particular as we had over one hundred visitors at this meeting.

We have endeavoured to co-operate with other technical societies and members of allied professions by holding joint meetings such as the meetings of April 24th and October 30th and by inviting other organizations to attend our meetings, for example the meeting of December 3rd.

We have under consideration a project to make an engineering survey of the resources of the city of Hamilton which is a fulfilment of section 1 (h) of the By-laws, namely to encourage original research, and the study, development and conservation of the resources of the Dominion.

FINANCIAL STATEMENT

Receipts

Balance, Jan. 1st, 1931	$1,172.57	
Branch Affiliates	48.00	
Rebates on fees	249.90	
Branch News	62.80	
Bank interest	9.53	
Bond interest (net)	40.47	
Advertising commission	12.75	
Journal subscriptions	6.00	
		$1,602.02

Expenditures

Printing and postage	$ 98.94	
Lecture expenses	125.60	
Refreshments	10.00	
Dinner, Apr. 2	9.35	
Stenographer	50.00	
Students' prizes	40.00	
Sundry	6.29	
Expenses of Councillor to Plenary Meeting	30.00	
Flowers	7.00	
Journal subscriptions	6.00	
Bonds purchased	915.00	
Balance, Jan. 1, 1932	303.84	
		$1,602.02

Respectfully submitted,
E. P. MUNTZ, M.E.I.C., *Chairman.*
J. R. DUNBAR, A.M.E.I.C., *Secretary-Treasurer.*

Kingston Branch

The President and Council,—

During the year 1931 the Branch held two meetings. At the first of these a résumé of the paper on the Chute-à-Caron power development (read at the General Meeting of The Institute) was given, the films having been lent through the courtesy of the Alcoa Power Company.

The second address, by Major G. R. Turner, A.M.E.I.C., Royal Canadian Engineers, was given on April 7th, at the Badminton Club of Kingston. The address was given following a dinner at which most of the corporate members of the Branch were present. The subject was **India**, special reference being made to matters of engineering interest.

Three proposed meetings had to be cancelled, because of the inability of the proposed speaker to be present.

The membership of the Branch is as follows:

Honorary Member	1
Members	12
Associate Members	13
Junior Members	4
Student Members	33
Affiliate	1
Total	64

FINANCIAL STATEMENT

Receipts

Balance	$85.98	
Dec. 31—Interest	1.68	
Jan. 21—Rebates	10.50	
" 21—News	2.63	
Feb. 15—Rebates	4.80	
June 20—Rebates	57.60	
" 30—Interest	1.10	
Sept. 15—Rebates	8.10	
" 15—News	3.56	
		$175.95

Expenditures

Jan. 15—Stationery	$ 0.40	
" 15—Rent of hall	2.50	
Feb. 21—Envelopes	.10	
Mar. 11—Cards and telegram	1.84	
" 11—Secretary	25.00	
Apr. 7—Dinner expense	5.00	
" 11—Cards	1.77	
" 11—Expenses, speaker	9.35	
Oct. 26—Secretary	25.00	
Balance	104.99	
		$175.95

Respectfully submitted,
L. F. GRANT, M.E.I.C., *Secretary-Treasurer.*

Lakehead Branch

The President and Council,—

On behalf of the Executive committee I beg to submit the following Annual Report of the Lakehead Branch of The Engineering Institute of Canada.

MEMBERSHIP

On January 1st, 1931, there were 41 Corporate Members and 11 Non-Corporate Members, and on December 31st, 1931, there were

43 Corporate and 11 Non-Corporate Members, showing a gain of 2 Corporate Members.

It is with the greatest regret that I have to announce that we lost, through death, the services of W. J. Fuller, A.M.E.I.C., district engineer of the Department of Public Works, Port Arthur-Fort William.

MEETINGS

I am sorry to have to report there were no meetings held during the year. Very few of our members are now living in the city, most of them being on the road work in the district.

F. C. Graham, A.M.E.I.C., of Port Arthur, is the Lakehead Branch representative on the Nominating Committee.

FINANCIAL STATEMENT
(1931)

Revenue

Balance in bank, December 31st, 1930	$298.60	
Rebates of fees	62.70	
Refund travelling expenses to Plenary Meeting	150.00	
Bank interest	9.30	
		$520.60

Expenditure

Travelling expenses to Plenary Meeting	$150.00	
Balance in bank, December 31st, 1931	370.60	
		$520.60

Respectfully submitted,
GEO. P. BROPHY, 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 during the past year.

Since January 1st 1931, ten regular meetings have been held when the average attendance was 41; also six Executive meetings when the attendance was almost 100 per cent.

The customary procedure has been continued in connection with our regular meetings, i.e. dinner meetings with short musical programmes and community singing before the address of the evening.

Once again, the Branch has been fortunate in having had some excellent speakers on highly interesting subjects, due entirely to a very energetic Programme committee. Interest in the meetings has also been maintained to a very great extent through the efforts of our Entertainment committee. The purchase of a motion picture projector has also very materially aided in making the meetings enjoyable as well as instructive, and the branch is indebted to a great extent to the generosity of those members who made this possible.

The list of speakers and subjects chosen follows:—

Jan. 10.—Dean C. J. Mackenzie, M.E.I.C., Vice-President E.I.C. Subject: **Urban Growth of Western Canada.** Lantern slides.

Jan. 24.—N. H. Bradley, A.M.E.I.C., Dist. Engineer, Prov. of Alberta. Subject: **Highway Construction,** illustrated with motion pictures.

Feb. 7.—K. R. Jallings, Chief Chemist, Maple Leaf Refining Co. Subject: **The Story of Gasoline,** illustrated with motion pictures.

Feb. 21.—G. B. Davies, Manager, Lethbridge Iron Works. Subject: **The Story of Steel,** illustrated with motion pictures.

Mar. 14.—Annual Meeting. Speaker: F. W. Cottam, Baalim Motor Co. Subject: **The Internal Combustion Engine,** illustrated with motion pictures.

Oct. 17.—Dr. W. G. Carpenter, Institute of Technology and Art, Calgary. Subject: **The Canadian Mid-North,** illustrated with motion pictures.

Oct. 31.—C. D. Howe, M.E.I.C., C. D. Howe & Co., Port Arthur. Subject: **Grain Handling,** illustrated with lantern slides.

Nov. 14.—J. D. Baker, Deputy Minister of Telephones, Alberta. Subject: **The Trans-Canada Telephone Line,** illustrated with lantern slides.

Nov. 28.—S. G. Porter, M.E.I.C., President of the Institute. Subject: **Some Observations on the Engineering Profession.**

Dec. 12.—Ladies night, musical programme and motion pictures.

The annual meeting of the Branch was held on March 14th, when the following officers were chosen for the season 1931-32.

Chairman	N. Marshall, M.E.I.C.
1st Vice-Chairman	W. Meldrum, A.M.E.I.C.
2nd Vice-Chairman	C. S. Clendening, A.M.E.I.C.
Executive	N. H. Bradley, A.M.E.I.C.
	J. B. deHart, M.E.I.C.
	J. Haimes, A.M.E.I.C.
	R. Livingstone, M.E.I.C.
Councillor	G. N. Houston, M.E.I.C.
Auditors	P. M. Sauder, M.E.I.C.
	C. S. Donaldson, A.M.E.I.C.
Secretary-Treasurer	W. Meldrum, A.M.E.I.C.

At December 31st, 1931, the membership of the Branch is as follows:

	Resident	Non-Resident	Total
Members	6	0	6
Associate Members	19	6	25
Junior Members	1	1	2
Student Members	2	2	4
Branch Affiliates	30	0	30
	58	9	67

FINANCIAL STATEMENT
(At December 31st, 1931)

Revenue

Bank balance as at December 31st, 1930	$230.05	
Rebates due from Headquarters	8.40	
Rebates received from Headquarters	64.95	
Branch News revenue from Headquarters	38.83	
Branch Affiliates fees	118.85	
Special donations towards motion picture projector	100.00	
Bank interest	2.60	
Miscellaneous	19.37	
Rebates due from Headquarters as per telegram...	2.70	
		$585.75

Expenditures

Printing and stationery	$ 35.25	
Meeting expenses, speakers, music, films, etc	96.23	
On a/c Holmes motion picture projector	318.00	
H.Q. Branch Affiliates Journal subscriptions	20.00	
Gratuities: hotel staff, orchestra, projector operator, etc	48.90	
Postage, telegrams, etc	10.80	
		$529.18

Assets

Bank balance at Dec. 31st, 1931 less o/s cheques..	$ 53.87	
Rebates due from Headquarters	2.70	
Holmes projector; cost $360.25 less 10% for depreciation	324.22	
Percentage of members' fees in arrears	39.04	
		$419.83

Liabilities

Headquarters for Journal subscription	$ 2.00	
Headquarters loan for balance on projector	60.25	
		$ 62.25

C. S. DONALDSON, A.M.E.I.C. }
P. M. SAUDER, M.E.I.C. } Auditors.

Respectfully submitted,
WM. MELDRUM, A.M.E.I.C., *Secretary-Treasurer.*

London Branch

The President and Council,—

On behalf of the Executive committee of the London Branch we beg to submit the following summary of London Branch activities for the year ending December 31st, 1931.

Nine meetings of the Executive committee were held and eight general meetings.

The year opened with a special meeting on January 15th with Capt. A. F. Ingram, of the Canadian Airways Ltd., as speaker. His subject was **Commercial Flying in Canada.** He outlined the extent of air mail and passenger service in Canada, gave a short historical sketch of this service and described the equipment used. The address was illustrated with slides and motion pictures. Attendance, 56.

The Annual Meeting of the Branch was held on Wednesday, January 21st, at 6.15 p.m. in the private dining room at Hotel London. Following the dinner, reports were presented as follows: The Councillor's report by W. P. Near, M.E.I.C., the Auditor's report by J. R. Rostron, A.M.E.I.C., and a report of the year's activities by the secretary. The Executive committee for 1931 was elected by ballot. The speaker of the evening was Dr. A. E. Berry, A.M.E.I.C., of the Ontario Dept. of Public Health, and his subject **Engineering and Public Health.** The work of the engineer was described in connection with refuse disposal, water purification, and the control of milk and other food supplies. Attendance, 33.

The regular February meeting was held in the County Council Chamber on Wednesday, February 18th. An address on **The Purposes of and Methods Employed in Railway Signalling** was delivered by Mr. C. H. Tillett, Signal Engineer, Canadian National Railways. The speaker described the equipment used, beginning with the hand-operated signals which are now giving way to the automatic systems. He described power interlocking, automatic train control, centralized traffic control and "hump" sorting yards. The address was generously illustrated with lantern slides. Attendance, 89.

On March 17th a meeting was held in the County Council Chamber at which Mr. J. H. Schofield was the speaker and his subject **Fuel Burning Equipment for Modern Steam Plants.** He described a large number of steam generating plants in use on this continent, illustrating the various types of grates and boilers used for small and large plants. He explained the use of the different kinds of coal and the apparatus used in handling them, illustrating his descriptions with lantern slides. Attendance, 34.

Colonel W. P. Wilgar, M.E.I.C., of Queen's University, was the speaker at the regular April meeting, held in the County Council Chamber on April 22nd. Professor Wilgar gave a very interesting address on **Engineering of the Ancients**, going back beyond the time of the first historical records for his material. Much information was gained by a study of such works as the pyramids, the Tower of Babel, drainage systems and stone arch bridges and aqueducts. Attendance, 38.

The regular May meeting was held on the 19th of the month in the City Hall Assembly Room. An address on **Reforestation**, illustrated with coloured slides, was delivered by Mr. A. H. Richardson, Forester in charge of Reforestation for Ontario. The speaker told of the scope of the work of his Department, the advantages of planting trees, the method of obtaining them from the Government and the profits to be derived. Prizes were distributed by the chairman to the winners of the essay competition among county school pupils. Attendance, 55.

The first meeting of the Fell Session was held on Wednesday, November 18th, in the private dining room of Hotel London, at 8.00 p.m. The chief speaker of the evening was A. H. Harkness, M.E.I.C., President of the Association of Professional Engineers of Ontario. In his address he gave the solution of many of the structural problems met with in the design and erection of the Chamber of Commerce building in Toronto, and illustrated his points with lantern slides. Following Mr. Harkness, Mr. H. Hellmuth, Organizer for the Association of Professional Engineers of Ontario, addressed the meeting explaining the constitution of the Association and its objects and outlining the existing and proposed legislation for the protection of the public and the engineering profession. Attendance, 40.

The last meeting of the year was held on December 16th in the new Bell Telephone station at Colborne and Oxford streets, where members of the Branch were guests of Mr. Stratton and his staff. The meeting opened with movies showing the work of the engineering department of the Bell Telephone Co. This was followed by an address by Mr. Ion, in which he described the new long distance cable from London to Toronto and the operation of the stations, finally conducting the party through the station and explaining its operation. A brief outline of the purposes and activities of The Engineering Institute of Canada was given by Mr. Near for the engineers who are not members of The Institute. Attendance, 47.

The increase in attendance at meetings in 1931 is worthy of note, the average for the eight meetings being 48 as compared with 42 for the previous year.

MEMBERSHIP

The membership of the London Branch at the close of 1931 was as follows:—

Members	16
Associate Members	30
Juniors	1
Students	7
Affiliates	1
Branch Affiliates	3
	58

FINANCIAL STATEMENT

(Year ending December 31st, 1931)

Receipts

Balance on hand, January 1, 1931	$ 72.62	
Rebates from Headquarters for December, 1930	11.10	
Rebates from Headquarters for 1931:		
Dues	120.30	
Branch News	49.11	
Fees for Branch Affiliates	15.00	
Rebates due from Headquarters	2.70	
		$270.83

Expenditures

Journal subscriptions for Branch Affiliates	$ 8.00	
Notices, printing and stationery	37.51	
Postage	14.81	
Telephone and telegrams	2.20	
Annual Dinner	17.50	
Refreshments, cigars, etc	16.88	
Hotel rooms	14.45	
Stenographer, janitor, elevator, motion picture operator	12.50	
Cash on hand	5.00	
Bank balance	139.28	
Rebates due from Headquarters	2.70	
		$270.83

V. A. McKillop, A.M.E.I.C. }
E. V. Buchanan, M.E.I.C. } Auditors.

Respectfully submitted,

W. R. Smith, A.M.E.I.C., *Chairman.*

Frank C. Ball, A.M.E.I.C., *Secretary-Treasurer.*

Moncton Branch

The President and Council,—

On behalf of the Executive committee we beg to submit the twelfth annual report of Moncton Branch.

The Executive committee held five meetings. There were seven meetings of the branch held, two of which were supper meetings and four were open to the public.

MEMBERSHIP

Our membership at present consists of seventy-three members, as follows:

	Resident	*Non-Resident*
Members	10	2
Associate Members	20	5
Juniors	2	..
Students	29	3
Affiliates	2	..
	63	10

OFFICERS

The annual meeting of the Branch was held May 30, 1931. The following officers were elected for 1931-32:—

Chairman	G. E. Smith, A.M.E.I.C.
Vice-Chairman	T. H. Dickson, A.M.E.I.C.
Secretary-Treasurer	V. C. Blackett, A.M.E.I.C.
Executive	H. J. Crudge, A.M.E.I.C.
	R. H. Emmerson, A.M.E.I.C.
	H. W. McKiel, M.E.I.C.

The members of the Executive committee in addition to the above are:—

	E. T. Cain, A.M.E.I.C.
	A. S. Gunn, A.M.E.I.C.
	A. F. Stewart, M.E.I.C.
Ex-officio	L. H. Robinson, M.E.I.C.
	G. C. Torrens, A.M.E.I.C.

FINANCIAL STATEMENT

(Year ending December 31, 1931)

Receipts

Balance in bank, January 1, 1931	$209.12	
Cash on hand, January 1, 1931	4.42	
Rebates on dues	131.70	
Affiliate dues	10.00	
Branch News	21.21	
Tickets sold for supper meetings	33.00	
Bank interest	6.43	
		$415.88

Expenditures

Expenses of meetings	$ 81.30	
Printing and advertising	43.42	
Postage	6.01	
Telegrams and telephones	2.32	
Miscellaneous	35.40	
Balance in bank	244.04	
Cash on hand	3.39	
		$415.88

Audited and found correct,

E. T. Cain, A.M.E.I.C. }
R. H. Emmerson, A.M.E.I.C. } Auditors.

Respectfully submitted,

G. E. Smith, A.M.E.I.C., *Chairman.*

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

Montreal Branch

The President and Council,—

We have the honour of submitting for your approval the following report on the activities of the Montreal Branch for the year 1931.

EXECUTIVE COMMITTEE

The Executive committee was comprised of the following members:—

Chairman	A. Duperron, M.E.I.C.
Vice-Chairman	P. E. Jarman, A.M.E.I.C.
Secretary-Treasurer	C. K. McLeod, A.M.E.I.C.
Past-Chairman	D. C. Tennant, M.E.I.C.
Executive	J. L. Clarke, A.M.E.I.C.
	H. G. Thompson, A.M.E.I.C.
	J. B. O. Saint-Laurent, A.M.E.I.C.
	A. Cousineau, A.M.E.I.C.
	W. McG. Gardner, A.M.E.I.C.
	N. L. Morgan, A.M.E.I.C.
Ex-officio	D. C. Tennant, M.E.I.C.
	O. O. Lefebvre, M.E.I.C.
	Julian C. Smith, M.E.I.C.
	W. C. Adams, M.E.I.C.
	F. A. Combe, M.E.I.C.
	C. V. Christie, M.E.I.C.
	P. B. Motley, M.E.I.C.
	J. A. McCrory, M.E.I.C.
	J. L. Busfield, M.E.I.C.

During the year there were eight meetings held by the Executive committee, at which the average attendance was nine.

Papers and Meetings Committee

The Papers and Meetings committee was comprised of the following members:—

Chairman	H. G. Thompson, A.M.E.I.C.
Vice-Chairman	R. M. Robertson, A.M.E.I.C.
Ex-Officio	C. K. McLeod, A.M.E.I.C.
Civil Section, Chairman	G. B. Mitchell, M.E.I.C.
Vice-Chairman	J. B. D'Aeth, M.E.I.C.
Electrical Section, Chairman	H. Milliken, M.E.I.C.
Vice-Chairman	H. J. Vennes, A.M.E.I.C.
Mechanical Section, Chairman	S. Hermans, A.M.E.I.C.
Vice-Chairman	J. G. Hall, M.E.I.C.
Municipal Section, Chairman	F. E. V. Dowd, A.M.E.I.C.
Vice-Chairman	Robert Dorion, A.M.E.I.C.
Railway Section, Chairman	A. E. Oulton, A.M.E.I.C.
Vice-Chairman	L. W. Deslauriers, A.M.E.I.C.
Aeronautical Section, Chairman	R. H. Mulock, A.M.E.I.C.
Vice-Chairman	C. M. McKergow, M.E.I.C.
Students' Section, Chairman	G. Lanctot, S.E.I.C.
Vice-Chairman	G. B. Jost, S.E.I.C.

During its term of office this committee arranged the papers for the fall term of 1931 and the spring term of 1932. These as far as possible were chosen so as to interest the various sections of the Montreal Branch and from the attendance at the meetings it was evident that the subjects were quite popular.

The papers actually delivered during its term of office were as follows:—

Jan. 8—Annual Meeting of the Branch.
Jan. 15.—**New Diesel Electric Suction Dredge "General Brock"** by B. G. Flaherty,
Jan. 22.—**Lighthouse Service of Canada** by J. G. Macphail, M.E.I.C.
Jan. 29.—**The British Grid** by C. C. Paterson.
Feb. 12.—**Back River Bridge** by J. L. Leroux, M.E.I.C.
Feb. 19.—**Arch Analysis** by Alfred Gordon, A.M.E.I.C., Am.Soc.C.E.
Feb. 26.—**The Art of Telegraphy and Other Forms of Railway Communication** by J. C. Burkholder.
Mar. 5.—**Remuneration of Engineers** by J. L. Busfield, M.E.I.C.
Mar. 12.—**Air Transportation** by Capt. A. F. Ingram.
Mar. 26.—Visit to Ecole Polytechnique—by Dr. A. Frigon, M.E.I.C.
Apr. 2.—**The Story of the Quantum** by W. B. Cartmel, M.E.I.C.
Apr. 9.—**River St. Lawrence Ship Channel** by N. B. McLean, M.E.I.C.
Apr. 16.—**Montreal Incinerators** by H. Gibeau, A.M.E.I.C.
Apr. 23.—**Airways Communications** by Lt. Col. W. Arthur Steel, M.E.I.C.
Apr. 30.—**Seven Sisters Hydro-Electric Power Development** by F. H. Martin, M.E.I.C.
May 7.—**New Fire Alarm Headquarters** by C. J. Desbaillets, M.E.I.C.
June 24.—Inspection of the "Empress of Britain."
Oct. 1.—**C.P.R. Wolfe's Cove Branch and Tunnel at Quebec** by Lt. Col. D. Hillman, M.E.I.C., D.S.O.
Oct. 8.—**Non-Resonating Transformers** by K. K. Palueff.
Oct. 15.—**National Research in Aviation** by Professor J. H. Parkin, M.E.I.C.
Oct. 22.—**Electrification of Canadian Copper Refiners Plant** by A. D. Ross, A.M.E.I.C.
Oct. 29.—**The Practical Application of the Microscope to Railway Service** by F. H. Williams.
Nov. 5.—**Montreal Harbour Developments** by J. P. Leclaire, M.E.I.C.
Nov. 12.—**Fusion Welding of Pressure Vessels** by J. E. Trainer.
Nov. 19.—**Montreal Power Supply System** by H. Milliken, M.E.I.C.
Nov. 26.—**Applying the Canadian Yardstick to Engineering and Architectural Methods** by James Govan.
Dec. 3.—**Aircraft Design** by M. J. Berlyn, A.M.E.I.C.
Dec. 10.—**Montreal Tramways Latest Rectifier Sub-Station** by J. A. Ouimet, S.E.I.C. **Structural Work in Europe** by Alex. Shearwood, S.E.I.C.
Dec. 16.—Dean Ernest Brown Dinner.

The average attendance at these meetings showed a decided improvement, the number being 91, with a maximum attendance of 156 and a minimum of 46.

It was noted that the attendance had improved during the fall programme, the average attendance at the last six meetings of the year being 105, showing that members are more interested in these activities, and possibly to a certain degree on account of having been provided with more comfort, for which we desire to express our appreciation to the House committee of The Institute.

We think that this committee deserves our sincere thanks for the first class programme they have arranged. We wish to mention in particular the excellence of the students nights. The papers read were most interesting and instructive, and we note with pleasure that our members take more and more interest in them.

The Executive cannot stress too much importance on the work of the Papers and Meetings Committee. Its responsibility is great, and the greatest care has to be made in the selection of its members. Considerable time and effort is involved in the preparation of the programme for our regular Thursday night meeting; we want them well attended and the type of papers to be presented has a great deal to do with it. The Montreal Branch, the largest in number, has the moral obligation to provide The Institute with works that will make its proceedings equal to any of similar societies.

The Executive takes this opportunity to make an appeal to all members on this matter. No doubt that it means a great deal of work to prepare an important paper, but it is our duty to do so, if we are to fulfil one of the purposes for which The Institute carries on:—

"To facilitate the acquirement and interchange of professional knowledge among its Members."

The Executive gave much consideration to the report to Council by R. B. Young, M.E.I.C., chairman of the Institute Papers Committee, and was of the opinion that there was large room for interchange of papers between the various Branches. It is suggested that in the preparation of the programme, certain dates be allocated for papers to be read by members of other Branches, it being the duty of said Branches to select their speaker. The Montreal Branch would reciprocate in the same way.

It was suggested to the Executive that when a speaker from out of town should visit the Branch an informal dinner might be held at which all members would be given the opportunity to attend, and it is arranged that this will be done at an early date.

Membership

The Executive is glad to report that the membership during the year has increased by 48, the record for the years 1930 and 1931 being as follows:—

	Year 1930	*Year 1931*
Corporate Members	769	783
Non-Corporate Members	357	391
Total	1,126	1,174

We believe that an effort should be made to enlist all students of universities before they graduate, and we respectfully ask the full co-operation of the professors in this repect.

Annual General Meeting

The Annual General and Professional Meeting of The Institute for the year 1931 was held in Montreal, February 4th, 5th and 6th.

The organization of such a meeting requires a vast amount of work and those responsible for its success deserve special mention. The following is a list of the Branch committee with whom the General-Secretary, Mr. Durley, co-operated:—

Chairman	D. C. Tennant, M.E.I.C.
Secretary	C. K. McLeod, A.M.E.I.C.
General Duties	A. Duperron, M.E.I.C.
Hotel Arrangements	J. L. Busfield, M.E.I.C.
Luncheons	J. A. McCrory, M.E.I.C.
Registration and Reception	H. Massue, A.M.E.I.C.
Papers and Meetings	P. E. Jarman, M.E.I.C.
Inspection Trips	F. Newell, M.E.I.C.
Smoker	C. M. McKergow, M.E.I.C.
Publicity	H. G. Thompson, A.M.E.I.C.
Ladies	W. McG. Gardner, A.M.E.I.C.

You will remark that the deficit incurred for this meeting is much less than that of previous ones. In spite of the fact that no special subscription was called for to defray this extra expenditure, the deficit was only $528. The Executive thought that on account of the short interval between Annual Meetings held in Montreal, it was not advisable to spend too much of the reserve we had in the bank. Consequently it was decided to abolish complimentary tickets to visiting members for the formal luncheon and smoking concert, and this was in conformity with suggestions received from other Branches. This meant only a small increase in the disbursement of members coming from out of town, but quite an important saving for the Branch. On the other hand, the price of tickets for the different functions were fixed at a minimum in order to permit the greatest number of members to attend.

An innovation was made in inviting the ladies to attend at the Annual Banquet and in evidence of the success of this practice, the lead of the Montreal Branch is, we understand, being followed by Toronto this year.

Special Dinner in Honour of Dean Brown

A special dinner was organized, December 16th, 1931, in honour of the appointment of Professor Ernest Brown, M.E.I.C., to the position of Dean of the Faculty of Engineering at McGill University. The Institute being so deeply interested in educational matters, the Executive took this opportunity of giving the members the privilege of expressing their appreciation to McGill University and to pay tribute to Dean Brown. We were honoured by the presence of Sir Arthur Currie, Vice-Chancellor and Principal of McGill University; Dr. A. Frigon, M.E.I.C., Director of Ecole Polytechnique; Professor C. R. Young, M.E.I.C., of Toronto University; Professor Alexander Macphail, M.E.I.C., of Queen's University, and also of four Past-Presidents of The Institute.

The dinner was attended by 162 members, proving the high esteem felt towards Dean Brown.

The committee responsible for the organization and the success of the dinner consisted of Messrs. Busfield, Tennant and Gardner and they deserve our most sincere gratitude.

Excursions

"Empress of Britain" Excursion—An invitation was received from the Canadian Pacific Steamships to visit their ship, *The Empress of Britain*, in Quebec on the 24th of June. A trip by special train was organized jointly with the Board of Trade of Montreal and attended by 25 of our members. A most agreeable and interesting day was provided. An informal luncheon was tendered on the ship and the inspection of the machinery proved to be most instructive.

Visit to Incinerator—Pursuant to a request made by members who attended the presentation of the paper read by H. A. Gibeau, A.M.E.I.C., Assistant Director of Public Works, City of Montreal, a very interesting inspection was made on the 18th of November of the new incinerator located on Atwater Avenue.

Wellington Street Tunnel—Preliminary arrangements have been made with the contractors of the Wellington street tunnel under the Lachine canal, the Dufresne Construction Company, and they have expressed their willingness to entertain the Montreal Branch at a visit of inspection some time early in the new year. The matter is referred to the incoming Executive.

Other Activities

It was reported to you in last year's annual report that the Branch had representation on a committee of the Province of Quebec Safety League which was preparing a safety code for construction industries. Our representatives also reported on December 2nd, 1930, that the "proposed code though containing some very valuable information and suggestions, was not acceptable as a document that might become law; and should be entirely revised, suggesting that it be separated into two parts; one to cover items to be made mandatory, and the second to cover articles and matters of an educational nature only. Any committee appointed in the preparation of such code should include members having special knowledge in each of the various branches of construction dealt with." Our Secretary was instructed to advise the Safety League of the above report of our representatives, and that the Branch would not sponsor the code in its present form. However, in spite of the above, advanced copies of the code had been printed by the League, the name of The Engineering Institute being used as a sponsor. Following protest made by the General Secretary of The Institute, we were assured that The Institute's name would not be used as a sponsor.

Town Planning Act

The Executive considered a request from the City Improvement League asking the Branch to support a petition to be presented to the Prime Minister of the province of Quebec for the passing of a Town Planning and Zoning Enabling Act. The Executive was in agreement with the principle of passing such an Act, but objected to some of the declarations in the preamble. The request was modified as follows and approved:—

"Whereas, we the undersigned are in favour of the adoption "of a general plan for the future guidance of development in "Montreal and its vicinity, we respectfully request the Provin- "cial Government of Quebec to enact a comprehensive Town "Planning and Zoning Enabling Act, on a model suitable for "application to any municipal or regional district in the "Province, and immediately applicable to the district contain- "ing Montreal and its surrounding municipalities."

Aeronautical Section

A communication was received from the General Secretary of The Institute, Mr. Durley, outlining the provisions of an agreement which had been entered into between the Council of The Engineering Institute of Canada and the Royal Aeronautical Society, and drawing special attention to the fact that the membership of the Aeronautical Sections included:—

(A) Corporate Members and Juniors of The Institute.
(B) Technical Members of the Aeronautical Society.
(C) Such other Members as might be admitted by the Branch Executive, and furthermore, that the local Branch have the right to determine the dues to be paid by Members in this group "C."

After consideration, the Executive decided to postpone for a while, any definite action regarding the admission of Class "C" members.

Plenary Meeting of Council

Following a request made by Headquarters, the Executive decided to grant a sum of $50 to be allocated towards travelling expenses of Councillors in connection with the Plenary Meeting.

Deaths

During the current year, the Branch mourned the loss of several Members, and it is with deep regret that we record their names herewith:

Robert Jack Anderson, A.M.E.I.C.
Orville Frank Bryant, M.E.I.C.
Gordon F. Cairnie, A.M.E.I.C.
Edward Park Cameron, A.M.E.I.C.
Joseph William Haywood, M.E.I.C.
F. C. Laberge, M.E.I.C.
Harold Elmer McLellan, A.M.E.I.C.
George Cleghorn Mackenzie, M.E.I.C.
Louis Gustave Papineau, A.M.E.I.C.
Graham Ferguson Paterson, A.M.E.I.C.
Henri Etienne Vautelet, M.E.I.C.

Financial Statement

Ordinary Revenue		
Branch news	$ 16.99	
Affiliate dues	115.00	
Rebates	1,842.20	
		$1,974.19
Extraordinary Revenue		
Balance from 1930	$1,316.81	
Interest	24.08	
A. G. and P. meeting	3,070.50	
Dinner	313.50	
		4,724.89
		$6,699.08
Ordinary Expenditures		
Post cards	$ 692.11	
Printing	84.52	
Stationery and stamps	18.74	
Secretary's honorarium	300.00	
Clerical assistance	120.00	
Telephone, etc	63.74	
Lantern slides, etc	104.25	
Subscriptions to *Journal*	32.00	
Miscellaneous	183.20	
		$1,598.56
Extraordinary Expenditures		
A. G. and P. meeting	$3,598.38	
Dinner	391.56	
		$3,989,94
Cash on hand		1,051.88
Amount due from Headquarters		58.70
		$6,699.08

You will note that there is a slight loss during the current year, but that this is due to the deficit in the financing for the Annual Meeting, and eliminating this item, we would have had a slight profit.

Respectfully submitted,

A. Duperron, M.E.I.C., *Chairman.*
C. K. McLeod, A.M.E.I.C., *Secretary-Treasurer*

Niagara Peninsula Branch

The President and Council,—

The Executive of this Branch presents herein the report for the year 1931.

The Executive held five regular meetings and one electoral meeting, with an average attendance of 9.16, or 58 per cent.

Eight regular meetings of the Branch were held, as listed below, and one joint meeting with Hamilton Branch. The subjects were quite varied; the attendance as shown by the larger numbers was augmented to a great extent by visitors.

The meetings are listed as follows:—

Jan. 14.—Dinner meeting at King Edward hotel, Niagara Falls. Speaker: Captain A. F. Ingram, Manager Canadian Airways. Subject: **Commercial Flying in Canada.** Attendance about 65.

Feb. 26.—Dinner meeting at Leonard hotel, St. Catharines. Speaker: Dr. R. W. Boyle, Ph.D., M.Sc., M.A., F.R.S.C., M.E.I.C., Director National Research Council, Ottawa. Subject: **The Engineer in the Nation.** Attendance 26.

Mar. 6.—Dinner meeting at St. Andrew's Hall, Thorold. Speaker: Thomas Wayling, Member Press Gallery, Ottawa. Subject: **While Cooks Touring Among the Clouds.** Descriptive of his return trip on the R-100. Attendance 79.

" 26.—Dinner Meeting at Hotel Reeta, Welland. Speaker: J. L. Busfield, M.E.I.C., Chairman of the Institute Committee on Classification and Remuneration of Engineers. Subject: **Remuneration of Engineers.** Attendance 28.

Apr. 2.—Joint Dinner meeting at Hamilton, with Hamilton Branch, and Ontario and Buffalo Sections A.S.M.E. Tour of inspection in afternoon of various plants.

" 30.—Inspection trip through Canadian Ohio Brass Company, and New Niagara Falls Filtration Plant at Chippawa, followed by a buffet lunch and descriptive talk on different features of the construction of the latter. Talk by S. W. Andrews of the H. G. Acres Company. Attendance about 80.

May 27.—Annual Meeting. Dinner meeting at General Brock hotel, Niagara Falls, Ont. Speaker: Mr. M. A. Sorsoleil, M.A., Assistant Director of Vocational Education, Province of Ontario. Subject: **Modern Trends in Education.** Attendance 79.

Oct. 6.—Dinner meeting at Fox Head inn, Niagara Falls, Ont. Speaker: W. C. Young, Manager of Aeronautics Department, Goodyear Tire & Rubber Co., Akron, Ohio. Subject: **Lighter-than-Air Transportation.** Description of the construction of the Airship "Akron." Attendance 79.

Dec. 7.—Dinner meeting at Memorial Hall, Thorold. Speakers: Messrs. A. H. Harkness, M.E.I.C., and H. Hellmuth. Subject: covered application to coming Session of Legislature for proposed amendment to Professional Engineer's Act, 1922. Attendance 29.

MEMBERSHIP

	At end 1929	*At end 1930*	*At end 1931*	*Loss*	*Gain*
Members	20	20	18	2	..
Associate Members	70	69	70	..	1
Junior "	17	16	9	7	..
Student "	24	14	12	2	..
Branch Affiliate Members	20	17	20	..	3
	151	136	129		

This decrease in membership calls for some very energetic work on the part of not only the Executive, but every member of the Branch.

Death caused part of this decrease. Our most serious loss was the death of our late Secretary-Treasurer, R. W. Downie, A.M.E.I.C., on January 23rd.

FINANCIAL STATEMENT
(January 1st to December 31st, 1931)

Receipts

Balance on hand		$143.12	
Rebates		198.30	
Branch news		35.95	
Proceeds meetings		212.25	
Branch Affiliate fees		97.00	
Miscellaneous—Ex. on cheques	$ .15		
Hamilton Branch	3.00		
		3.15	
Bank interest		1.07	
Bank loan		100.00	
			$790.84

Expenditures

Telephone	$ 7.05	
Telegrams	4.26	
Expenses meetings	319.85	
Printing and stationery	58.00	
Stamps and post cards	31.30	
Flowers	35.97	
Journal subscription	40.00	
Stenographic services	6.00	
Late Secretary's honorarium	100.00	
Bank Loan	100.00	
Bank discount	1.25	
Bank balance, December 31	87.16	
		$790.84

Respectfully submitted,
WALTER JACKSON, M.E.I.C., *Chairman.*
PAUL E. BUSS, A.M.E.I.C., *Secretary-Treasurer.*

Ottawa Branch

To the President and Council,—
Gentlemen:

On behalf of the Managing committee of the Ottawa Branch we beg to submit the following report for the calendar year 1931.

During the year the Managing committee held seven meetings. In addition, the Branch held sixteen luncheons, three evening meetings and four visits of inspection.

An event of outstanding importance was the formation of an Aeronautical section of the Ottawa Branch, the object of this section being to bring together those engaged or interested in aeronautics and to promote the dissemination of information dealing with aeronautics and allied subjects and also to promote a close liaison with the Royal Aeronautical Society in Great Britain. The membership roll of this section contains 186 names, including 56 corporate members of The Institute, 12 technical members of the Royal Aeronautical Society and 118 affiliates who are not otherwise connected with The Engineering Institute of Canada. During the year ten meetings were held.

It is with deep regret that we report the loss, through death, of one member, G. F. Richan, M.E.I.C., and one branch affiliate, Dr. Adam Shortt.

PROCEEDINGS AND PUBLICITY

During the year sixteen luncheons, three evening meetings and four visits of inspection were held as follows:—

Jan. 8.—Annual Meeting, Chateau Laurier.

Jan. 15.—**A Visit to South Africa** by Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines; luncheon meeting at the Chateau Laurier.

Jan. 29.—**Engineering Methods of Former Days** by Lt.-Col. D. S. Ellis, M.A., M.C.E., D.S.O., A.M.E.I.C., Head of Hydraulics Dept. of Queen's University; luncheon meeting at the Chateau Laurier.

Feb. 12.—**Developments in Steam Heating** by H. D. Henion, Sales Manager of C. A. Dunham Company Ltd., of Toronto; luncheon meeting at the Chateau Laurier.

Feb. 26.—**Construction and Transportation Methods in Connection with the Island Falls Power Development on the Churchill River** by N. J. Kayser, B.Sc., M.E.I.C., Director and Assistant to the 1st Vice-President of the Fraser-Brace Engineering Company; luncheon meeting at the Chateau Laurier.

Mar. 12.—**Naval Conference in the Scheme of Armament Reduction and Limitation** by Commodore W. Hose, C.B.E., R.C.N., Chief of Naval Staff; joint luncheon with the United Service Institute of Ottawa at the Chateau Laurier.

Mar. 19.—**Remuneration of Engineers** by J. L. Busfield, M.E.I.C.; evening address at the University Club.

Mar. 26.—**Structural Engineering in Some Recent Buildings** by A. H. Harkness, B.A.Sc., M.E.I.C., of Harkness & Hertzburg, Consulting Engineers, of Toronto; luncheon meeting at the Chateau Laurier.

Apr. 9.—**Corrosion of Metals** by A. Stansfield, D.Sc., A.R.S.M., F.R.S.C., M.E.I.C., Birks, Professor of Metallurgy at McGill University; luncheon meeting at the Chateau Laurier.

Apr. 23.—**Petroleum and Its Relation to our Present Day Civilization** by A. W. Sime, B.A.Sc., Technical Engineer, Imperial Oil Co., Ltd., of Toronto; luncheon address at the Chateau Laurier.

May 7.—**The New Diesel Electric Suction Dredge "General Brock"** by B. G. Flaherty, Chief Engineer of the General Dredging Contractors Ltd.; luncheon meeting at the Chateau Laurier.

May 14.—**Construction of C.P.R. Co's. Multi-Pressure Locomotive No. 8000** by W. A. Newman, Chief Mechanical Engineer of C.P.Ry. Co.; evening address at R.C.A.F. Projection Room, Jackson Bldg.

June 6.—Afternoon visit to Chats Falls Power Development.

Sept. 17.—Address by Sir Alexander Gibb, C.B.E., C.B., F.R.S.E., M.I.C.E., formerly Consulting Engineer to British Admiralty for naval base at Singapore, in Canada making survey of the national ports on behalf of the federal government; luncheon meeting at the Chateau Laurier.

Oct. 2.—**Engineering Institute of Canada** by S. G. Porter, B.A., B.S., M.E.I.C., President of the E.I.C.; luncheon meeting at the Chateau Laurier.

Oct. 8.—**The Ontario Association of Professional Engineers** by A. H. Harkness, M.E.I.C., President of Ontario Assocation of Professional Engineers, and H. Hellmuth; luncheon meeting at the Chateau Laurier.

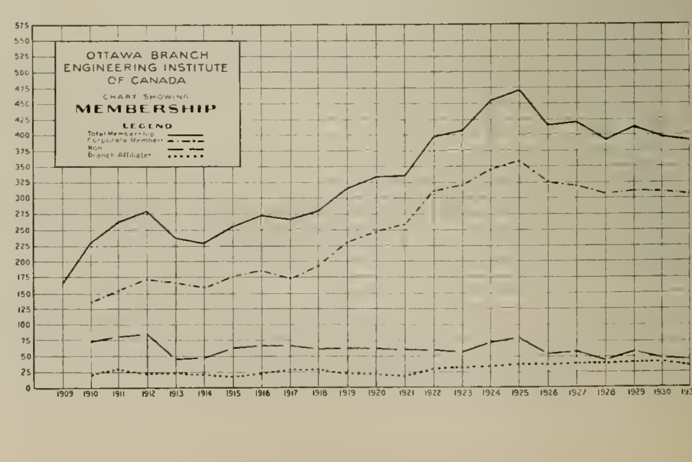
Oct. 13.—Tour of inspection of Fuel Research and Ore Dressing Laboratories of the Department of Mines, Ottawa.

Oct. 22.—**Engineering a Total Solar Eclipse** by R. Meldrum Stewart, M.E.I.C., Director of the Dominion Observatory, Ottawa; luncheon meeting at the Chateau Laurier.

Oct. 24.—Evening visit to the Dominion Observatory.

Nov. 12.—**The Diesel Ferry "Prescotont"** by Walter Lambert, M.E.I.C., M.I.N.A., senior partner of the firm Lambert & German, Consulting Naval Architects, Montreal, and J. W. Hughes, Electrical Engineer, Eastern Lines C.P.Ry.; luncheon meeting at the Chateau Laurier.

Nov. 26.—**The Northwest Frontier of India** by Major G. R. Turner, A.M.E.I.C., Asst. Director of Engineer Services, Dept. of National Defence, Ottawa; luncheon address at Chateau Laurier.



Dec. 10.—**The City of Ottawa Rapid Sand Water Purification Plant** by W. E. MacDonald, Water Works Engineer for Corporation of City of Ottawa; luncheon meeting at the Chateau Laurier.

Dec. 12.—Tour of inspection of the City of Ottawa Rapid Sand Water Purification Plant at Lemieux Island.

The average attendance at the luncheon meetings was 89, at the evening meetings (including the Annual Meeting) 78, and at the visits of inspection 120.

MEMBERSHIP

Owing to death, resignation and members removed from the roll the membership shows a decrease of three for the year. The membership of the Branch from 1909 to date is shown on the accompanying chart.

The following table shows in detail, the comparative figures of the Branch membership for the years 1929, 1930 and 1931:—

	1929	*1930*	*1931*
Honorary Members	1	1	1
Members	108	107	103
Associate Members	204	202	205
Affiliates of Institute	7	4	4
Juniors	24	17	17
Students	27	22	24
Branch Affiliates	41	40	36
Total	412	393	390

ROOMS AND LIBRARY

For several years the Branch library has been located on the third floor of the Stephen building. Owing to the fact that this space is no longer available, it has been found necessary to place the books in storage for the time being until other arrangements can be made.

ADVERTISING IN THE JOURNAL

Commissions due for advertising in the Journal during 1931 amounted to $28, which is equivalent to the rebates from fourteen associate members.

FINANCES

The attached financial statements shows the steady growth of the Branch with a credit balance of $108.52 of revenue over expenditure for the year. It will be noticed, however, by comparison with the previous year's statement of assets, that there is a reduction of $52.84. This is due mainly to the sale of furniture for $20 which was nominally valued at $80.

The Branch closed the year with a balance of $741.96 in the bank, $8.97 cash on hand and $1,000 in Victory Bonds, a total balance of $1,750.93. In addition to this balance the Branch has assets of $15.90 in rebates due from the main Institute, $28 in commissions due for advertising in The Journal and $121 in equipment, etc., making a total of $1,915.83. The accompanying chart shows the financial standing of the Branch from 1910 to date.

OFFICERS FOR 1932

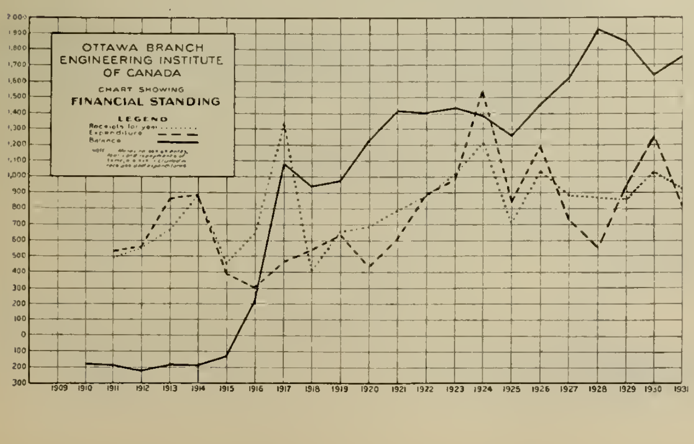
The Annual Meeting of the Branch will be held in Ottawa on the 14th January when the officers and members of the Managing committee for 1932 will be elected.

FINANCIAL STATEMENT

(Year ending December 31, 1931)

Receipts

Balance in bank, Jan. 1, 1931	$ 629.10	
Cash on hand, Jan. 1, 1931	13.31	
Interest on Victory Bonds	52.50	
Bank interest	16.73	
Rebates from Main Institute, Dec., 1930	29.50	
" " " " Jan. to Apr., 1931	456.80	
" " " " May to Aug., 1931	65.90	
" " " " Sept. to Nov. 1931	34.90	
" " " " Branch News, Jan. to Apr., 1931.	36.32	
Rebates from Main Institute, Branch News, May to Aug., 1931	24.89	
" " " " Sept. to Dec., 1931	24.08	
" " " " Advertising, 1930.	95.76	
Branch Affiliates fees	66.00	
Proceeds from sale of luncheon tickets	707.25	
Proceeds from sale of furniture	20.00	
Refund from Ball committee	10.43	
Refund from United Service Institute (share of luncheon expenses)	75.00	
Refund from 1930 Proceedings committee	.50	
		$2,358.97



Expenditures

Chateau Laurier, Annual Meeting	$ 45.00	
Chateau Laurier, Luncheon	1,175.75	
University Club—rent of room	7.00	
Advance to Ball committee	100.00	
Board of Trade Membership fee	15.00	
Advance to Proceedings committee (1931)	5.00	
Advance to Aeronautical Section, E.I.C	10.00	
Subscription to Engineering News Record	5.15	
Subscription to Engineering Journal	6.15	
Contribution to Plenary Meeting of Council	25.00	
Printing, stationery, etc	20.60	
Petty cash, postage, etc	150.89	
Sundries, entertainment, etc	42.50	
Balance in bank, Dec. 12, 1931	741.96	
Cash on hand, December 12, 1931	8.97	
		$2,358.97

Assets

Stationery and equipment	$ 20.00	
Library—		
Book cases (cost $105) (nominal)	75.00	
Bound Magazines (nominal)	1.00	
Books (nominal)	25.00	
Rebates due from Main Institue on 1931 fees	15.90	
Rebates due from Main Institute for advertising 1931	28.00	
Victory Bonds due November 1, 1934	500.00	
" " " October 15, 1943	500.00	
Cash in bank	741.96	
Cash on hand	8.97	
		$1,915.83

Liabilities

Surplus	$1,915.83	
		$1,915.83

Audited and found correct: JOHN MCLEISH, M.E.I.C.

G. J. DESBARATS, *Chairman.*

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

Peterborough Branch

The President and Council,—

On behalf of the Executive committee of the Peterborough Branch, we have the honour to submit the following report covering the activities of the Branch during the year 1931.

MEETINGS AND PAPERS

Jan. 8.—**Exploration in Northern Canada** by Major L. T. Burwash, M.E.I.C., of the Northwest Territories Branch, Department of the Interior, Ottawa.

Jan. 22.—**Research Problems in General** by Dr. O. W. Ellis, Director of Metallurgical Research, Ontario Research Foundation, Toronto.

Feb. 13.—**Some Municipal Works of Water Supply and Sewage Treatment under Construction** by William Gore, M.E.I.C., of Gore, Nasmith and Storrie, Consulting Engineers, Toronto.

Feb. 26.—**Radio Communication and Aids to Navigation** by Commander C. P. Edwards, A.M.E.I.C., Director of Radio Service, Department of Marine, Ottawa.

Mar. 12.—STUDENTS PAPERS:

Synchronized Sound on the Screen by H. Ainsworth.

Photoelectric Cells—Theory and Application by T. L. Woodhall, S.E.I.C.

Selectivity Without Distortion Using Band Pass Filters by H. E. Barnett, Jr.E.I.C.

Mar. 26.—**Automobile Body Designs** by Mr. R. L. Kelly, General Motors, Oshawa.

Apr. 9.—**Metal Enclosed Switchgear** by F. Kunst, S.E.I.C., Switchboard Engineering Department, Canadian General Electric Company, Peterborough.

Apr. 23.—**Manufacture of Refractories** by Mr. E. Rigby, Canadian General Electric Company, Peterborough.

May 7.—**Annual Meeting**—Reports of Committees, Election of Officers.

Sept. 12.—**Annual Picnic** at the Rotary Camp, Clear Lake.

Oct. 8.—**Water Supply and Sewage Disposal from a Medical Viewpoint** by Dr. N. H. Sutton, District Officer of Health, Peterborough.
Oct. 22.—**Long Distance Telephonic Communication** by Mr. H. A. Wilson and Mr. H. H. P. Johnston, of the Bell Telephone Company of Canada, Peterborough.
Nov. 12.—**Romance of Transportation** by Lieutenant Colonel F. Chappell, Plant Manager, General Motors Corporation of Canada, Oshawa (read by B. Ottewell, A.M.E.I.C., in Lieutenant Colonel Chappell's unavoidable absence due to illness).
Nov. 17.—**Annual Dinner**—Empress Hotel, Peterborough.
Dec. 10.—**Canadian Pacific Railway—New No. 8000—High Pressure Locomotive** by Mr. W. A. Newman, Chief Mechanical Engineer, of the Canadian Pacific Railway Company.

Average attendance, including guests, at Branch Meetings—40.

Two somewhat radical departures from the ordinary type of branch meeting were attempted during the year. The first meeting, January 8th, addressed by Major L. T. Burwash, M.E.I.C., was held in the Collegiate Auditorium. The talk on Exploration in Northern Canada was illustrated with films and lantern slides and was open to the public. The attendance was approximately 800.

The last meeting of the year, December 10th, consisted of the showing of a number of reels of film, demonstrating the principles of operation and showing the construction of the Canadian Pacific Railways' new No. 8000 locomotive. These pictures were shown at the Capitol Theatre by the courtesy of the management, in conjunction with the regular show. Following the show Mr. Newman gave a further account of the development and answered a large number of questions. The attendance at the theatre and at the meeting was approximately 54.

Brigadier-General C. H. Mitchell, C.B., C.M.G., C.E., D Eng., M.E.I.C., Dean of the Faculty of Applied Science of the University of Toronto, gave a very timely address on the occasion of the Annual Dinner, the subject being "The Significance of Canada's Resources." Eighty-two attended the dinner.

The following were elected to the Branch Executive for the year 1931:

Chairman........................A. B. Gates, A.M.E.I.C.
Secretary........................F. G. A. Tarr, S.E.I.C., (W. F. Auld, Jr.E.I.C.)
Treasurer........................B. Ottewell, A.M.E.I.C.
Executive........................A. E. Caddy, M.E.I.C.
P. P. Westbye, M.E.I.C.
A. L. Killaly, A.M.E.I.C.
B. L. Barns, A.M.E.I.C.
R. C. Flitton, A.M.E.I.C.
H. R. Sills, Jr.E.I.C.
Ex-officio........................R. L. Dobbin, M.E.I.C.
W. E. Ross, A.M.E.I.C.

Membership

	Jan. 1 1929	Jan. 1 1930	Jan. 1 1931
Members	20	18	15
Associate Members	31	30	34
Juniors	20	20	19
Students	30	23	19
Branch Affiliates	25	17	15
Total	126	108	102

Financial Report
(For year ending December 31, 1931)

Receipts

Bank balance, January 1, 1931	$ 86.70	
Rebates on fees	156.30	
Journal news	34.09	
Affiliate fees	41.00	
Picnic surplus	16.00	
Annual Dinner receipts	134.00	
Bank interest	4.55	
		$472.64

Expenditures

Rent	$ 65.00	
Printing	65.70	
Meetings and speakers	33.48	
Affiliate Journal subs	24.95	
Annual Dinner expense	149.36	
Flowers	10.00	
Secretary's expenses	6.02	
Presentation (W.E.R.)	8.15	
Sundry	5.85	
Bank balance, Dec. 31, 1931	104.13	
		$472.64

Auditor: E. R. Shirley, M.E.I.C.
B. Ottewell, A.M.E.I.C., *Treasurer.*

Respectfully submitted,
A. B. Gates, A.M.E.I.C., *Chairman.*
W. F. Auld, Jr.E.I.C., *Secretary.*

Quebec Branch

The President and Council,—

The Executive committee of the Quebec Branch begs to submit the following report for the year 1931:

Membership

	Residents	Non-Residents
Honorary Members	1	..
Life Members	3	1
Members	13	..
Associate Members	57	7
Juniors	9	3
Students	11	2
Affiliate Members	1	2
	95	15

Annual Meeting

The Annual Meeting of the Branch took place on June 15th and was presided over by S. L. de Carteret, M.E.I.C., chairman of the Branch for the year 1930-31.

Ballot returns favoured the following officers for the year 1931-32:

Honorary Chairman for Life........A. R. Decrary, D.A.Sc., M.E.I.C.
Chairman........................Hector Cimon, M.E.I.C.
Vice-Chairman....................Alexandre Larivière, A.M.E.I.C.
Secretary-Treasurer................Marc Boyer, S.E.I.C., Quebec Bureau of Mines, Quebec.
Executive Committee..............Philippe Méthé, A.M.E.I.C.
Louis Beaudry, A.M.E.I.C.
T. F. J. King, A.M.E.I.C.
J. G. O'Donnell, A.M.E.I.C.
L. C. Dupuis, A.M.E.I.C.
Ex-officio (Past Pres. Branch).....S. L. de Carteret, M.E.I.C.
Ex-officio (Past Pres. Branch).....A. B. Normandin, A.M.E.I.C.
Ex-officio (Vice-Pres. E.I.C.)......W. G. Mitchell, M.E.I.C.

Branch Activities

During the year 1931 the Executive committee held twelve meetings:

In addition the Branch held, during the year, five luncheon and four evening meetings, as follows:

Jan. 20.—Luncheon-meeting. **Water Power and Industrial Prosperity** by R. O. Sweezey, M.E.I.C., of the Beauharnois Power Corporation.
Mar. 2.—Luncheon-meeting. **The Saguenay Stream Diversion at the Chute-à-Caron Power Development** by C. P. Dunn, M.E.I.C., Chief Engineer, Alcoa Power Company Limited.
Mar. 11.—Luncheon-meeting. **The Quebec Tunnel** by Colonel Daniel Hillman, D.S.O., M.E.I.C., Engineer of Construction, Canadian Pacific Railways.
Mar. 23.—Evening meeting. **New Tendencies in American University Education** by Professor James L. Tryon of Massachusetts Institute of Technology.
Apr. 13.—Evening meeting. Visit to the Jean Talon vaults at the Boswell Brewery and lecture by Hector Cimon, M.E.I.C., of Price Bros. and Co. Limited, on **The French Regime under Jean Talon.**
Apr. 17.—Luncheon-meeting. **Quay Wall Construction and Design** by Louis Beaudry, A.M.E.I.C., Engineer of the Quebec Harbour Commission.
Sept. 28.—Luncheon-meeting. Address by the President of The Institute, Sam G. Porter, M.E.I.C.
Oct. 26.—Banquet in honour of Alex. Larivière, A.M.E.I.C., vice-chairman of the Quebec Branch, on the occasion of his appointment as a member of the Quebec Public Service Commission.
Dec. 14.—Evening-meeting. **L'Alaska et l'Ouest Canadien vus par un Ingénieur** by Philippe Méthé, A.M.E.I.C., Director of the Ecole Technique de Québec. This lecture was preceded by a visit to the Ecole Technique, where the meeting took place.

Financial Statement

Receipts

Cash in bank, January 1, 1931	$210.53	
Interest	2.92	
Rebates	215.10	
Branch News	21.20	
		$449.75

Expenditures

Stamps, stationery, etc.	$ 24.25
Meetings	151.26
Stenographic services	12.00

Printing	46.86	
Honorarium to Secretary	100.00	
		$334.37
Cash in Bank, January 1, 1932		115.38
		$449.75

Respectfully submitted,
MARC BOYER, S.I.E.C., *Secretary-Treasurer.*

Quebec Branch

Au Président et au Conseil:

Le Conseil de la section de Québec a l'honneur de vous soumettre son rapport pour l'année 1931, comme suit:—

RÔLE DES MEMBRES

	Résidents	Non Résidents
Membres honoraires	1	..
Membre à vie	3	1
Membres	13	..
Membres associés	57	7
Juniors	9	3
Membres étudiants	11	2
Membres affiliés	1	2
	95	15

ASSEMBLEE ANNUELLE

L'assemblée annuelle de la Section de Québec eut lieu le 15 juin sous la présidence de Monsieur S. L. de Carteret, M.I.E.C., président pour l'année 1930-31.

Les officiers suivants furent élus pour l'année 1931-32:—

Président honoraire à vie	A. R. Décary, D.Sc., M.E.I.C.
Président	Hector Cimon, M.E.I.C.
Vice-Président	Alex. Larivière, A.M.E.I.C.
Secrétaire-trésorier	Marc Boyer, S.E.I.C., Service des Mines, Québec.
Conseillers	Philippe Méthé, A.M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
	F. T. J. King, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.
	L. C. Dupuis, A.M.E.I.C.
Ex-officio (anc. prés. Québec)	A. B. Normandin, A.M.E.I.C.
Ex-officio (anc. prés., Québec)	S. L. de Carteret, M.E.I.C.
Ex-officio (Vice-prés. E.I.C.)	W. G. Mitchell, M.E.I.C.

RAPPORT DES ACTIVITES

Il y eut douze réunions des membres du Conseil durant l'année 1931, en plus de neuf conférences et déjeuners-causeries qui se résument comme suit:—

Le 20 janvier.—Déjeuner-causerie. M. R. O. Sweezey, M.E.I.C., de la Beauharnois Power Corporation. M. Sweezey mesure la prospérité de notre pays et de notre province en particulier à ses immenses ressources hydrauliques.

Le 2 mars.—Déjeuner-causerie. M. C. P. Dunn, M.E.I.C., Ingénieur-en-chef de l'Alcoa Power Company, donne une intéressante causerie sur le harnachement du Saguenay à la Chute-à-Caron.

Le 11 mars.—Déjeuner-causerie. Le Colonel Daniel Hillman, D.S.O., M.E.I.C., Ingénieur en construction pour le Canadian Pacific Railways, nous décrit comment s'est réalisé le projet du tunnel de Québec.

Le 23 mars.—Conférence par le Professeur James L Tryon du Massa chusetts Institute of Technology sur les tendances modernes de l'enseignement universitaire américain.

Le 13 avril.—Visite des voûtes de Jean Talon à la Brasserie Boswell et causerie par M. Hector Cimon, M.E.I.C., sur "Le Régime français au Canada sous l'Intendant Talon."

Le 17 avril.—Déjeuner-causerie. M. Louis Beaudry, A.M.E.I.C., ingénieur à la Commission du Hâvre de Québec, traite du calcul et de la construction des quais du nouveau port de Québec.

Le 28 septembre.—Déjeuner-causerie. Hôte d'honneur M. Sam G. Porter, M.E.I.C., Président de l'Engineering Institute of Canada, en visite officielle des Branches de l'Est de l'Institut.

Le 26 octobre.—Banquet offert à M. Alex. Larivière, A.M.E.I.C., Vice-Président de la Section de Québec, à l'occasion de sa nomination comme Membre de la Commission des Services Publics.

Le 14 décembre.—Conférence de M. Philippe Méthé, A.M.E.I.C., Directeur de l'Ecole Technique de Québec, "L'Alaska et l'Ouest Canadien vus par un Ingénieur." La conférence était précédée par une visite de l'Ecole Technique.

RAPPORT FINANCIER

Recettes

En caisse au 1er janvier 1931	$210.53	
Intérêt sur dépôt	2.92	
Remises du Bureau-Chef	215.10	
Nouvelles	21.20	
		$449.75

Déboursés

Timbres, papeterie, etc	$ 24.25	
Réunions	151.26	
Sténographie	12.00	
Impression	46.86	
Gratification au Secrétaire	100.00	
	$334.37	
En caisse au 1er janvier 1932	115.38	
		$449.75

Respectueusement soumis,
MARC BOYER, *Secrétaire.*

Saguenay Branch

The President and Council,—

On behalf of the Executive committee of the Saguenay Branch of The Engineering Institute of Canada, we beg to submit the following report covering the activities of the Branch for the calendar year 1931.

MEMBERSHIP

During the year our membership roll has changed considerably. We have been unfortunate in losing eighteen of our members, the great portion of whom were engineers employed by the Alcoa Power Company on the Chute à Caron dam, a project which has now been completed.

On January 31, 1931, the Branch was deeply grieved by the sudden death of P. E. M. Rosenorn, A.M.E.I.C., who had been an active member of this Branch since its inauguration in 1923.

The additions to our membership number only four, making a net loss of fourteen. The following table gives a comparison between the present membership and that of a year ago.

	Dec. 1930	Dec. 1931
Members	6	5
Associate Members	25	18
Junior Members	7	5
Student Members	11	7
Total	49	35

FINANCIAL STATEMENT
(As at December 31, 1931)

Receipts

Balance on hand December 31, 1930	$264.14	
Total rebates from Headquarters	101.73	
		$365.87

Expenditures

Printing, stationery and postage	$ 25.81	
Meeting expenses	15.40	
Miscellaneous expenses	15.57	
Donation to Plenary Meeting Fund	25.00	
Total Disbursements	$ 81.78	
Balance on hand	284.09	
		$365.87

BRANCH MEETINGS

On May 22nd, 1931, the Branch held its first meeting after the winter season at the offices of the Aluminum Company of Canada at Arvida.

The speaker was Dr. Charles A. Sanky, a member of the Research Department of Price Brothers and Company Limited. The subject chosen was rather out of the ordinary, and for that reason proved to be very interesting. Dr. Sankey gave the meeting a very good description of the work now going on among astrologists and metallurgists. He described the modern methods of calculating the age of the earth, the distances between the earth and the various planets and the method used in determining the composition of these planets.

The annual general meeting of the Branch was held at Kenogami on September 29th, 1931.

The election of officers for the year 1931 took place at this meeting and resulted as follows:

Chairman	J. F. Grenon, A.M.E.I.C.
Vice-Chairman	N. F. McCaghey, A.M.E.I.C.
Secretary-Treasurer	W. P. C. LeBoutillier, Jr.E.I.C.
Executive Committee	G. F. Layne, A.M.E.I.C.
	J. W. Ward, A.M.E.I.C.
	F. W. Bradshaw, A.M.E.I.C.
	J. Joyal, A.M.E.I.C.

We were most fortunate in having as our guest speaker the president of The Institute, S. G. Porter, M.E.I.C.

Mr. Porter reviewed the aims and object of The Institute, and gave the meeting some very valuable suggestions regarding the organization and operation of the smaller branches of The Institute.

Respectfully submitted,
J. F. GRENON, A.M.E.I.C., *Chairman.*
W. P. C. LEBOUTILLIER, JR.E.I.C., *Secretary-Treasurer.*

Saint John Branch

The President and Council,—

Following is the Annual report of the Saint John Branch for the year ending December 31st, 1931:

Executive Committee

During the year the Branch Executive committee met fourteen times. The personnel at this date is as follows:—

Chairman	J. N. Flood, A.M.E.I.C.
Vice-Chairman	A. A. Turnbull, A.M.E.I.C.
Secretary-Treasurer	G. H. Thurber, A.M.E.I.C.
Executive	G. A. Vandervoot, A.M.E.I.C.
	V. S. Chesnut, A.M.E.I.C.
	J. T. Turnbull, A.M.E.I.C.
(*Ex-officio*)	A. R. Crookshank, M.E.I.C.
	W. J. Johnston, A.M.E.I.C.

Standing Committees

Chairmen of standing committees of the Branch are as follows:—

Programme and Meetings	The Branch Executive
Entertainment	G. G. Murdoch, M.E.I.C.
Employment	J. A. W. Waring, A.M.E.I.C.
Membership	The Branch Executive
Policy	The Branch Executive
Salaries	G. N. Hatfield, A.M.E.I.C.
Publicity	C. G. Clark, S.E.I.C.
Natural Resources and Engineering Industries	Professor A. F. Baird, M.E.I.C.
Auditors	To be appointed.

Branch Meetings

During the year, Branch Meetings were held as follows:—

Jan. 22.—A joint Dinner Meeting with the Association of Professional Engineers of the Province of N.B. Speaker: Professor H. W. McKiel, M.E.I.C., of Mount Allison University. Subject: **The Autobiography of the Earth.**

Feb. 19.—Speaker: Capt. A. F. Ingram. Subject: **Air Transportation.**

Mar. 19.—Speaker: Dr. W. J. Wright, Provincial Geologist. Subject: **Experiences of an Oil Geologist in India.**

Apr. 16.—Joint Inspection Trip to Newcastle Creek with the Engineering Society of the University of New Brunswick to view the power plant under construction for the New Brunswick Power Commission.

May 5.—Annual Meeting held at the Riverside Golf and Country Club.

Sept. 24.—S. G. Porter, M.E.I.C., President of The Institute, visited the Branch. An informal dinner was held at the Admiral Beatty hotel, following which Mr. Porter spoke to the Members generally regarding the relations of the Branches with their Profession.

Nov. 5.—A Cabaret Dinner dance was held at the Admiral Beatty hotel.

Dec. 3.—Speaker: W. R. Pearce, M.E.I.C. Subject: **Impressions of South America.**

Membership

The following is a statement of the membership, as at December 31st, 1931:—

	Branch Residents	*Branch Non-Residents*	*Total*
Members	13	5	18
Associate Members	29	14	43
Juniors	3	3	6
Students	14	10	24
Affiliates	1	..	1
			92

The total membership at the end of 1930 was 75, making a net gain of 17 for the year 1931. Part of this gain was, however, due to the temporary employment within the Branch district of several members who may in the ensuing year be transferred to other Branches.

Financial Statement

(Year ending December 31st, 1931)

Assets

Balance in Bank—December 31, 1931	$246.68	
Rebates due from H.Q. for Dec. 1930	7.20	
		$253.88

Liabilities

Outstanding Accounts	$ 6.00	
Surplus at Dec. 31st, 1930	247.88	
		$253.88

Receipts

Balance in bank, Dec. 31st, 1930	$210.68	
Rebates from H.Q. for Dec. 1930	5.40	
Rebates, January to April, 1931	93.60	
Rebates, May to August, 1931	11.10	
Rebates, September to November 1931	5.10	
Branch News, $17.26, $10.66, $4.74	32.66	
		$358.54

Expenditures

Stamps, Post Cards, etc	$ 18.39		
Printing	52.47		
Meeting	36.00		
Miscellaneous (flowers)	5.00		
		$111.86	
Balance in bank, Dec. 31, 1931		246.68	
			$358.54

Respectfully submitted,

J. N. Flood, A.M.E.I.C., *Chairman.*
G. H. Thurber, A.M.E.I.C., *Secretary-Treasurer.*

St. Maurice Valley Branch

Le Président et Conseil,—

Nous avons l'honneur de vous soumettre le rapport des opérations de la branche de la Vallée du St-Maurice de l'Institut des Ingénieurs du Canada pour l'année 1931.

La branche n'a tenu qu'une seule assemblée durant l'année 1931, au Cascade Inn, à Shawinigan Falls.

C'était à l'occasion de la visite de M. S. G. Porter, M.E.I.C., qui après avoir assisté à l'assemblée plénière du conseil général à Montréal, les 21, 22 et 23 septembre 1931, en était venu à la conclusion que comme Président de l'Institut, il se devait de visiter les branches de l'Est.

M. Porter arriva à Shawinigan Falls par le Canadien Pacifique, vers les 3.35 hres mercredi le 30 septembre.

Il fut reçu par le Président de la branche, M. Ellwood Wilson, M.E.I.C. Après la visite des industries de la progressive ville de Shawinigan Falls, un dîner lui fut offert, auquel assistaient pratiquement tous les membres de la profession du génie civil de la Vallée du St-Maurice.

Le lendemain, il allait visiter sur invitation du Président de la branche locale, la ville de Grand'Mère.

Le bureau de direction de la branche de la Vallée du St-Maurice pour l'année 1931 fut composé de M.M. Ellwood Wilson, M.E.I.C., comme président; Henri Dessaulles, M.E.I.C., de Shawinigan Falls, comme conseiller; A. A. Wickenden, A.M.E.I.C., de Trois-Rivières, comme conseiller, et Bruno Grandmont, M.E.I.C., de Trois-Rivières, comme conseiller.

M. Roméo Morrissette, A.M.E.I.C., ingénieur conseil de Trois-Rivières a été maintenu en ses fonctions de Secrétaire-Trésorier.

M. J. A. Bernier, A.M.E.I.C., gérant de la Ville de Grand'Mère a été appointé sur le comité des Nominations.

Quoique la branche n'ait eu qu'une seule assemblée et qu'elle soit l'une des plus petites branches au Canada, elle finit ses opérations financières avec un surplus de $59.38.

La branche de la Vallée du St-Maurice se compose d'ingénieurs établis à Trois-Rivières, Cap-de-la-Madeleine, Grand'Mère, Shawinigan Falls et dans le district du St-Maurice.

Les assemblées sont toujours très enthousiastes et elles ne sont pas tenues mensuellement, parce que le percentage des présences était difficilement maintenu.

Le tout humblement soumis,

Ellwood Wilson, M.E.I.C., *Président.*
Romeo Morrissette, *Secrétaire.*

Saskatchewan Branch

The President and Council,—

On behalf of the Branch Executive we beg to sumit the following report covering the activities of the Saskatchewan Branch for the calendar year 1931.

Membership

The membership of the Branch shows an increase of two over last year with the usual fluctuations due to transfers, etc.

The present membership of the Branch is:

	Branch Residents	*Branch Non-Residents*	*Total*
Members	6	11	17
Associate Members	46	34	80
Juniors	3	7	10
Students	2	15	17
Affiliates	1	..	1
Branch Affiliates	5	..	5
Total	63	67	130

Executive Committee

The present Executive was elected on March 21st at the Branch Annual meeting and with those continuing in office is as follows:

Chairman	D. A. R. McCannel, M.E.I.C.
Vice-Chairman	J. D. Peters, A.M.E.I.C.
Secretary-Treasurer (Acting)	Stewart Young, A.M.E.I.C.

Executive—2 years	W. H. Hastings, A.M.E.I.C.
	G. M. Williams, A.M.E.I.C.
	Stewart Young, A.M.E.I.C.
1 year	J. M. Campbell, A.M.E.I.C.
	D. A. Smith, A.M.E.I.C.
	R. A. Spencer, A.M.E.I.C.
	W. G. Worcester, M.E.I.C. (Past Chairman)
	C. J. MacKenzie, M.E.I.C. (Councillor)
Auditors	O. Inkster, A.M.E.I.C.
	C. D. Lill, A.M.E.I.C.

COMMITTEES

Chairmen of the standing committees are:

Papers and Library	C. D. Lill, A.M.E.I.C.
Legislation	P. C. Perry, A.M.E.I.C.
Nominating	A. P. Linton, A.M.E.I.C.

MEETINGS

The Executive held eight meetings for the transaction of Branch affairs. There were four regular meetings of the Branch and two special meetings (ladies nights). The regular meetings in all cases were preceded by a dinner at which the average attendance was thirty-six. The general interest in the meetings has been satisfactory.

We regret to record the loss, by death, of two of our members, R. W. E. Loucks, A.M.E.I.C., Regina, and E. F. Bateman, A.M.E.I.C. Saskatoon. Mr. Loucks served for several years as Branch Secretary.

The programme for the year included the following:—

Jan. 23.—Dr. H. R. Wolfe. Address on **The Work of the Research Laboratories of the General Motors.**

Feb. 13.—Dance at the Saskatchewan Hotel.

Mar. 27.—Annual meeting. W. L. Gilliland. Address on **The Financing of Canadian Engineering Projects.**

Oct. 27.—S. G. Porter, M.E.I.C., President of The Institute. Address on **Some Observations on the Engineering Profession.**

Nov. 20.—Bridge Party.

Dec. 18.—Major John Barnett. Address on **Our Undeveloped Natural Resources—A Problem and Inspiration for the Engineering Profession.**

The annual scholarship of $50 offered by the Branch to the most deserving student in engineering in the graduating class, 1931, University of Saskatchewan, was awarded to C. R. Forsberg, S.E.I.C., and D. W. Wood, S.E.I.C.

The financial statement as of date April 1st, 1931, is as follows:

Cash	$253.71	
Rebates (H. Q.)	216.90	
Printing		$101.18
Meetings	2.70	39.05
Sundries	126.19	108.00
Honorarium		267.00
Scholarship		50.00
Bank balance, 1930-31		34.27
	$599.50	$599.50

FINANCIAL STATEMENT

(April 1st, 1931 to December 31st, 1931).

Bank Balance, April 1st	$ 34.27	
Rebates from Headquarters	221.85	
Branch News	19.48	
Branch dues	8.00	
Office		$ 31.83
Meetings		24.78
Scholarship		50.00
Miscellaneous		14.50
Bank balance, December 31st, 1931		162.49
	$283.60	$283.60

Respectfully submitted,

D. A. R. McCANNEL, M.E.I.C., *Chairman.*
STEWART YOUNG, A.M.E.I.C., *Acting Secretary.*

Sault Ste. Marie Branch

To the President and Council,—

There were nine regular meetings and one trip of inspection during the year.

The meetings held and the papers given were as follows:—

Jan. 30.—**Natural Gas** by Mr. A. H. Sikes of the Great Northern Gas Co.

Feb. 27.—**Refractories** by Mr. F. B. Cornell of the Harbison-Walker Refractories Company of Pittsburgh.

Mar. 27.—**Atlantic Outports of Canada** by H. F. Bennett, A.M.E.I.C., District Engineer, Department of Public Works, Sault Ste. Marie.

Apr. 24.—Social evening and smoker.

May 29.—**Construction Features of the New Windsor Hotel** by Mr. Russell Wiber of the firm McLartys, Harten and Wiber.

June 26.—Paper by Mr. H. F. Coon of the Alexander Murray Co., Toronto, on **Methods of Treating Roads With Tar Products.**

Aug. 15.—Visit to the dredge *Mogul* in the upper St. Marys River due to courtesy of H. F. Bennett, A.M.E.I.C.

Sept. 25.—**Dredging in the St. Marys River** by Mr. O. M. Frederick, Engineer with the United States government at Sault Ste. Marie, Mich.

Oct. 30.—**Deep Well Pumps and Well Drilling** by Mr. C. F. Layne.

Nov. 27.—**Lumbering in North America** by Mr. Lynn Hollingsworth of the Soo Lumber and Mill Co. of Sault Ste. Marie, Ont.

Dec. 18.—**Impressions of England** by C. H. Speer.

MEMBERSHIP

	Branch Resident	*Branch District*	*Total*
Members	8	10	18
Associate Members	17	31	48
Juniors	4	10	14
Students	0	10	10
Affiliates	2	1	3
Branch Affiliates	8	0	8
			101

This is a decrease of two members from last year.

FINANCIAL STATEMENT

Receipts

Balance from 1930—savings account	$222.85	
Balance from 1930—current account	120.69	
Income from H.Q. rebates	150.90	
Income from H.Q. advertising	30.00	
Income from H.Q. Branch News	35.45	
Affiliates fees	15.00	
Journal subscriptions	8.00	
Dinners	143.00	
Interest on savings	6.72	
		$732.61

Expenditures

Postage and stationery	$ 35.00	
Printing and advertising	50.17	
Gratuities and donations	25.00	
Stenographer	25.00	
Dinners	153.50	
Honorarium to Secretary	25.00	
Entertainment	25.70	
Journal subscriptions	12.00	
Exchange	.30	
Rent of Y.M.C.A.	15.00	
Telegram	.60	
Express	1.10	
Headquarters Council meeting expenses	15.00	
		$383.37
Balance in current account		119.67
Balance in savings account		229.57
		$732.61

Respectfully submitted,

A. H. RUSSELL, A.M.E.I.C., *Chairman.*
A. A. ROSE, A.M.E.I.C., *Secretary-Treasurer.*

Toronto Branch

The President and Council,—

The Executive committee of the Toronto Branch respectfully submits the following report for the calendar year 1931:—

The Executive Committee for 1931-32 which was elected at the Annual Meeting of the Branch held on April 3rd, 1931 is as follows:

EXECUTIVE COMMITTEE

Chairman	C. S. L. Hertzberg, M.E.I.C.
Vice-Chairman	J. R. Cockburn, M.E.I.C.
Secretary-Treasurer	W. S. Wilson, A.M.E.I.C.
Committee	*W. W. Gunn, A.M.E.I.C.
	*G. H. Davis, M.E.I.C.
	*R. E. Smythe, A.M.E.I.C.
	A. B. Crealock, A.M.E.I.C.
	J. W. Falkner, A.M.E.I.C.
	F. B. Goedike, A.M.E.I.C.

*Elected for a period of two years.

Ex-officio	J. J. Traill, M.E.I.C.
	J. J. Spence, A.M.E.I.C.
Councillors	L. W. Wynne-Roberts, A.M.E.I.C.
	R. B. Young, M.E.I.C.
	T. Taylor, M.E.I.C.
	T. R. Loudon, M.E.I.C.

Standing Committees

Papers	C. S. L. Hertzberg, M.E.I.C.
Finance	J. R. Cockburn, M.E.I.C.
Publicity	W. W. Gunn, A.M.E.I.C.
Membership	G. H. Davis, M.E.I.C.
Meetings	J. W. Falkner, A.M.E.I.C.
Student Relations	J. J. Spence, A.M.E.I.C.
Branch Editor	R. E. Smythe, A.M.E.I.C.

The Toronto Branch has been fortunate enough to secure the Annual General and Professional Meeting for February 3, 4 and 5, 1932, and a committee under the Chairmanship of L. W. Wynne-Roberts, A.M.E.I.C., with W. B. Dunbar, A.M.E.I.C., as Secretary has been actively at work preparing for this for some months.

The Executive committee of the Branch has held twelve meetings for the transaction of Branch business and eleven general meetings. Two joint meetings were also held, one in February with the A.I.E.E. and one in October with the A.I.E.E. and A.S.M.E. On January 7th, 8th and 9th, 1931, the Branch in conjunction with the General Contractors Association, the Ontario Association of Architects, the Portland Cement Association and the University of Toronto, held a series of three meetings on the "Design and Control of Concrete Mixtures."

For some time it has been the custom of the Branch to entertain any out-of-town speakers at dinner previous to the meeting. This policy has been continued and during the past few months all members of the Branch have been asked to come to dinner previous to the regular meetings to meet the speaker and this procedure has materially increased the attendance at the meeting. The average attendance has been about one hundred.

The various meetings for the year 1931 were as follows:—

Jan. 7, 8, 9.—**Design and Control of Concrete Mixtures** by R. S. Phillips of the Portland Cement Association of Chicago. Held in conjunction with the General Contractors Association, The Ontario Association of Architects, The Portland Cement Association and the University of Toronto.

Jan. 22.—**Grain Elevators** by C. D. Howe, M.E.I.C., of C. D. Howe & Co., Port Arthur.

Feb. 12.—**Applied Psychology in Business** by Professor S. N. F. Chant, Associate Professor of Psychology in the University of Toronto. This meeting was held jointly with the A.I.E.E.

Feb. 19.—**The Alexander Power Development on the Nipigon River** by Dr. T. H. Hogg, C.E., D.Eng., M.E.I.C., Chief Hydraulic Engineer of the Hydro-Electric Power Commission of Ontario.

Mar. 5.—**The Civil Government Activities of the Royal Canadian Air Force** by Wing Commander G. O. Johnston, Officer in Charge, Flying Operations Branch, Department of National Defence.

Mar. 19.—**Structural Engineering in Some Recent Buildings** by A. H. Harkness, M.E.I.C., of Harkness & Hertzberg, Structural Engineers, Toronto.

Apr. 3.—Annual Meeting of the Branch.

Oct. 2.—Joint meeting with A.S.M.E. and A.I.E.E. Speakers, S. G. Porter, M.E.I.C., President of The Engineering Institute of Canada, Mr. Roy V. Wright, President of the A.S.M.E., and Mr. Chubbuck, Vice-President, District No. 10, A.I.E.E.

Oct. 22.—**Army Engineering** by Colonel H. F. H. Hertzberg, C.M.G., D.S.O., M.C., General Staff Officer, M.D. No. 2.

Nov. 5.—**Telescopes and Their Work, with Special Reference to the Telescope Being Made for the Dunlap Memorial Observatory** by Professor C. A. Chant, Professor of Astro-Physics, and Professor R. K. Young, Assistant Professor of Astronomy, University of Toronto.

Nov. 19.—**The Engineer and Public Affairs** by Dr. Horace L. Brittain, Director of the Bureau of Municipal Research. A. H. Harkness, M.E.I.C., and Mr. Hellmuth of the Association of Professional Engineers of the Province of Ontario also addressed this meeting.

Nov. 26.—**The Beauharnois Power Development with Special Reference to the Problems of Power House Construction** by J. A. Knight, M.E.I.C., Designing Engineer of the Beauharnois Construction Company.

Dec. 3.—**Some Non-Technical Aspects of Telephone Engineering** by A. M. Reid, A.M.E.I.C., Division Plant Engineer of Bell Telephone Company, Toronto.

Dec. 17.—**Recent Progress in Bridge Engineering** by Professor C. R. Young, M.E.I.C., Professor of Civil Engineering, University of Toronto.

The membership of the Branch as of December 31st, 1931, is a follows:—

	Resident	*Non-Resident*	*Total*
Members	114	6	120
Associate Members	266	17	283
Juniors	57	1	58
Students	75	13	88
Affiliates	6	..	6
Branch Affiliates	2	..	2
Total 1931	520	37	557
Total 1930	530	24	554
	−10	+13	+3

It is with regret that we record thd death of C. L. Fellowes, M.E.I.C., during the past year.

Financial Statement
(For calendar year 1931)
Receipts

Bank balance at January 1st, 1931	$1,523.32	
Rebates and Branch News	729.95	
Bank interest	65.45	
Affiliate fees	20.00	
Rebate of Library insurance	5.40	
Rebate, Association of Professional Engineers	7.00	
Proceeds of sale of book cases	60.00	
		$2,411.12

Expenditures

Advertising and printing	$ 257.33	
Room rental	80.00	
Stenographic assistance	43.72	
Chairman's expenses to Annual Meeting	30.80	
Affiliate Journal fees	4.00	
Councillors expenses to Montreal	27.50	
Secretary's honorarium and expenses	171.45	
Chairman expenses	11.90	
Insurance on Library	6.75	
Contribution to H.Q. for Councillors' expenses	75.00	
Entertainment of guests and gratuities	21.15	
Flowers	20.00	
*Advance to Annual General Meeting Committee	50.00	
	$ 799.60	
Bank balance at December 31, 1931	1,611.52	
		$2,411.12

*This is part of the amount of $800.00 voted but not yet expended for the Annual General Meeting.

Respectfully submitted,

C. S. L. Hertzberg, M.E.I.C., *Chairman.*
W. S. Wilson, A.M.E.I.C., *Secretary-Treasurer.*

Vancouver Branch

The President and Council,—

We beg to submit the following report of the activities of the Vancouver Branch of The Institute for the year 1931:—

Meetings

During 1931 nine meetings of the Branch were held as outlined below:

Jan. 21.—Student Banquet.

Feb. 18.—E. V. Ablett, on **Forest and Game Conservation.**

Feb. 25.—Student Night.

Mar. 25.—J. P. Hodgson, M.E.I.C., on **Jordan River Power Plant.**

Apr. 16.—Joint Luncheon with Professional Engineers Club to welcome S. G. Porter, M.E.I.C., President of the Institute.

May 20.—R. Carter Guest on **Modern Trend in Aviation.**

Oct. 14.—J. Friend Day on **The Economic Effect of the Russian 5-Year Plan on Canada.**

Nov. 9.—P. E. Doncaster, M.E.I.C., on **Reconstruction of Wharf on Kaslo Street.**

Dec. 22.—Annual Meeting.

An effort was made during the year to present papers on general topics of interest to the members, as well as those treating of more technical subjects, and the change seems to have been beneficial as far as increasing the interest and attendance at meetings is concerned.

Executive Meetings

During the year eight meetings of the Executive were held to transact the routine business of the Branch, and to discuss matters of policy.

Walter Moberley Memorial Prize

The prize for 1931 was awarded to James W. Smith for the best essay submitted by any student in the Senior year of the Faculty of Applied Science at the University of British Columbia.

Library

It will be noted in the financial statement that the Branch during this year have repaid to Headquarters the full amount of the library loan, so that the Branch are under no further indebtedness in this regard.

The Association of Professional Engineers

The Vancouver Branch have always taken great interest in the work of The Institute Committee on relations with the Professional Engineering bodies, and during the last year the President and Councillor of the Branch have, at the request of the Association of Professional Engineers, attended all meetings of the Council of the Association. As a result they were enabled to present their views at the Plenary Meeting of The Institute Council in September and materially aided the work of The Institute along the lines of closer co-operation with the various Professional Associations.

American Institute of Electrical Engineers

During 1931 the Branch has been very fortunate in its relations with the local branch of the American Institute of Electrical Engineers. Arrangements have been completed between the two bodies relative to the rental of the Medical Dental auditorium, and it is expected that two or more joint meetings will be held in the near future, on topics of interest to both bodies.

Student Section

The Student Section of the Branch has maintained its usual activities at the University, and a banquet and joint meeting were held with the local section. In addition several papers were presented at noon hour talks by prominent engineers.

Elections

Forty-four ballots were returned out of a total of one hundred and twenty mailed.

Financial Statement

(December 29, 1930, to December 22, 1931)

Receipts

Bank balance at Dec. 29, 1930		$181.33	
Cash on hand		.50	
Rebates from H.Q. (Aug. 1930-Aug. 1931)		314.75	
Branch News		10.79	
Student Section News		2.63	
Refund—C.P.R. Telegraph		.18	
			$510.18

Expenditures

Office Expenses:			
Rent	$ 75.00		
Petty cash	3.80		
Telegrams	3.31		
Addressograph	3.67		
Stenographer	15.00		
		$100.78	
Meetings.			
Notices, etc	60.95		
Auditorium	40.50		
Screen	1.00		
		$102.45	
Student Section		11.00	
Library loan payments		125.00	
Councillor—Plenary Meeting		25.00	
Honorarium to Secretary—1930		50.00	
Balance.			
Bank balance	$125.97		
Cash in hand	6.88		
	$132.85		
Bills outstanding	36.90		
		95.95	
			$510.18

Walter Moberley Memorial Fund

Receipts

Bank balance of Dec. 1930	$ 73.65	
City of Vancouver bond interest	25.00	
Dominion of Canada bond interest	5.00	
Bank interest	2.64	
		$106.29

Expenditures

Bank charges	$ 1.00	
Bursar, University of B.C	25.00	
Bank balance, 1931	80 29	
		$106.29

Bonds Held in Trust

City of Vancouver, No. 663—5%—1964	$500.00	
Dominion of Canada No. TAO65189—5%—1943	100.00	
		$600.00

Library Capital Account

(December 22, 1931)

	Dr.	*Cr.*
By loan for Headquarters	$300.00	
By installment repaid 1927		$ 25.00
" " " 1928		100.00
" " " 1929		50.00
" " " 1931		125.00
	$300.00	$300.00

Respectfully submitted,

H. B. Muckleston, M.E.I.C., *Chairman.*
John Oliver, Jr.E.I.C., *Acting Secretary.*

Victoria Branch

The President and Council,—

Membership

The changes noticed during the past year in this branch include two members returned to Victoria after being away, one new member has come to the city and one has passed on. Three Associate Members have left us for various reasons while one new Associate Member has come to the city.

The membership now stands as follows:—

	Resident	*Non-Resident*
Members	20	1
Associate Members	23	4
Juniors	1	..
Students	6	3
Affiliates	2	..
Totals	52	8

Total Branch membership for the island, 60.

The Executive has held five meetings during the year all well attended.

In accordance with a resolution passed at the last Annual Meeting the club room in the Brown building has been closed and the books loaned to the Provincial Library in the Parliament buildings where they can be read by our members, they are in safe keeping till the Branch requires them again, the furniture has been sold and the proceeds turned into the Branch funds.

Some forty members attended the Annual Dinner held at Work Point Barracks on April 11 and enjoyed a very pleasant evening.

On June 5 a very interesting visit was made to the Canadian Explosives Limited plant on James Island, where the members were shown the manufacture of modern explosives.

Sir Charles Radcliffe, K.C.M.G., C.B., C.V.O., spoke to the members on **Photogrammetric-Three Dimensional Surveys From the Air** On October 27, when the lecturer described the new invention of Signor Nistri. Some seventy-five members and friends were present.

A. L. Carruthers, M.E.I.C., was elected as the Victoria Branch representative on the Nominating Committee.

The following officers have been elected for the coming year:—

Chairman .... Major H. L. Swan, M.E.I.C.
Vice-Chairman .... K. M. Chadwick, M.E.I.C.
Executive Committee:

Elected last year for two years and still have another year to serve: F. G. Aldous, A.M.E.I.C., and Major E. C. B. Chambers, A.M.E.I.C.

Elected this year: O. W. Smith, M.E.I.C., and H. N. Gahan, A.M.E.I.C.

Secretary-Treasurer .... I. C. Barltrop, A.M.E.I.C.

Financial Statement

Receipts

Balance in hand, December 1, 1930	$ 80.72
One Affiliate dues	3.00
Rebates on subscriptions paid to Headquarters	100.35
Branch News for year	1.05
Balance from Annual Dinner, 1930	1.00
Sale of Branch room furniture	44.90
Refund on Engineering News	3.00
	$234.02

Expenses

Rent of Branch Room, two months	$ 25.00
Electric light	1.85
Wreath	4.00
Postcards, stamps, etc	5.92
Pemberton & Son, room	2.50
Honorarium, 1929—K. M. Chadwick (Secretary)	50.00
Honorarium, 1930—K. M. Chadwick (Secretary)	50.00
Express	4.00
Annual Dinner 1931	18.99
	$162,26
Balance in hand, December 1, 1931	71.76
	$234.02

Audited and found correct,

H. F. Bourne, A.M.E.I.C.
I. C. Barltrop, A.M.E.I.C. } Auditors.

Respectfully submitted,

K. M. Chadwick, A.M.E.I.C., *Secretary-Treasurer.*

Winnipeg Branch

The President and Council,—

The following report for the year ending December 31st, 1931, is respectfully submitted.

The membership at the end of the year stood as follows:—

	Resident	Non-Resident	Total
Members	40	4	44
Associate Members	92	31	123
Juniors	10	3	13
Students	58	6	64
Affiliates	5	0	5
Branch Affiliates	12	0	12
	217	44	261

We regret to report that the corporate membership of the Branch was reduced by the death of Frank H. Martin, M.E.I.C., past chairman of the Branch, and chairman of its Nominating committee. Mr. Martin died on December 16th, 1931, after a lengthy illness.

Regular meetings of the Branch were held as follows:

Jan. 15.—**Control Surveys** by G. H. Herriot, M.E.I.C. Attendance, 40.

Feb. 5.—**Some Interesting Data Regarding Residual Frost in Northern Canada** by W. G. Chace, M.E.I.C. Attendance, 43.

Feb. 19.—**Colour** by Rt. Rev. Mgr. Morton. Attendance, 37.

Mar. 5.—**Fire Protection** by T. W. MacKay. Attendance, 40.

Mar. 19.—**Scientific Manufacturing of Steel** by J. Olafsson. Attendance, 48.

Apr. 2.—**Vitamizing Radiation** by J. W. Dorsey. Attendance, 52.

Apr. 16.—**The Seven Sisters Hydraulic Electric Power Development** by F. H. Martin, M.E.I.C., and Engineers of Northwestern Power Co. Attendance, 64.

Apr. 27.—(Special Meeting). Discussion of Paper by F. H. Martin and Associated Engineers. Attendance, 41.

Oct. 1.—**Unemployment** by F. H. Martin, M.E.I.C. Attendance, 44.

Oct. 15.—**Impact Value of Rail and Other Steels at Low Temperatures** by J. F. Cunningham. Attendance, 24.

Oct. 26.—(Special Meeting). Visit of President S. G. Porter. **The Gold Standard** by W. J. Waines. Attendance, 79.

Nov. 5.—**The Peace River Problem** by T. C. Macnabb, M.E.I.C. Attendance, 49.

Nov. 19.—**Drought and Soil Drifting in Western Canada** by T. C. Main, A.M.E.I.C. Attendance, 50.

Dec. 3.—**Electrical Equipment at the Flin Flon Mine** by Fred. A. Becker, A.M.E.I.C. Attendance, 43.

Dec. 17.—This meeting was adjourned as a mark of respect to the late F. H. Martin. No register of attendance was recorded.

Early in the year the Branch was much impressed by the criticism of engineering bodies made by A. G. Dalzell, M.E.I.C., President of the Town Planning Institute of Canada, who stated that engineers had failed to take their rightful position on public questions, and in so doing, had passed by many opportunities to be of full service to the communities in which they moved; so that many public enterprises were inadvisedly undertaken through lack of corporate constructive opinion, which engineers were particularly fitted to voice.

With this end in view, the Winnipeg Branch at the instigation of Messrs. F. H. Martin, M.E.I.C., and W. P. Brereton, M.E.I.C., called upon the Executive to make a study of what became known as the Dalzell Criticism, with the result that a Reporting committee was formed containing ten members, Mr. Martin being convenor of the Reporting committee. The duty of the Reporting committee is to bring before the Executive committee all proposed schemes of public development falling under its notice. The Executive committee then appoints Project Study committees consisting of men particularly adapted to study and report on each specific scheme. The Project Study committee then reports to the Executive committee after thorough and comprehensive study has been made of the allotted scheme. The Executive committee then convenes with the Project Study committee in question, and prepares a report to lay before the Branch. The Branch then decides whether or not it shall voice and record its corporate opinion upon the subject in question.

The problem of unemployment proved to be one which gave great scope for the activities of the Reporting committee. In this regard four Project Study committees were appointed for the purpose of suggesting to the provincial government such public works as might advisedly be undertaken for the relief of unemployment. The provincial government was requested to transmit these suggestions to the Federal government.

Financial Statement

Receipts

Bank balance, Dec. 31st, 1930	$ 319.45	
Rebates from Headquarters and Branch News payments	367.75	
Interest on Victory Loan	41.25	
Branch dues	413.50	
Journal subscriptions	30.00	
Bank interest	9.04	
Surplus from Supper Dance	7.72	
Advice from Headquarters, Credit $9.50, Dec. rebates	9 50	
		$1,198.21

Expenditures

Secretary's honorarium and Steno. allowance	$ 200.00	
Refreshments at Branch meetings	33.71	
Printing, stationery and postage	246.64	
Journal subscriptions forwarded to Headquarters	26.00	
Student prizes	80.00	
Annual Supper-Dance	200.00	
Flowers	10.00	
Circulation of "Tabloid"	10.00	
		$ 806.35
Bank Balance Dec. 31st, 1931	$ 479.34	
Credit advice from Headquarters	9.50	
	$ 488.84	
Less cheques outstanding	200.00	
	$ 288.84	
Cash on hand	103.02	
		391.86
		$1,198.21

Respectfully submitted,

CHAS. T. BARNES, A.M.E.I.C., *Chairman.*

ERIC W. M. JAMES. A.M.E.I.C., *Secretary.*

Institute Committees for 1931

FINANCE
J. L. Busfield, Chairman
W. C. Adams
F. A. Combe
T. J. Lafreniere
F. P. Shearwood

LIBRARY AND HOUSE
D. C. Tennant, Chairman
H. Massue
A. R. Roberts
E. A. Ryan
J. H. Trimingham

LEGISLATION
H. Cimon, Chairman
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H. D. Paine

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R. B. Young, Chairman
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R. S. Trowsdale
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K. L. Dawson

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J. A. McCrory, Chairman
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C. R. Lindsey
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R. O. Wynne-Roberts, Chairman
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J. M. Oxley
B. Ripley
C. E. Sisson

LEONARD MEDAL
F. W. Gray, Chairman
F. D. Adams
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S. C. Mifflen
W. S. Wilson

PLUMMER MEDAL
W. H. DeBlois, Chairman
A. C. D. Blanchard
A. A. Bowman
H. D. Cameron
G. H. Kohl

STUDENTS' AND JUNIORS' PRIZES

Zone A	H. B. Muckleston R. W. Ross N. M. Hall
Zone B	T. R. Loudon D. M. Jemmett L. W. Wynne-Roberts
Zone C (English)	W. G. Mitchell F. A. Combe J. A. McCrory
Zone C (French)	O. O. Lefebvre H. Cimon B. Grandmont
Zone D	F. R. Faulkner G. C. Torrens A. L. Hay

BOARD OF EXAMINERS AND EDUCATION
A. R. Roberts, Chairman
E. Brown
J. M. R. Fairbairn
A. Frigon
P. S. Gregory
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INTERNATIONAL CO-OPERATION
John Murphy, Chairman
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A. Surveyer
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CANADIAN ENGINEERING STANDARDS
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C. J. Mackenzie

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Brig.-Gen. C. J. Armstrong, Chairman
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BIOGRAPHIES
F. H. Peters, Chairman
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Col. A. F. Duguid

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Fraser S. Keith, Chairman
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F. R. Faulkner
E. P. Fetherstonhaugh
A. Frigon
W. J. Johnston
C. J. Mackenzie
C. H. Mitchell
J. Stephens
R. S. L. Wilson

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XV FEBRUARY 1932 No. 2

Canada's Transportation Question

Under existing social conditions, the public is apt to divide its attention among a multitude of topics of the moment, remaining only dimly conscious of some fundamental problem whose solution, in the opinion of thoughtful observers, must be found, and found without delay, if the country is to avoid very unpleasant economic consequences. Something like this seems to have happened in connection with the general question of transportation in Canada, and possibly, if hard times had not come upon us, we should still be turning a deaf ear to the people who have so long been telling us that something ought to be done about it. The real questions at issue have been obscured to some extent by clouds of propaganda, but there are now very definite signs of awakening, and the man in the street is beginning to realize the need for a plan of campaign which will put a stop to the waste resulting from our present lack of co-ordination between the various transportation agencies which operate in this country. It is becoming evident that unless a remedy is applied, our commercial and economic progress may be halted, and our present burden of taxation increased, to an indefinite extent.

The situation as it now exists has been well put by a recent speaker at a meeting of the Montreal Branch of The Institute, who pointed out that with a population of ten million people, we possess about 50,000 miles of railway, representing an investment of over $3,000,000,000. Our waterway and harbour development has cost over $600,000,000. With nearly 400,000 miles of road, of which 85,500 are surfaced, our investment in highways and motor vehicles is over $2,000,000,000. There is an ever-increasing expenditure on aviation equipment, landing fields and accessories.

All these services have developed independently, without any scientific co-ordination. The question now presses, how can the best features of each system be "utilized in combination, to procure for the people of Canada the maximum of service at the minimum of cost."

In a situation of this kind, if public opinion is to be well informed, accurate data must be presented in a shape free from any bias or tendency to favour one interest rather than another. We may ask, who is better qualified for the selection and presentation of such data, than the engineer? Accustomed to weighing the advantages and disadvantages of alternative plans, he should be among the first to give serious thought to a question such as this, involving both technical and economical considerations.

The Dominion government, in appointing the Royal Commission on Railways and Transportation, which is now sitting, has made the first real advance towards the desired goal, and its report, which will probably be presented during the coming session of Parliament, will no doubt mark out the course to be steered. But public education is required if the Commission's recommendations are to be understood and supported by public opinion, as they must be if they are to be put in effect. It is lack of such support which has caused the efforts of so many Royal Commissions to prove fruitless in the past. A measure of public interest in the subject has now been aroused by many recent articles in the daily and weekly press and by discussions at meetings of public and semi-public organizations, but much still remains to be done, and in this work The Engineering Institute is taking its share. A number of our Branches have already been active and have taken the problem as the topic of their meetings. Thoughtful addresses have been delivered, for instance, before the Hamilton and the Montreal Branches and have placed various phases of the situation before their members. They will no doubt be followed by others.

Realizing that the country's future is bound up in the proper solution of our transportation difficulties and wishing to place at the disposal of members the data necessary in the case, the Council has arranged for a discussion to be held at the forthcoming General Professional Meeting of The Institute at Toronto. One of the Technical Sessions will be entirely devoted to the presentation and discussion of papers which will deal with various aspects of this Canadian problem and attention will be directed to the statistics which bear upon them. Thus material will be available from which our members may draw their own conclusions, and which will aid them in following the report of the Royal Commission and the measures which may be taken to give effect thereto.

One of the principal topics will be the influence of the motor vehicle on Canadian transportation, and very properly so, for in the opinion of many well qualified to judge, our expenditure on highway maintenance and construction and the regulation of highway traffic are points which call for immediate consideration if our national and provincial balance sheets are not to present a dismal aspect like that now shown by the statements of our railways. The plight of the railways of course will also receive its due share of attention, and it is hoped that the whole session will aid in clearing away some of the misconceptions which are so general on the part of intelligent people who ought to be better informed on this vital matter.

Fondation George Montefiore Prize

In connection with the Institut Electrotechnique Montefiore, Liege, Belgium, there has been founded a prize, known as the "Fondation George Montefiore," awarded every three years, for the most meritorious original work presented on scientific progress, particularly in the technical application of electricity in all spheres of activity. Works which merely popularize knowledge or are mere compilations are excluded from competition for this prize.

The papers, which may be in English or French, should, of course, be printed or typewritten, and are judged by a committee of ten electrical engineers, of whom five are Belgian and five foreigners, one of the Belgian delegates being, *ex-officio*, the director of the Institut. The prize is only awarded if, in the opinion of the committee, a work of sufficient merit is submitted, although in certain circumstances the prize may be divided.

The competitor must furnish twelve copies of his paper, which are to be delivered post free to the secretary, George Montefiore Fondation, rue Saint Gilles 31, Liege, Belgium.

Papers submitted in competition, which the committee decide to have printed, are published in the Bulletin of the Association.

For the competition of 1932, the value of the prize is 21,500 Belgian francs, and the last date for the reception of papers is April 30th, 1932.

Such papers should be headed, "Travail soumis au concours de la Fondation George Montefiore, session de 1932."

Further information can be obtained from the general secretary, Institut Electrotechnique Montefiore, rue Saint Gilles, 31, Liege, Belgium.

Meeting of Council

A meeting of Council was held on Tuesday, January 19th, 1932, at eight o'clock p.m. with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and six other members of Council present.

The minutes of the meeting held on December 15th, 1931, were taken as read and confirmed.

It was noted that a number of letters had been received from members of The Institute congratulating Council on the course taken in connection with the tenders for the design of sewage disposal works called for by the city of Oshawa on a competitive basis.

The report of the Finance committee and the financial statement for the year 1931 were presented and approved.

The membership of the Nominating committee for 1932, as submitted by the various branches, was approved, and the chairman appointed.

Council also received and approved the awards of the committees dealing with the prizes and medals of The Institute.

In connection with the forthcoming visit of the Institution of Mechanical Engineers to Canada in August the Secretary was directed to organize a committee with a view of arranging for the welcome of the party by the branches of The Institute in the cities that will be visited.

The Council noted with approval a suggestion that the Twenty-fifth Anniversary of the formation of the Quebec Branch should be celebrated at a dinner to take place on February 22nd in Quebec.

A suggestion from the Saint John Branch that a General Professional Meeting should be held in Saint John in 1932 was unanimously approved.

The By-laws of the Border Cities Branch, as adopted at their annual meeting in December, were submitted and approved.

Dean C. J. Mackenzie, M.E.I.C., of Saskatoon, was re-nominated as a representative of The Institute on the Main Committee of the Canadian Engineering Standards Association.

Four resignations were accepted, six members were placed on the Suspended List, one Life Membership was granted, and two special cases were dealt with.

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

Elections		*Transfers*	
Members	1	Junior to Assoc. Member	2
Associate Members	2	Student to Assoc. Member	1
Juniors	4	Student to Junior	2
Students Admitted	33		

The Council rose at eleven o'clock p.m.

The Skilled Man

The following notes are abridged from an editorial appearing in a recent issue of *Engineering*, commenting on an address by Major F. L. Watson to the Yorkshire Branch of the Institution of Mechanical Engineers, which contains some observations which might well be taken to heart in Canada.

The article points out that continuous adjustment to changing conditions is essential to the permanent prosperity of the engineering industry, and that that industry has been handicapped by a tendency to undervalue technical skill and knowledge in comparison with executive and business ability.

The creative artist is not necessarily a good business man. Insight into scientific and mechanical principles is by no means invariably associated with the tact and restraint required in the successful management of men, but this admission seems, unfortunately, to be interpreted as implying that the very possession of technical or scientific knowledge renders a man unsuitable for any administrative post.

In many engineering and chemical establishments dating from pioneering days, the technically skilled man who brought the undertaking to prosperity was too often succeeded by someone with but little knowledge of either science or mechanics, and as men are naturally prone to magnify the importance of such qualities as they themselves possess, and to depreciate ability of a different type, the contention arose that salesmanship and business ability were the sole essentials to success. Why, the business man asked, should costly experiments be undertaken in search for improvement when the whole output could be readily marketed as it stood.

The adoption of this point of view led in many cases to the policy of purchasing improvements ready-made from abroad, rather than providing a staff competent to solve the novel problems as they arose.

Attention is directed to the prejudicial effect of this policy on certain British industries, taking as an example a certain manufacturing company which, during the past two years, has brought to Britain from Denmark the manufacture of automatic vending machines, from Holland the making of slicing machines, from Belgium the making of certain types of weighing machines, and from the United States the manufacture of vacuum cleaners.

Not a single item in the above list, says *Engineering*, necessitated the services of a genius for its design. Each of them—or rather, equally good equivalents—could quite well have been developed in Britain. A further disadvantage lies in the fact that, in many cases at least, the purchasers of foreign licenses secure only the home market, and are definitely restricted from selling abroad. The purchaser of rights to foreign patents, thus restricted, does nothing to help international trade, whilst the fees he pays (in most cases quite unnecessarily) to the licenser go to help the foreigner.

While this situation has perhaps not arisen to such a large extent in Canada as in Britain, there have been cases where Canadian manufacturers have taken the easy path of depending for their progress upon the enterprise and investigation of firms in other countries.

The activities of the National Research Council are in a large measure devoted to work which will be of direct benefit to the Canadian manufacturer in this respect; their policy will undoubtedly receive the general approval of the Canadian public, and will aid our industrialists to progress on their own initiative.

L. W. Wynne-Roberts, A.M.E.I.C.,
Wynne-Roberts, Son and McLean, Toronto.
Chairman of
Annual Meeting Committee.

The Annual General Professional Meeting

TORONTO, FEBRUARY 3rd, 4th and 5th, 1932

C. S. L. Hertzberg, M.E.I.C.,
Harkness and Hertzberg, Toronto, Ont.
Chairman. Toronto Branch.

W. B. Dunbar, A.M.E.I.C.,
University of Toronto, Toronto.
Secretary of
Annual Meeting Committee.

W. S. Wilson, A.M.E.I.C.,
University of Toronto, Toronto.
Treasurer of
Annual Meeting Committee.

J. J. Traill, M.E.I.C.,
Hydro-Electric Power Commission, Toronto.
Chairman of
Committee in Charge of Papers and Technical Events.

A. M. Reid, A.M.E.I.C.,
Bell Telephone Company of Canada, Ltd., Toronto.
Chairman of
Committee in Charge of Information, Registration, Printing and Signs.

COMMITTEE of TORONTO BRANCH

In Charge of Arrangements

●

A. R. Robertson, A.M.E.I.C.,
Dominion Bridge Company, Ltd., Toronto.
Chairman of
Finance Committee.

W. E. Bonn, A.M.E.I.C.,
Canadian Dredging Company, Ltd., Toronto.
Chairman of
Committee in Charge of Entertainment and Excursions.

A. U. Sanderson, A.M.E.I.C.,
Water Supply Section, City Hall, Toronto.
Chairman of
Publicity Committee.

T. Taylor, M.E.I.C.,
Railway and Bridge Department,
City Hall, Toronto.

OBITUARIES

Frank Henry Martin, M.E.I.C.

The membership of The Institute will learn with regret of the death of Frank Henry Martin, M.E.I.C., which occurred in Winnipeg, Man., on December 16th, 1931, after a lengthy illness.

Mr. Martin was born at Nanuet, N.Y., on December 22nd, 1881, and received his education at the public school at Nanuet and by private study. After serving an apprenticeship with the Dexter Folder Company at Pearl River, N.Y., he was employed as a draughtsman by various firms in the United States until 1905, when he went to Brazil to take charge of the technical department of the Rio de Janeiro Tramway, Light and Power Company at Rio de Janeiro. For some years after that, Mr. Martin was engaged in the design, construction and operation of hydro-electric plants for several Ontario power companies, and in 1914 he went to Winnipeg, Man., as designing engineer for the Winnipeg River Power Company. In July 1916, he returned to the east as designing engineer for Willis L. Adams, consulting and constructing engineer at Niagara Falls, N.Y., with which concern he remained until April 1919, becoming chief engineer in January 1917. In May 1919, Mr. Martin returned to Winnipeg to resume

FRANK HENRY MARTIN, M.E.I.C.

the work engaged in during the years 1914-1916, as designing engineer for the Winnipeg River Power Company, and was also in charge of the electrical research department for the Winnipeg Electric Railway Company. Mr. Martin designed the 168,000-h.p. Great Falls plant of the Manitoba Power Company, and following this was appointed chief engineer in charge of design and construction for the Northwestern Power Company, in which capacity he directed the completion of the initial development of the 225,000 h.p. plant at Seven Sisters Falls.

Mr. Martin joined The Institute as a Member on March 22nd, 1921, and took an active interest in the affairs of The Institute. He was a past-chairman of the Winnipeg Branch and was chairman of its Nominating and other committees.

John Smith Whyte, M.E.I.C.

In the death of John Smith Whyte, M.E.I.C., which occurred at Glace Bay, N.S., on January 15th, 1932, The Institute loses a member of many years' standing.

Mr. Whyte was born at Osgood, Ont., on February 28th, 1870, and graduated from McGill University in 1899, with the degree of B.Sc.

Following graduation, Mr. Whyte entered the draughting room of the Dominion Coal Company, Ltd., where he remained until March 1900, at which time he was appointed mechanical engineer. In 1923 he became chief mechanical engineer of the company. Later Mr. Whyte was associated with D. H. McDougall, M.E.I.C., at the Acadia Mine at Stellarton, N.S., and in 1925 he went to St. Petersburg, Florida, where, forming a partnership with Mr. Vincent McFadden, he entered the contracting field. Returning to Cape Breton in 1928, Mr. Whyte was an official at the New Campbellton mine for a time, and in 1929 rejoined the Dominion Coal Company.

Mr. Whyte joined The Institute (then the Canadian Society of Civil Engineers) as a Student on March 16th, 1899, and on January 14th, 1911, became a Member.

PERSONALS

W. E. Ross, A.M.E.I.C., has been transferred by the Canadian General Electric Company from Peterborough, Ont., where he was industrial control engineer, to Toronto, where he is manager of the contract service department.

Arnold V. Armstrong, Jr.E.I.C., is now in charge of illumination sales for Ontario for the Northern Electric Company, at Toronto, Ont. Mr. Armstrong, who is a graduate of McGill University, was at one time with the English Electric Company of Canada, Toronto.

D. MacBride, A.M.E.I.C., formerly consulting engineer for the Nova Scotia Public Cold Storage Terminals Limited, Halifax, N.S., is now general manager of the Victoria Cold Storage and Terminal Warehouse Company, Ltd., and is located at Victoria, B.C.

R. E. Jamieson, A.M.E.I.C., has been appointed professor of civil engineering and head of the civil engineering section in the Department of Civil Engineering and Applied Mechanics, McGill University. Professor Jamieson graduated from McGill University in 1914, with the degree of B.Sc. During the war he served overseas as a lieutenant with the Canadian Siege Artillery, and returning to Canada he was engaged on post graduate work at the same University, obtaining his M.Sc. in civil engineering in 1920. In the same year Professor Jamieson joined the teaching staff of the Faculty of Engineering as a lecturer, and was promoted successively to assistant professor and associate professor.

Walter J. Armstrong, M.E.I.C., has recently entered practice as a consulting engineer in Montreal. Mr. Armstrong, who was formerly chief engineer with Ross and Macdonald Inc., Montreal, graduated from Cornell University in 1909, and from that time until 1911 was employed as an assistant engineer with Messrs. Westinghouse, Church, Kerr and Company, New York. He later became assistant chief engineer and chief engineer for the same company in the field, and was in charge of the installation of all mechanical and electrical features in connection with the Chateau Laurier, Central Union Station baggage annex and service power plant at Ottawa. Mr. Armstrong was later connected with Westinghouse, Church, Kerr and Company's office in Montreal, and in April 1913 joined the staff of Messrs. Ross and Macdonald Inc., as assistant chief engineer. In January 1914 he became the company's chief engineer, which position he has held up to the present time.

F. M. Byam, M.I.E.C., has resumed active practice with the firm of Ewart, Armer and Byam, industrial engineers, Toronto. Following his graduation from the University of Toronto in 1906, Mr. Byam was for a time structural draughtsman with the Canada Foundry Company, in 1907 and 1908 he was structural draughtsman and checker with the Riverside Bridge Company of Wheeling, West Va., and from June to October 1908, he was structural checker and designer and mechanical designer for the Dickson Bridge Works Company at Campbellford, Ont. In 1908, Mr. Byam joined the staff of Messrs. Smith, Kerry and Chace, Toronto, as structural and hydraulic designer, and in November 1909, he was placed in charge of the civil engineering drawing office, having charge of all the structural and hydraulic design. In 1911 he became associated with Messrs. McGregor and McIntyre Ltd., as chief engineer, and remained in that position until December 1919, when he went into private practice with Messrs. Ewart and Jacob, under the name of Ewart, Jacob and Byam, Ltd., Toronto. In 1928, Mr. Byam returned to McGregor and McIntyre Ltd., as chief engineer, and in 1929 he became connected with the National Bridge Company Ltd., at Montreal.

O. S. Finnie, M.E.I.C., Retires

O. S. Finnie, M.E.I.C., for over ten years Director of the North West Territories and Yukon Branch of the Department of the Interior, Ottawa, has retired from the service.

Mr. Finnie was born at Arnprior, Ont., and received his education at the public schools in Ottawa, graduating from McGill University in 1897, with the degree of B.Sc. He entered the service of the Dominion government in 1898, going into the Yukon in that year as mining recorder with the late Mr. William Ogilvie, who had just been appointed governor of that Territory. Mr. Finnie returned to Ottawa in 1910, having been appointed inspecting engineer of mines for the Department of the Interior. He was appointed director of the North West Territories Branch in December, 1920, with headquarters at Ottawa. This branch was later enlarged to administer Yukon affairs.

Mr. Finnie joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member in 1912, and became a Member in September 1921. He has always taken a keen interest in the affairs of the Ottawa Branch, having acted as the chairman of the Branch in 1923, and represented it on the Council of The Institute in 1926.

Correction

In Mr. J. L. Busfield's letter, published on page 39 of the January issue of The Journal, in the eighth line of the fourth paragraph, for *The Institute* read *the engineer.*

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Royal Philosophical Society of Glasgow: Proceedings, Vol. 59, 1931.
National Electric Light Association: Proceedings, 54th Convention, June 8-12, 1931, Vol. 88.
American Institute of Consulting Engineers, Inc.: Proceedings of a Special Meeting held November 4th, 1931.
The Institution of Mechanical Engineers: Notices of Works Visited in the Excursions at the Manchester Meeting, 1929.
American Society for Testing Materials: Index to A.S.T.M. Standards and Tentative Standards, 1931.

Reports, etc.

Dept. of Mines, Mines Branch, Canada:
  Les Abrasifs, Partie 3: Le Grenat.
  Investigations of Mineral Resources and the Mining Industry, 1930.
Dept. of the Interior, Canada:
  Publications of the Dominion Observatory, Ottawa, Vol. 10: Bibliography of Seismology, July-September, 1931.
Dept. of Mines, Ontario:
  Bulletin No. 80: Money and the World Crisis.
Corporation of the County of Wentworth, Ontario:
  Ninth Annual Report of the County Engineer and Road Superintendent, 1931.
The Quebec Forest Industries Association, Ltd.:
  Fourth Report: The Burning of Settlers' Slash and Meteorological Conditions in the Province of Quebec during 1931.
Aeronautical Research Committee, Great Britain:
  Reports and Memoranda, No. 1401: Motion of H.M.A. R. 101 Under Certain Assumed Conditions.
  1403: Measured Spins on Aeroplane H.
  1404: Free-Flight Spinning Experiments with Several Models.
  1405: The R.A.E. Automatic Observer Mark IA.
  1407: Note on Change of Wind With Height.
  1408: Relation Between Heat Transfer and Surface Friction for Laminar Flow.
  1409: The Drag of Small Streamline Bodies.
  1410: Experiments on the Flow Past a Rotating Cylinder.
Bureau of Standards, United States:
  Supplement to Recommended Minimum Requirements for Plumbing—Progress Revision, May, 1931.
  Building and Housing Publication No. BH17: How to Own Your Home: A Handbook for Prospective Home Owners.
  Miscellaneous Publication No. 128: A Survey of Storage Conditions in Libraries Relative to the Preservation of Records.
  129: Report of the Twenty-fourth National Conference on Weights and Measures, June 2-5, 1931.
Bureau of Mines, United States:
  Mineral Resources of the United States, 1930 (Summary).
  Annual Report of the Director of the Bureau of Mines to the Secretary of Commerce for Fiscal Year Ended June 30, 1931.
  Coal in 1929.
  Gold, Silver, Copper, Lead and Zinc in Colorado in 1929.
  Sulphur and Pyrites in 1930.
  Arsenic, Bismuth, Selenium and Tellurium in 1930.
  Iron Ore, Pig Iron and Steel in 1930.
  Platinum and Allied Metals in 1930.
  Lead and Zinc Pigments and Salts in 1930.
  Feldspar in 1930.
  Clay in 1930.
  Abrasive Materials in 1930.
  Bulletin 343: Permissible Coal Handling Equipment.
  347: Gases That Occur in Metal Mines.
  Technical Paper 505: Influence of Fractionation on Distribution of Sulphur in Gasoline.
Geological Survey, United States:
  Bulletin 824-B: The Slana District, Upper Copper River Region, Alaska.
  824-C: The Lake Clark-Mulchatna Region, Alaska.
  824-D: Mining in the Circle District, Alaska.
  824-E: The Occurrence of Gypsum at Iyoukeen Cove, Chicagof Island, Alaska.
  828 : Geology and Mineral Resources of the Quakertown-Doylestown District, Pennsylvania and New Jersey.
  Water-Supply Paper 663: Surface Water Supply of the United States, 1928, Part 3: Ohio River Basin.
  681: Surface Water Supply of the United States, 1929, Part 1: North Atlantic Slope Drainage Basins.
  684: Surface Water Supply of the United States, 1929, Part 4: St. Lawrence River Basin.
  687: Surface Water Supply of the United States, 1929, Part 7: Lower Mississippi River Basin.
  689: Surface Water Supply of the United States, 1929, Part 9: Colorado River Basin.
  693: Surface Water Supply of the United States, 1929, Part 12: North Pacific Slope Drainage Basins, (b) Snake River Basin.

Professional Paper 164: The Kaiparouwits Region.
165: Shorter Contributions to General Geology, 1930.
168: Origin and Microfossils of the Oil Shale of the Green River Formation of Colorado and Utah.

Dept. of the Interior, United States:
Annual Report of the Director of the Geological Survey, June 30, 1931.

National Electric Light Association:
Insurance Committee: Casualty Insurance for Gas and Electric Utilities (Revised).
Prime Movers Committee, Engineering National Section: Stoker Equipment and Furnaces.
Electrical Apparatus Committee, Engineering National Section: Outdoor Substation Illumination.
Electrical Apparatus Committee, Engineering National Section: Performance of Insulating Oils in Circuit Breakers.

Purdue University:
Engineering Experiment Station Research Series, No. 36: Tests of Gas Home Heating Equipment.

The Smithsonian Institution:
Annual Report of the Board of Regents . . . for the year ending June 30, 1930.

Ohio State University:
Eng'g Experiment Station Circular No. 25: A Resumé of Published Data on Steel Foundry Practice.
Eng'g Experiment Station Bulletin No. 66: The Moment Distribution Method of Structural Analysis Extended to Lateral Loads and Members of Variable Section.

Forest Research Institute, India:
Forest Bulletin No. 74-1931: Summary of Results of Treated Experimental Sleepers Laid in the Various Railway Systems of India, brought up to date.

Technical Books, etc.

Presented by Canadian Newspaper Service, Reg'd:
"Reference Book," 1931-32, 4th ed.: Biographical Reference Data and Other General Information.

Presented by McGraw-Hill Book Company:
Principles of City Planning, by Karl B. Lohmann. 1931.

Presented by the Royal Architectural Institute of Canada:
Data on Foreign Building Products Used in Canada, Nov. 1931. [19 pp.]

Presented by American Chemical Society:
List of Periodicals Abstracted by Chemical Abstracts, with Key to Library Files, 1931.

Presented by Universal Oil Products Company:
How to Safeguard Cracking Operations from Accident.—Series reprinted from "Refiner and Natural Gasoline Manufacturer," Jan.-Aug., 1931.
The Cracking Process in the Gas Making Industry.

National Business Publications, Limited:
The Pulp and Paper Engineering Catalogue of Canada and Newfoundland, 2nd ed., 1931.
National Directory of the Canadian Pulp and Paper Industries, 1932.

Purchased:
British Engineering Standards Association: British Standard Specification for Portland Cement, No. 12-1931.
The High-Speed Internal-Combustion Engine, 2nd ed., 1931, by Harry R. Ricardo. Published by Blackie & Son, London.
American Society of Mechanical Engineers, Boiler Code Committee: Boiler Construction Code, 1931.

Catalogues, etc.

De Laval Steam Turbine Company:
Catalogue B-3: De Laval Balanced Single Suction Series Pumps, [11 pp.].

Armstrong Cork & Insulation Company, Ltd.:
The Insulation of Cold-Storage Rooms. [39 pp.].
Roofs That Pay Dividends. [15 pp.].
Circle A Cork Brick for Dairy Barns and Hog Houses. [32 pp.].
Industrial Applications of Cork. [48 pp.].
Nonpareil Insulating Brick. [72 pp.].
The Insulation of Roofs to Prevent Condensation. [35 pp.].
The Insulation of Roofs with Armstrong Corkboard. [31 pp.].
Refrigerated Drinking Water. [52 pp.].
Cork—Its Origin and Uses. [32 pp.].
Armstrong's Corkoustic. [31 pp.].
The Insulation of Paper Mill Roofs. [12 pp.].
Nonpareil Cork Covering [48 pp.].
Armstrong's Corkboard Insulation. [66 pp.].
Data and Details for the Application of Armstrong's Cork Machinery Isolation, [6 pp.].
Nonpareil High Pressure Insulation. [10 pp.].
Armstrong's Insulating Brick. [7 pp.].
Building an Insulated Milk Cooling Tank. [4 pp.].

CORRESPONDENCE

Toronto, Ont., Dec. 30, 1931.

The Editor,
The Engineering Journal.

Sir:

The writer has recently picked up a "wrinkle" in surveying which he would like to pass on to engineers who are called upon to tie in their surveys with Land Surveyor's stakes.

Townships, in making surveys for roadways, search for the original stakes at transit points and prepare plans and profiles, which are used in laying down water mains, giving grades for houses, pavements, etc; but in many cases it is only the levels which have been permanently located by means of bench marks giving the elevations of hydrants, culverts, etc., and no attempt has been made to preserve the location of the original stakes; these may get covered with building debris or become so rotten as to be unrecognizable. Thus it may take days to locate the alignment, while the levels can be quickly picked up by means of the bench marks.

At the present time it is not difficult to find some of the rotted cedar stakes of the original surveys, but it is necessary to find enough of them in agreement with the old plans to be sure that they are in their original positions and not misplaced by someone. Thus even a rotted cedar stake is taken as the legal boundary if it agrees closely with the remainder of the old survey, and is a valuable point. In the writer's opinion such points should be permanently located; because it is very difficult for another surveyor to pick up a rotted stake, even if the frost does not push it up, on account of the ground having been loosened in the search for it.

It occurred to the writer to make permanent transit points by having three-foot lengths of old galvanized pipe cut and drilled with a small hole about an inch from the top, and driving these pipes flush with the ground (to prevent them being disturbed) and by the side of the Land Surveyor's stake towards the most important road, when at intersections; great care being taken not to move the original stake. These pipes should be placed at all important transit points and carefully tied in with at least two permanent objects in the vicinity, such as trees (noting the diameter), telephone poles, houses, corner fence posts, etc.; even objects a couple of hundred feet away will limit very considerably the area in which it may be necessary to search for the iron pipe at some future date.

At that time the engineer, with this description before him, will not mind taking some trouble in searching for this transit point, when he knows that he is looking for a hard metallic object like a pipe; whereas otherwise he cannot afford to spend time in looking for a wooden stake which may have been pulled up by a mowing machine, or the frost, or may even have been destroyed by his axe men while searching for it.

In fields which are liable to be ploughed the pipes can be driven to about nine inches below the surface, but in most cases transit points can be located at the ends of the field.

The hole drilled in the top of the pipe is of course necessary to identify these pipes, because property owners occasionally drive in old pipes, car axles, etc., to mark their boundaries.

Iron pipe was selected as being generally available and also as being different from the square iron bars the Land Surveyors now drive, one at each intersection and at different points of their surveys. These points are of course only generally known to the Land Surveyors, but certainly are very useful when found.

All the information of the survey should be on the combined plan and profile—bench marks with their description, location and elevation; and description of all transit points together with their witness or tied in permanent objects.

If Townships, railways, highways, pipe lines, transmission lines, etc., would follow this practice, transit points would be almost as easy to find as bench marks, which would make for economical surveying.

E. C. EVANS FOX, Jr.E.I.C.

Link-Belt Limited, Toronto, Ont., has published the fourth of the series of Material Handling and Power Transmission Data Sheets, which were first issued in 1931. This fourth sheet, which contains power formulae for chain conveyors and elevators, giving instructions and calculations for figuring the pull on chains in conveyors and elevators and in drives for them, as well as the torsional and bending strains for the shafting, may be obtained from the offices of the company in Toronto, Ont.

The Harland Engineering Company of Canada, Ltd., Montreal, supplied the following equipment in connection with the development of the McLaren-Quebec Power Company at Masson on the Lièvre river: centrifugal pump sets, comprising two vertical sets for dewatering the tunnel and two horizontal sets, one for pumping out the draught tubes and the other for emptying a sump at the bottom of the access shaft. All these sets are driven by Harland squirrel cage induction motors.

ELECTIONS AND TRANSFERS

At the meeting of Council held on January 19th, 1932, the following elections and transfers were effected

Member

REYNOLDS, Philip, (Swindon Tech. Sch.), chief engr., The Shell Oil Company of Canada, Limited, Toronto, Ont.

Associate Members

BOYD, Harold Cecil Trayner, B.A., M.A. (Mech. Sci.), (Cambridge Univ.), designer, Power Corporation of Canada Ltd., Montreal, Que.

MARCOTTE, Pacifique, B.A.Sc., (Ecole Polytech.), designing engr., highway bridges, Dept. Public Works, Quebec, Que.

Juniors

LABERGE, Charles René, B.A.Sc., (Ecole Polytech.), designing engr., Dept. Public Works, Quebec, Que.

LYNCH, John Franklin, B.Sc., (Univ. of N.B.), telephone engr., 201 Northumberland St., Fredericton, N.B.

MARTIN, Lucien, B.A.Sc., (Ecole Polytech.), civil engr., Dept. Public Works, Quebec, Que.

REEVELY, Frederick Richard, B.A., (Univ. of Toronto), development engr., on mfg. methods, Northern Electric Co. Ltd., Montreal, Que.

Transferred from the class of Junior to that of Associate Member

BROWN, Thomas Alan, B.Sc., (Queen's Univ.), mgr., Eastern Distribution District, Gatineau Power Company, Ottawa, Ont.

WEBB, Harry Randall, B.Sc., M.Sc., (Univ. of Alta.), asst. professor of civil engrg., University of Alberta, Edmonton, Alta.

Transferred from the class of Student to that of Associate Member

BURPEE, Lawrence Hanington, B.A.Sc., (Univ. of Toronto), bridge engr., Beauharnois Construction Company, Beauharnois, Que.

Transferred from the class of Student to that of Junior

GORDON, Arthur I. E., B.A.Sc., (Univ. of B.C.), asst. engr., Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C.

LEBLANC, Jules, B.A.Sc., (Ecole Polytech.), B.Sc. (Elec.), (Mass. Inst. Tech.), engr., B.B. Electric Co. Ltd., Montreal, Que.

Students Admitted

Undergraduates at the University of Toronto:

ADDISON, John Hillock, 431 Broadview Ave., Toronto 6, Ont.
BARRATT, Ernest Frederick Ellerby, 21 Strath Ave., Toronto, Ont.
BLACK, Ernest Arthur, 310 Russell Hill Road, Toronto, Ont.
DONALDSON, John Logie, 132 St. George Street, Toronto, Ont.
FISHER, John Alexander, 158 St. George St., Toronto, Ont.
HENDRICK, Max Morton, 48 Rosedale Heights Drive, Toronto, Ont.
MOORE, John F., 259 Russell Hill Road, Toronto 5, Ont.
McDOUGALL, Elmer J., 187 Albany Avenue, Toronto, Ont.
PARK, Beverley D., 22 St. Joseph St., Toronto, Ont.
PEPALL, John Ritchie, 124 Heath St. North, Toronto, Ont.
POWELL, John Giles, 129 Springhurst Ave., Toronto 3, Ont.
SMITH, Herbert Malcolm, 308 Indian Road, Toronto, Ont.
TAIT, Douglas Leonard, East House, University of Toronto, Toronto, Ont.
THOM, James Edwin, 123 St. George St., Toronto, Ont.
WHYTOCK, James William, 318 Heath St. East, Toronto, Ont.

Undergraduates at Mount Allison University:

BLANE, Donald, Sackville, N.B.
CARSON, James Russell, Pictou, N.S.
JOHNSON, Kenneth Lorne, 122 Dolbeau St., Quebec, Que.
KERR, Joseph Gesner, Fox River, N.S.
KING, Ewen, Sackville, N.B.
MITCHELL, James Grant Smith, New Carlisle, Que.
STOTHART, Arthur Bliss Copp, Newcastle, N.B.
WAGNER, Gordon Dexter, Shelburne, N.S.

Undergraduates at the University of Alberta:

ECKENFELDER, George, Edmonton, Alta.
FOWLER, Sydney Henry David, 9316-106-A Ave., Edmonton, Alta.
HOLE, William G., 9421-108-A Ave., Edmonton, Alta.
MAIR, Robert Comrie, Edmonton, Alta.
WYLLIE, Frank James, B.Sc., (E.E.), (Post grad.), 10913-73rd Ave., Edmonton, Alta.

Undergraduates at McGill University:

DEXTER, Joseph Dimock, B.Sc., (Arts), (Acadia Univ.), 3555 University St., Montreal, Que.
MURRAY, William MacGregor, 1509 Sherbrooke St. West, Montreal, Que.
POOLE, Gordon Dean, 30 Ballantyne Ave. So., Montreal West, Que.
YOUNG, Horace Colquhoun, 3560 Hutchison St., Montreal, Que.

HAMILTON, Parker Cleveland, (N.S. Tech. Coll)., 242 Oxford St., Halifax, N.S.

The Association of Professional Engineers of Ontario

Annual Meeting

At the annual meeting of the Association of Professional Engineers of Ontario, held on December 28, it was unanimously decided to introduce a bill at the next session of the Ontario Legislature with the object of restricting the practice of engineering to properly qualified persons. It was pointed out by A. H. Harkness, M.E.I.C., president of the Association, that Ontario was eight to twelve years behind the other provinces in this respect, and the fact was emphasized that the Association was not seeking legislation in advance of that in the other provinces but was rather trying to catch up with them.

The Association was incorporated in 1922. At that time, the government of the day struck out from the Act of incorporation the restrictive clauses in regard to practice, explained Mr. Harkness. The result was that Ontario engineers were left with their professional organization but with little else. As the law stands at present, no one but a member of the Association has the right to call himself a "professional engineer," but anyone may practise engineering whether he be qualified to do so or not. The amending bill which is to come before the next session will make it necessary for a person desiring to practise engineering to be a member of the Association of Professional Engineers. Thus, the Association, which is now merely a qualifying body, will become a licensing body as well. In other words, the control of the profession will be in the hands of the profession.

The public is now protected from the quack doctor, the shyster lawyer, and the unqualified dentist by similar legislation, and the benefit of such legislation and organization has been widely recognized in the medical, legal and dental professions.

It was also pointed out that the proposed legislation would place Ontario engineers on the same plane as those of other provinces, and would thus remove the last impediment to the granting of reciprocal rights whenever such a development would come to pass. At the same time it would prevent foreigners without qualifications from coming into the province and securing positions to the detriment of graduates of our own Universities, on some of which government spends hundreds of thousands of dollars annually. It was reported that all the members of the legislature so far consulted were in favour of the bill which was receiving support from members of other professions.

If this bill becomes law, it will have the effect of placing the Ontario engineer on the same footing as his brother engineers in the other provinces.

Canada Buys a High-Capacity Testing Machine

The largest vertical compound lever machine yet made in Great Britain for testing wire cables has been made to the order of the government of Ontario Department of Mines, by the Avery Company, and it is intended for carrying out tensile tests on wire rope specimens of 11-inch circumferential maximum, and 6-foot length unstretched, to a capacity of 1,000,000 pounds. A section of the new wing of the government house, Toronto, is to be set aside for its installation.

A massive three section base box encloses the main lever system and straining gear. It is surmounted by a heavily ribbed cast steel platform supported on knife edges and bearings on the weighing levers. Bolted to each of the four corners of the platform are robust cast iron columns supporting at their upper end the weighing crosshead, into which the upper end of the specimen is held.

Projecting through the weighing platform are four five-inch diameter steel straining screws for holding the cast steel straining crosshead, in which the lower end of the specimen is held during the test.

The system for measuring the strain has been obtained by means of an acurately designed system of levers floating on knife edges working within the British Board of Trade tolerances of five tons per linear inch on the knife edges.

A load of 1,000,000 pounds is broken down by transmitting it through 9 to 1 ratio main levers coupled at the centre to a suitably proportioned transfer lever, and so to the steel yard. By combination with a steelyard ratio of 20 to 1, the load is broken down by 20,000 to 1, and readings of 50 pounds on a micrometer dial fitted to the poise propelling screw are easily obtainable.

Two notable features are the autographic recording apparatus and the electrically controlled and propelled poise.

This machine will go in a maximum space of 18 feet 6 inches by 13 feet 11 inches, whilst its height above floor level will be only 12 feet.

The same company supplied the 1,250-ton machine to Messrs. Dorman Long and Company, which was used for testing scale models of sections of the Sydney harbour bridge.

BRANCH NEWS

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

The chairman of the Branch, R. C. Harris, M.E.I.C., presided over about thirty members and friends who had gathered at a general meeting held on Thursday, December 10, 1931.

After the reading of the minutes, the chairman introduced the speaker of the evening, Dr. W. G. Carpenter, Affil.E.I.C., principal of the Provincial Institute of Technology and Art, Calgary.

The Mid-North

Dr. Carpenter's talk on "The Mid-North" proved to be of absorbing interest, in both a general and professional sense, to the members present.

He described a trip along the MacKenzie river, one of the great rivers of the world. The point of departure was Summit lake a few miles out from Prince George and the course followed was along the Crooked river and its expansions into the park and the Parsnip which with the Finlay at Finlay Forks make the mighty Peace. This series of mountain rivers are most picturesque and they teem with fish. At Fort Lake McLeod is encountered the oldest white settlement west of the Rockies and north of Mexico; a fort established by Simon Fraser. From Fraser Summit lake to the mouth of the MacKenzie is a distance of about 2,800 miles.

About 70 miles from Finlay Forts the Peace river contracts and falls 800 feet in 16 miles as it passes through Rocky Mountain Canyon, a great potential source of water power. The valley of the Peace is delightful with good crops of grain and vegetables near the settlements; also near the canyon at Carbon Creek is an outcropping seam of coal of good quality.

At the eastern outlet of the canyon Hudson Hope is located, and about 70 miles further down Fort St. John is situated in a beautiful farming country on a plateau 900 feet above the river. From here to the mouth of the river the fertile Peace river agricultural belt is located.

A few miles from Fort Chipeweyan on Lake Athabasca the Peace joins the Athabasca river flowing from Lake Athabasca through the Rocker river. These two form the mighty Slave river which flowing past Fort Fitzgerald make the famous Smith Rapids to avoid which all water traffic is taken overland a distance of about 16 miles.

Coming into the north by way of the Athabasca river one traverses the tar sand areas of northern Alberta from Fort McMurray to near Fort Chipeweyan. This area contains vast quantities of petroleum products overlying deep beds of rock salt and it is not difficult to imagine a great chemical industry in this vicinity in the future.

While in this area the summers are short the long days are delightful and are contributory to the rapid development of crops, the winters are not unduly severe. An average rainfall of about 17 inches occurs during June, July and August at the right time to nurture the growing crops which come to early maturity.

No area in the world, concluded the speaker, has possibilities of a greater future; extensive areas of agricultural land within easy access of immense areas of the mineral-bearing pre-Cambrian shield which will inevitably be a hive of industry in future ages, and with a comparatively easily developed outlet to the Pacific ocean.

Dr. Carpenter showed films of the route and exhibited prints illustrating the nature of the country in larger detail.

A hearty vote of thanks was accorded the speaker at the conclusion of his talk.

The Expedition of Warre and Vavasour in 1845

About forty-five members and friends gathered at the Board of Trade rooms Calgary, at a general meeting to hear another 'popular' as distinct from 'technical' lecture on Thursday, January 7.

In the absence of the chairman the meeting was in the hands of the Vice-Chairman, F. M. Steel, M.E.I.C., who introduced the speaker of the evening, H. S. Patterson, K.C., President of the Calgary Branch of the Alberta Law Association.

Mr. Patterson spoke on "The Expedition of Warre and Vavasour to investigate conditions in connection with the Oregon dispute in 1845 for the British government."

The expedition, said the speaker, had as its secret object to report on the possibility of transporting troops over the mountains into the Oregon district and the members of the expedition were well qualified for their task; both were military men, Warre also was an artist while Vavasour was a Royal Engineer. Despatches sent home showed that the chief factor of the Hudson's Bay Company, Dr. McGoughlin, who was a great colonizer, encouraged emigrants from the United States by means of extending credit and reduced prices to such an extent that the proportion of United States to British settlers rose very rapidly between 1840 and 1845.

In 1844, continued the speaker, the United States residents fought the famous election calling for the $54^0\ 40^1$ parallel as the boundary or fight, and in 1845 a bill was introduced but not passed which awakened the British government to the imminent danger of losing Canada and this was the reason for the expedition of Warre and Vavasour.

The speaker traced their journey across the continent, and this is fairly well recorded as far as the crossing of the Bow river west of Calgary, but it is doubtful which pass was used in crossing the mountains.

The interests of the Hudson's Bay Company required settlers and apparently British interests had been jeopardized by the large percentage of United States immigrants permitted by the British government in view of the representations of the company that the country could easily be held. Warre and Vavasour, on the contrary, reported it almost impossible to transport troops across the mountains. Fortunately, however, international peace had been preserved by the joint government of the Oregon district. Later the company found it necessary to invoke the aid of the British government against the United States settlers previously encouraged by extensive credits and favourable prices.

In 1846, continued the speaker, Warre published a post-folio of sketches made during his trip across the mountains, only four copies of which are now known to be in existence. This journey is of considerable interest as it was the first military expedition sent by the British government across these mountains and the object of the expedition adds to that interest. Mr. Patterson showed slides of these pictures which were very much appreciated.

In moving a hearty vote of thanks to the speaker, J. H. Ross, A.M.E.I.C., commented on the unusual nature of the subject. The motion, seconded by R. S. Trowsdale, A.M.E.I.C., was received with hearty applause by those assembled.

The chairman commented on the very extensive research necessary in preparing an address of this nature, largely from original manuscripts which have not hitherto been published.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
W. J. DeWolfe, A.M.E.I.C., Branch News Editor.

The Annual Meeting of the Halifax Branch of The Institute was held at the Nova Scotian hotel on December 19th, 1931, J. Lorn Allan, M.E.I.C., chairman of the Branch, presiding.

The meeting was preceded at 6.30 p.m. by an informal dinner, fifty members being present as well as a few invited guests.

Mr. Allan introduced the principal speaker, C. H. Wright, M.E.I.C., general manager of the Canadian General Electric Company in the Maritime Provinces. Mr. Wright, before delivering his address, sketched for those present the district to which the address would refer, giving, at the same time, some of its salient features. Mr. Wright felt that a well-known poem by Kipling would be appropriate, and asked Professor F. R. Faulkner, M.E.I.C., to recite "Martha and Mary," which has an appeal to engineers.

Engineering Projects in Northern Manitoba

The speaker pointed out that of a total of about 34,000,000 h.p. available in Canada from waterpower, the province of Manitoba has about 6,000,000 h.p. Two rivers in that province, the Nelson and the Churchill, are comparable in the horse power available to the two largest rivers in the east—the Saguenay and the Niagara. These water powers are already being put to use near the city of Winnipeg, and also at such developments as Island Falls on the Churchill river.

There were considerable engineering difficulties in constructing the Island Falls development, and in building the Manitoba Northern Railway from Le Pas to Flin Flon, some 90 miles over permanently frozen ground. From the end of the rails at Flin Flon, all equipment had to be carried by sleighs, scows, etc., over forest road and ice, a distance of 70 miles. Most of the heavy transportation had to be done in winter, using tractors. The total expenditure at Island Falls and Flin Flon is in the neighbourhood of $26,000,000. The two mines there are producing about 4,000 tons of ore daily.

The first charter for the Hudson Bay Railway was obtained by Hugh Sutherland in the year 1881, but the 510 miles of road from Le Pas to Churchill were not completed until the year 1931, when two steamers carried out of that harbour half a million bushels of wheat across the Atlantic to Europe, a dramatic undertaking. The total expenditure for railway, bridges, terminals, elevator, etc., was over $56,000,000. A large part of the rails are laid over permanently frozen ground, a method which was first used from Le Pas to Flin Flon. The railway was located in the winter of 1928-29, when the temperature at times went to sixty degrees below zero. Rails were also laid that winter. On one occasion, a hospital train with patients from the upper part of the construction was snowed in during the months of April and May, 1929, and relief had to be brought by means of dog teams, tractors, etc. It was the middle of May before trains could again operate up the line. A monument to the memory of the engineers and men who died on this construction was erected at Cranberry Junction, and another at Churchill. These piles carry on each of the four sides, two verses of Kipling's poem "The Sons of Martha."

The engineering developments at Churchill are of very high character. The harbour is safe, well protected and has been well dredged where necessary. The elevator of 2½ million bushels capacity is modern in every respect. Due to perpetual frost, sometimes going 50 feet into the earth, difficulties in the handling of water and sewage were encountered, but as usual, Canadian engineers have been able to overcome the difficulties, and an adequate supply of pure, fresh water is now available. To protect water pipes, roundhouses, tanks, etc., has of course been a formidable undertaking. Due to lack of water, all permanent buildings must be of fireproof or semi-fireproof construction.

The Hudson Bay Railway runs through a large area that can never have real agricultural value, but the possibilities of the mines are unknown. Copper, silver, zinc, gold, etc., have been discovered in the Canadian shield where northern Manitoba is located. The present annual output of gold from the Flin Flon mine alone is in the neighbourhood of $2,000,000. The Mandy mine produced, in three years, $2,000,000 worth of copper, besides other values in gold, silver, etc.

It is reasonable to suppose that northern Manitoba and parts of our country nearer the pole are highly mineralized. It is quite evident that Canadian engineers are equal to the problems which they may have to encounter in the future, as has been shown by their past record.

At the conclusion of his address, Mr. Allan tendered Mr. Wright a hearty vote of thanks on behalf of the members.

The Branch then proceeded to the Annual Report and elections.

The minutes of the 1930 Annual Meeting were read and approved.

The interesting annual report of the Secretary-Treasurer showed the present state of the Branch finances and membership, and contained graceful reference to two of our lately deceased members: C. E. W. Dodwell, M.E.I.C., a charter member of the original Canadian Society of Civil Engineers, and district engineer of the Public Works Department at Halifax for many years, and G. A. Bernasconi, M.E.I.C., an old and valued member who had been associated with the Public Works Department for a number of years.

The annual report of the Papers committee, presented by W. H. Noonan, A.M.E.I.C., contained a list of the papers read before the Branch during the year just closed, and of several to be given at later meetings.

Professor W. P. Copp, M.E.I.C., presented the report of the Membership committee, with interesting comment on the large proportion of the total Student enrollment which came from Halifax Branch during the past year.

The report of the Publicity committee was presented by W. J. De Wolfe, A.M.E.I.C., who referred briefly to the welcome response of the Halifax papers to requests for news items of Branch activities.

The Students' Prize committee report was tendered by Professor F. R. Faulkner, M.E.I.C., with pertinent comments regarding it.

All reports given were well received and favourably commented upon, as showing the keen efforts made by the committees.

Professor F. R. Faulkner, who has taken such an ardent interest in the matter of co-operation between The Institute and the Professional Associations, gave the Branch a very clear and comprehensive statement on the present state of the negotiations and of the outlook for future conferences. This whole subject is to be discussed by the incoming Executive at a later date.

The scrutineers' report, presented by H. W. L. Doane, M.E.I.C., named the following as elected to office for 1932:

Chairman	A. F. Dyer, A.M.E.I.C.
Councillor	J. B. Hayes, A.M.E.I.C.
Executive	H. S. Johnston, M.E.I.C.
	K. L. Dawson, M.E.I.C.
	A. Scott, A.M.E.I.C.
	J. F. Wightman, A.M.E.I.C.
	J. F. F. Mackenzie, A.M.E.I.C.

The retiring chairman, J. Lorn Allan, M.E.I.C., then gave his address, an abstract of which follows:

Address of Retiring Chairman

Before turning over the chairmanship of the Branch to my successor, permit me to say a few words of appreciation of the honour which was done me in entrusting the affairs of our Branch to my guidance during the past year. Many things have been left undone and those that have been done might have received more care and study, nevertheless, there has been a measure of success due to the hearty co-operation of the Executive committee and members. The meetings have been well attended and interesting, the spirit has been excellent and there has been every indication that there is a real attachment to The Institute.

May I at this time make a few remarks about the engineering profession and the service that The Engineering Institute of Canada is performing on our behalf.

An address by Sir Robert Falconer to the students of the University of Toronto at the opening of the last session is well worth the attention of Canadian citizens. Under the title "The Lawful Mind" President Falconer warns the students that during this period of depression and uncertainty through which the world is passing, they are more fortunate than many and that they should be on guard lest by word or behaviour they justify criticism from those less favoured.

As engineers we are fortunate in having the opportunity of setting an example of high integrity and purpose. We have a great responsibility to the public and by them are accorded a trust which we must be very careful not to abuse. In every contract the engineer becomes the arbitrator between the owner and contractor and is trusted by both to see that the contract is carried out in fairness to both.

More and more engineers are occupying executive positions in large corporations.

When the public is so ready to trust our profession it behooves us to walk with circumspection and avoid dragging our calling in the mud by lending our abilities to financial operations that are a blot on Canadian records. By reason of the faith the public have in us, much is expected of us.

In these troublous times we should be active in our endeavours to be good citizens, always looking for opportunities to help those less fortunate and assist in every effort to improve conditions. Devotion to duty and steadfastness in honour, uprightness and integrity should be our motto.

If any group of men of a particular calling is to function properly, organization is essential. The Engineering Institute of Canada is that organization which binds the engineers of Canada together in one great educative body. With headquarters in Montreal and branches throughout Canada, it exists for the benefit of the profession. By meetings, literature, visitations, etc., it places before its members means of getting together to discuss mutual problems and addresses of educational value and high ethical standards. If The Engineering Institute has not succeeded to a greater extent in advancing our interests, it is because our support has not been wholehearted. I am afraid that in spite of our advantages we are like all other citizens in various walks of life, very ready to criticize when certain actions on the part of the Council at Montreal or our local Executive do not meet with our approval, but neglecting to lend the helping hand which is needed for the solution of the problem.

Since 1887, when the Canadian Society of Civil Engineers was incorporated, this organization, which is now known as The Engineering Institute of Canada, has been endeavouring to promote the interest of the engineering profession. By its effort, the public has gradually grasped the value of the man with an engineering education and experience. Due to The Institute's exertions, the Provincial Professional Associations were established by acts of the provincial legislatures, thus giving the profession a legal status. The Institute stands ever ready to assist the associations in obtaining better legislation.

In view of this, I appeal to you one and all to support The Institute loyally.

In expressing my deep appreciation of the interest which the members and Executive committee have taken in the year's work, I wish especially to thank our Secretary, Mr. R. R. Murray, for his never failing courtesy and assistance and to Professor Faulkner, Vice-President of The Institute for this zone, and Professor Copp, our representative on the Council, for the time and energy they have given to the advancement of the Branch's interests.

In welcoming Mr. Dyer to the chair, I congratulate the Branch on the choice they have made. I am confident that with the co-operation of the members and the assistance of the new Executive this Branch under his leadership will have a very prosperous year.

Mr. Allan's address was received with well-merited praise which was ably expressed by A. F. Dyer, A.M.E.I.C.

A committee of three to be appointed by the Executive committee to join with the Professional Association in conducting a combined banquet in January, was approved.

The Secretary-Treasurer, who had so faithfully and successfully fulfilled his duties in 1931, was voted an honorarium.

C. H. Wright, M.E.I.C., was named as Branch representative on the Nominating committee of The Institute.

Professor F. R. Faulkner, M.E.I.C., and Professor G. H. Burchill, A.M.E.I.C., were re-elected as auditors for 1932.

A hearty vote of thanks to the retiring chairman and Executive committee was given by those present at one of the most successful Annual Meetings ever held by the Branch.

Lethbridge Branch

Wm. Meldrum A.M.E.I.C., Secretary-Treasurer.

The Lethbridge Branch of The Engineering Institute of Canada held its first regular dinner meeting of the new year on Saturday evening at the Marquis hotel.

The speaker was J. R. Mackenzie, western superintendent of the Dominion Glass Company Limited at Redcliff, Alberta.

During the dinner the orchestra under the direction of George Brown entertained, as usual, with a splendid programme of music and assisted in the lively period of community singing which followed.

The guest artists of the evening were Mrs. H. W. Meech and Tom Smith both of whom entertained with delightful vocal numbers. Mrs. George Brown and W. Meldrum, A.M.E.I.C., were the accompanists.

The Art of Glass Making

Mr. Mackenzie was introduced by N. Marshall, M.E.I.C., Branch chairman, and took for his subject "Glass Making."

The art of glass making stated Mr. Mackenzie is one of the oldest trades known, dating back as far as the early Egyptians.

This industry naturally falls into four groups as follows:

1. Sheet and plate glass.
2. Decorative and novelty glass.
3. Special glass, i.e. heat-resisting, etc.
4. Containers for food, drugs, spirits, etc.

While the composition of glass in these four divisions varies somewhat, generally speaking it may be said to be made up as follows:

1. Silica sand, 65 to 74 per cent.
2. Lime, 8 to 10 per cent.
3. Flux soda ash or borax, 14 to 16 per cent.

In addition to these constituents numerous other elements are introduced either for colouring or bleaching purposes.

Amber glass, for example, is obtained by the addition of ground coal and metallic sulphur.

Iron oxide is also employed extensively in the colouring of glass and it is of interest to note that fifteen different shades of colour may be obtained by simply varying the amounts of the iron oxide used.

From this Mr. Mackenzie went on to discuss the difference between ordinary commercial glass and special glass. In this connection, it is of interest to note that in pyrex glass, which has a high degree of heat resistance, borax is used as a flux in the place of soda ash in order to secure the correct coefficient of expansion required in the manufacture of this special product.

In the production of glass bottles the first step is to weigh the constituents required for a batch and these are then very carefully mixed.

These are then introduced into a furnace (at about 2,600 degrees F.) holding 125 tons of molten glass. As the batch is taken from the furnace it is automatically cut into drops or gobs of glass each sufficient to make a bottle. Air is then introduced so that the glass will take the required shape and then they are sent to the finishing mould.

The final stage is the annealing oven where they are kept for about six hours when they are removed, cooled and packed for shipment.

Mr. Mackenzie, in concluding his address, said the industry in Alberta dates back to 1912-1913 starting with the erection of the plant at Redcliff. This plant represents an investment of $1,250,000 and employs upwards of 140 persons. The output of the plant is 3,000 tons of glass per year, all in the form of containers.

At the conclusion of the address H. W. Meech, M.E.I.C., moved a hearty vote of thanks to the speaker for his instructive and entertaining address.

London Branch

Frank C. Ball, A.M.E.I.C., Secretary-Treasurer.
John R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the Branch was held on the 16th of December, 1931, at the new Bell Telephone repeater station for long distance calls at Colborne and Oxford streets.

As this was a meeting specially arranged by the local manager, Mr. R. L. Stratton, for the benefit of the London Branch the ordinary business of the meeting was suspended. About fifty persons were present comprising members and affiliates of the Branch, guests and members of the Bell Telephone staff.

Mr. Stratton announced that prior to an inspection of the installation and machinery two reels of moving pictures would be shown followed by an explanation of the aims and objects of the whole plant by Mr. A. C. Ion, equipment engineer.

The first reel pictured the elaborate and effective means employed in locating the inroads of the "Imp of Trouble" and making good the results of his activities. Views were shown of some of the causes of trouble, notably the interference and damage caused by the limbs of swaying trees in contact with overhead wires and the way in which the trouble was registered and located at the station. Also the speedy way in which men with trucks and equipment were dispatched to the scene of the trouble and the damage repaired.

The second reel depicted the routes taken by long distance messages to cities and towns across the seas on the European continent. Many views were shown of the busy operators at work in the exchanges in London, England, and in France, Sweden, Holland, and Germany, together with the different and interesting rest and recreation grounds provided for the operators.

Mr. Ion opened his remarks by referring to the time when long distance calls were in their infancy—some forty years ago—and noted the advance in the perfection of equipment and the results up to the present time.

The repeater station was one of the links in the chain which it was proposed to establish from Montreal to Windsor. At the present time the chain had been completed between Toronto and London with repeater stations at Toronto and London, 120 miles apart, and intermediate stations at German Mills, with branch to Kitchener, and at Hornsby with an outlet to Hamilton. The distance between these stations was 50 miles, London to German Mills; 35 miles, from the latter to Hornsby; 35 miles again to Toronto. Between these points a 302 pair quadded composite cable weighing six pounds per lineal foot had been installed. Of these 302 pair wires, 6 pair were of No. 16 gauge pure copper wires for broadcasting purposes and 296 pair were 19 gauge pure copper wires. All the wires in this cable were wrapped with paper, compressed tightly together and the whole encased in a lead covering giving a total diameter of 2⅝ inches. It is possible to operate 444 telephone and telegraph circuits over this medium, the ground not being used for return currents as it was found that the metallic circuit gave a better balanced operation. A distance of 50 miles was found to be about the limit at which the current could be carried without amplifying. A diagram was shown giving the strength of the current at the start and the amount by which it had diminished at the next repeater station and how it was reboosted there for its journey to the next station and so on.

Mention was also made of one device for locating trouble which however was not employed on this cable. It consists of surrounding the cable by nitrogen gas contained in an outer casing. Immediately on the release of this gas, various signals came into evidence at the station which enable the operator to locate the trouble. Mr. Ion then conducted the party through the building explaining as far as possible in a non-technical way the use and operation of the many delicate and intricate units. A very interesting unit was one by which the operator adjusted the current to the proper number of cycles to cope with the high and low pitched sound in the carrying of music to the broadcast station. Automatic switchboards for regulating the current, and automatic generating plant for supplying electric current for bell signals and lighting purposes in case of hydro failure were inspected, as were also the complete battery installation.

At the close of the inspection, Mr. Stratton gave a short address in which he outlined the progress and improvements made in the Bell Telephone and other systems throughout the Dominion. He said that in a very short time now telephone communication would be established from the Atlantic to the Pacific coasts over Canadian lines in the Dominion of Canada. Formerly, these messages crossed the border and travelled over American systems in their journey to the west causing a good deal of trouble and inconvenience which would now be eliminated. He finished by stating that the ladies of the staff were holding a social and dance in the recreation room of the Bell Telephone building on Dundas street and that he had been requested to extend a cordial invitation to any of those present to join in the festivities. Needless to say the invitation was accepted by a number of the gathering.

W. R. Smith, A.M.E.I.C., chairman, called upon V. A. McKillop, A.M.E.I.C., assistant engineer to the Public Utilities Commission, to propose a vote of thanks. Mr. McKillop, in the course of his remarks, referred to the large cost incurred in the manufacture and installation of the various units. He humorously remarked that he was pleased to note that they (the Telephone Company) had at any rate left the earth to the Hydro and concluded by proposing a hearty vote of thanks to Mr. Stratton and Mr. Ion for the trouble they had taken to make this visit and inspection a success and to convey even to non-technical minds the need for and use of the various units. This was seconded by W. C. Miller, M.E.I.C.

In connection with the drive for new members of The Institute, the chairman called upon W. P. Near, M.E.I.C., city engineer of London and Branch Councillor, to address the meeting. Mr. Near outlined the scope and activities of The Engineering Institute and urged upon the members of the Bell Telephone staff the advisability and advantages of joining The Institute as he understood there were some thirty of them who were possibly qualified by experience and education to become members.

Moncton Branch

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

Pulverized Coal and its Contribution to Industry

"Pulverized Coal and its Contribution to Industry" was the subject of a very interesting address delivered before the Branch on December 10th by Mr. N. T. Avard, Manager of the Maritime Coal, Railway and Power Company Ltd., Amherst, N.S. F. O. Condon, M.E.I.C., presided.

Under equal conditions, declared Mr. Avard, power can be generated as cheaply from coal as from hydro. In many cases it would be of distinct advantage to both consumer and producer, as well as to the coal mining industry of the Dominion, to utilize coal for power generation. During the Great War scarcity of coal had compelled attention to the economical use of fuel and it is a remarkable fact that since then boiler efficiencies have been more than doubled.

The pulverizing of coal had been suggested as far back as 1831 but it was not until the war years that any real development of the idea had taken place. In this process the coal is first ground to the consistency of highly refined flour and then blown into the boiler and burned in suspension. The advantages of this method of burning are: almost perfect combustion with any grade of coal, elimination of smoke to a large extent, no clinker trouble, very little ash, and ability to burn low grade fuel. Another notable advantage is flexibility of control through ability to extinguish the fire instantly when a light load comes on and relight in a few seconds when new steam supply is needed. At the present time, 26 per cent of the coal burned in stationary boilers for power purposes is pulverized. Mr. Avard told of tests of this process that had been made on steamships and on the railways. He also described the new "Rupamotor" which needs no boiler but introduces coal dust directly into the cylinder and operates in much the same way as the gasoline engine. Powder of bituminous coal, brown coal, peat, wood dust, rice husks and furnace coke have been used successfully in this motor. It is still in the experimental stage but much is expected of it.

A hearty vote of thanks was tendered the speaker on motion of E. V. Moore, M.E.I.C., seconded by James Pullar, A.M.E.I.C.

The Engineer in Bush Country

On December 16th, speaking on the subject "The Engineer in Bush Country," L. H. Robinson, M.E.I.C., assistant engineer of maintenance of way, Canadian National Railways, delivered an intensely practical and instructive illustrated address before a combined meeting of Moncton Branch and the Engineering Society of Mount Allison University, Sackville. Mr. Gordon Wagner, president of the Society, presided, and there was a large attendance of the student body and members of the engineering faculty.

Mr. Robinson held the close attention of his audience while he tendered advice to the young engineer who temporarily leaves the comforts of civilization for the primitive life of our Canadian northland. The intimate details of canoe packing and handling were dealt with, also portages, direction finding, and perhaps not the least important, protection against insects.

Winter surveys are not so terrible as one might think. Proper clothing is the all essential. A man who knows how to take care of himself can sleep comfortably in the open, without a blanket, even though the thermometer be sixty below zero. But whatever you wear, declared Mr. Robinson, do not wear whiskers. Six inches of ice encased around one's countenance is not conducive of comfort. Ninety per cent of Arctic explorers are clean-shaven.

Ferocious wild animals are few, even a wolf will go miles out of his way to avoid crossing a snowshoe track. Personally, the speaker would rather shoot wild-life with a camera than a gun.

A high tribute was paid to the Indians of the north country and an interesting description given of their languages and customs. Particularly noticeable is the gradual change of speech of the native tribes from guttural to dental and labial, as one travels north.

A vote of thanks was tendered Mr. Robinson on motion of Angus Firth, S.E.I.C. The Engineering Society also expressed its appreciation of Moncton Branch for arranging for Mr. Robinson's address.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

The Annual Meeting of the Montreal Branch was held on Thursday evening, January 7th, when the retiring chairman, A. Duperron, M.E.I.C., presided. There was a very good attendance at the meeting and proceedings were opened by the reading of the report of the Executive committee for the past year in which special attention was drawn to the excellency of the student nights, to the general work of the Papers and Meetings committee and to the good average attendance which had been obtained at the meetings.

The committee reported an increase in the membership from 1,126 to 1,174.

Special reference was made in the Committee's report to the holding of the Annual General and General Professional Meeting in Montreal in 1931; to the special dinner which had been given in honour of Dean Ernest Brown; to the visits to the *Empress of Britain* and to the Montreal incinerator works.

The Executive committee also reported on its action in forwarding a resolution to the Prime Minister of the province of Quebec favouring the passing of suitable legislation regarding Town Planning and Zoning.

Regrets were expressed at the passing away of eleven members of the Branch.

The finances of the Branch indicated a loss of over $300 in the year's operation which was more than accounted for by the cost of the Annual General and General Professional Meeting.

As a result of the ballot the following officers were declared elected:—

Chairman	P. E. Jarman, A.M.E.I.C.
Vice-Chairman	E. A. Ryan, M.E.I.C.
Committeemen	F. S. B. Heward, A.M.E.I.C.
	G. B. Mitchell, M.E.I.C.
	J. Labelle, A.M.E.I.C.

The new chairman, P. E. Jarman, A.M.E.I.C., was escorted to the chair, and presided at the meeting during the general discussion on the affairs of the Branch, following which the members adjourned to partake of refreshments and to enjoy a social gathering.

Ottawa Branch

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

Aeronautical Laboratories of the National Research Council

At the first luncheon meeting of the new year, held on January 7th, the speaker was J. H. Parkin, M.E.I.C., F.R.Ae.S., Assistant Director of the Division of Physics of the National Research Laboratories, his subject being the "Aeronautical Laboratories of the National Research Council."* G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local Branch, presided at the luncheon, other head table guests being Hon. D. M. Sutherland, Major-General A. G. L. McNaughton, M.E.I.C., A. M. Narraway, M.E.I.C., Dr. H. M. Tory, Dr. R. W. Boyle, M.E.I.C., F. H. Peters, M.E.I.C., N. J. Ogilvie, M.E.I.C., and C. Pitts, A.M.E.I.C.

Mr. Parkin, in his address, dealt with the aeronautical research and testing facilities of the laboratories which included a wind tunnel for aerodynamic work, a test tank for hydrodynamic investigation and dynamometer and other equipment for engine tests. The address was illustrated with lantern slides throughout, particular attention being paid to the wind tunnel and the test tank.

As a matter of fact, stated the speaker, the use of the equipment was not confined solely to aviation but was also of real service for other purposes. The wind tunnel, for instance, had proved of value in obtaining information on wind-mills for power generation, wind pressures on chimneys, towers, transmission lines, ventilators, automobile and train resistance and the calibration of instruments. Experiments are proceeding also in connection with the possibility of so directing the smoke issuing from the short smoke stacks of locomotives as to keep it from drifting back into the eyes of the engineman looking out of his cab or back along the windows of trains, inconveniencing the passengers.

Similarly the experiments in the test tank have already proved of service in connection with the hulls of vessels and marine propellers, while the dynamometer is of value in connection with testing all internal combustion engines and especially marine engines.

The speaker pointed out that the National Research Council laboratories would do much to advance aviation in Canada and to build up a strong, independent aircraft industry in this country. To enable aircraft to assist to the full extent of which they are capable in the development of the Dominion, he further stated, aircraft of special types suited to the services required and the operating conditions must be provided. These include freight carriers capable of operating in the north country under all conditions, mail planes, photographic machines and aircraft for forest patrol, crop and forest dusting, etc. No such machines wholly satisfactory for Canadian conditions are now available and these machines can and should be produced in Canada. The sound development of national aviation depends upon the building up of an industry capable of constructing and servicing aircraft required and a flourishing industry depends upon successful aviation; they are mutually interdependent.

*A description of these Laboratories by Mr. Parkin was published on page 564 of the November, 1931, issue of The Engineering Journal.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. Gordon Clark, S.E.I.C., Branch News Editor.

A meeting of the Saint John Branch of The Engineering Institute of Canada was held at the Admiral Beatty hotel on the evening of December 3rd, 1931. John N. Flood, A.M.E.I.C., chairman of the Branch, presided. After a short business session the speaker of the evening, W. R. Pearce, M.E.I.C., a past chairman of the local Branch, was introduced.

Impressions of South America

The subject of the speaker's address was "Impressions of South America." Mr. Pearce, who spent three years in Buenos Aires and six months in Montevideo as assistant South American chief engineer of the International Telephone and Telegraph Corporation of New York, dealt with the nature and customs of the people of the Argentine Republic and Uruguay and the peculiar customs that prevail in the social and business life of the natives.

To illustrate the differences in the methods of conducting business operations used in South America and North America, Mr. Pearce gave some interesting illustrations of the way the foreign owned public utilities have to approach and maintain the good will of the government. All business must be conducted by means of a third party and the problem of finding the right person to act as a medium either between the seller and the purchaser or between the public utility and the government is very real and sometimes very costly, said Mr. Pearce. The government controls all commercial operations so much that it is necessary to obtain a permit from the President of the Republic before any new work or even maintenance can be done. This attitude is carried out in all the branches of business and pleasure and even if one wants to join an athletic club or obtain a permit for driving a car, it may take months and endless trouble before the necessary preliminaries can be passed.

Mr. Pearce spoke in a vivid way of his experiences during the telephone strikes and the political revolution during his stay in the Argentine. A short time after his arrival he received a letter saying that if he carried out certain orders issued by his company his family and himself would be put to considerable trouble and inconvenience, and that if he still persisted "gloom and a sadness will come over your household." Shortly before this he had narrowly missed being blown up by a bomb, which some curious spectator picked up while the authorities were hunting for instruments to open it. A few minutes after Mr. Pearce passed, the bomb and the spectator were blown to pieces. These things, said Mr. Pearce, were typical of ordinary life in Buenos Aires.

At the close of the address the meeting was thrown open for discussion and Mr. Pearce answered a great many questions regarding features of interest.

Saskatchewan Branch

Stewart Young, A.M.E.I.C., Acting Secretary.

The regular meeting of the Branch was held on the evening of December 18th, 1931, at the Hotel Champlain, Regina, being preceded by a dinner at which thirty-four were present.

Immediately following the dinner certain matters of business were attended to.

Our Undeveloped Resources

The chairman, in a few appropriate remarks, introduced the speaker of the evening, Major John Barnett, Deputy Minister of Natural Resources, Saskatchewan, his address being entitled "Our Undeveloped Resources—a Problem and Inspiration for Engineering Science."

In presenting his subject Major Barnett stressed four outstanding features of northern Saskatchewan:

1. Development in Alberta on the west and Manitoba on the east has proceeded to points much farther north than in the province of Saskatchewan.
2. There is much greater diversification of activity in northern than in southern Saskatchewan.
3. The first development in northern Saskatchewan will be along agricultural lines, chiefly in the river valleys.
4. The aggregate potential resources of northern Saskatchewan are high, making for slower development but greater stability.

Major Barnett's address was well received, being the cause of considerable discussion; following which a hearty vote of thanks was tendered the speaker.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The annual meeting of the Sault Ste. Marie Branch was held in the Windsor hotel on Dec. 18th, 1931, following the regular monthly dinner.

A. H. Russell, A.M.E.I.C., was in the chair and after the reading of the minutes of the last meeting, the report of the Membership committee was given by J. H. Jenkinson, A.M.E.I.C., and the Secretary-Treasurer's report was read. These reports were adopted on motion of Messrs. H. F. Bennett, A.M.E.I.C., and R. H. Burns, Jr.E.I.C.

The sum of twenty-five dollars was voted to city relief on motion of Messrs. J. H. Jenkinson, A.M.E.I.C., and J. W. LeB. Ross, Jr.E.I.C.

G. H. E. Dennison, Jr.E.I.C., chairman of the Nominating committee, reported the results of the elections as follows:

Chairman	C. E. Stenbol, M.E.I.C.
Vice-Chairman	K. G. Ross, A.M.E.I.C.
Executive Committee:—	
Resident (1 year)	W. S. Wilson, A.M.E.I.C.
(2 years)	R. A. Campbell, A.M.E.I.C.
Non-resident (1 year)	C. H. N. Connell, M.E.I.C.
(2 years)	G. W. Holder, A.M.E.I.C.
Ex-officio	A. H. Russell, A.M.E.I.C.
Secretary-Treasurer	A. A. Rose, A.M.E.I.C.

This report was adopted on motion of Messrs. J. W. LeB. Ross, M.E.I.C., and F. H. Barnes, A.M.E.I.C.

In vacating the chair to the new chairman, Mr. Russell reviewed the work of the year just closing, thanked the various officers and committees, for their support, and solicited similar support for the incoming chairman.

A vote of thanks was tendered the retiring chairman and officers on motion of Messrs. H. J. Bennett, A.M.E.I.C., and J. H. Jenkinson, A.M.E.I.C.

In taking the chair Mr. Stenbol thanked the members for the honour they had conferred on him.

On motion of Messrs. G. H. E. Dennison, Jr.E.I.C., and R. H. Burns, Jr.E.I.C., J. H. Jenkinson, A.M.E.I.C., was appointed to the Nominating committee of The Institute.

The membership of the Executive committee for 1932 is as follows:

Chairman	C. Stenbol, M.E.I.C.
Vice-Chairman	K. G. Ross, A.M.E.I.C.
Secretary-Treasurer	A. A. Rose, A.M.E.I.C.
Executive	R. A. Campbell, A.M.E.I.C.
	G. W. Holder, A.M.E.I.C.
	W. S. Wilson, A.M.E.I.C.
	C. H. N. Connell, M.E.I.C.
Ex-officio	A. E. Pickering, M.E.I.C.
	A. H. Russell, A.M.E.I.C.

Messrs. C. J. Russell, A.M.E.I.C., and F. H. Barnes, A.M.E.I.C., were appointed auditors for the year, on motion of Messrs. A. H. Russell, A.M.E.I.C., and G. H. E. Dennison, Jr.E.I.C.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.

Drought and Soil Drifting in Western Canada

There were 50 members and visitors present. The chairman introduced the speaker of the evening, T. C. Main, A.M.E.I.C., who delivered a most interesting address under the title "Drought and Soil Drifting in Western Canada."

At the close of the address the discussion was opened by F. G. Goodspeed, M.E.I.C., who was followed by Messrs. C. E. Joslyn, A.M.E.I.C., W. E. Hobbs, A.M.E.I.C., C. H. Attwood, A.M.E.I.C., and J. W. Porter, M.E.I.C.

Mr. Main asked that the resolution proposed by the Meteorological Conference in Winnipeg on November 5th and 6th, 1931, to the effect that more meteorological stations should be established in western Canada, should be given the support of the Branch.

Moved by C. H. Attwood, A.M.E.I.C., seconded by J. W. Porter, M.E.I.C., that the petition of the Meteorological Conference held in Winnipeg on November 5th and 6th, 1931, to the Minister of Marine and Fisheries, requesting that more meteorological stations throughout western Canada be established and that all stations record more detailed information; is strongly endorsed by the Winnipeg Branch of The Institute and that a copy of this resolution be sent to the Minister of Marine and Fisheries in the hope that it will be favourably considered. Carried.

A hearty vote of thanks was accorded the speaker, and the meeting went into business session.

The minutes of the previous meeting were read and confirmed.

The chairman brought up the question of the discussion of the paper of F. H. Martin, M.E.I.C., on "Unemployment," which paper had been given by Mr. Martin on October 1st. The discussion had been deferred at the suggestion of J. W. Porter, M.E.I.C., in order that the members should have opportunity to give greater thought to the subject. It was then decided to further postpone the discussion until such time as Mr. Martin should be well enough to be in attendance.

The question arose of the annual supper-dance held jointly by the Branch and the Association of Professional Engineers.

Moved by G. S. Roxburgh, A.M.E.I.C., seconded by E. V. Caton, M.E.I.C., that this matter be dealt with by the Executive Committee. Carried.

W. F. Oldham, A.M.E.I.C., introduced the subject of the proposed Town Planning Commission for the city of Winnipeg. Mr. H. Stainton of the Town Planning Institute pointed out that there were several proposals in this regard; one of a commission of the mayor, three aldermen and two citizens not being aldermen, another that the commission consist of the mayor, two aldermen and five or six citizens not being aldermen.

S. E. McColl, A.M.E.I.C., stated that the personnel of the Commission is highly important and that citizens appointed to the commission should be chosen for their familiarity with the requirements and details of modern town planning.

Moved by S. E. McColl, A.M.E.I.C., seconded by W. F. Oldham, A.M.E.I.C., that the Winnipeg Branch E.I.C. endorses the formation of a Town Planning Commission consisting of the mayor, two aldermen and a predominating number of citizens not being aldermen, and that these should be chosen for their ability to serve efficiently in this specific matter and for their familiarity with the requirements of modern city development. Carried.

The meeting then adjourned for refreshments.

Twelfth Annual Meeting of the Association of Professional Engineers of British Columbia

The Twelfth Annual Meeting of the Association of Professional Engineers of British Columbia was held in Vancouver on December 5th. Three hundred members from all parts of the province were present and the occasion was marked by two outstanding speeches from the retiring President, Major J. C. MacDonald, M.E.I.C., and the President-elect, A. S. Gentles, M.E.I.C.

The first subject was that of engineering education. The speaker referred to the debt which the engineering profession owed to Mr. William E. Wickenden, President of the Case School of Applied Science, Cleveland, Ohio, and Director of Investigation for the Society for the Promotion of Engineering Education. Major MacDonald referred to two works of which Mr. Wickenden was the author or chiefly the author, entitled "A Comparative Study of Engineering Education in the United States and Europe" and "A Study of Technical Institutes." Major MacDonald considered these works as the outstanding contribution of any one man on the subject, and added that they should be in the hands of every engineer.

As a result of the study of these books and other means of information, and particularly prospectuses of all the Canadian universities and of the technical schools throughout Canada, Major MacDonald was of opinion that a most inadequate system of engineering education operated in the Dominion. He was not criticizing the education given by our universities. He had nothing but praise for these institutions, but he remarked that they did not constitute the whole field of preparation for the engineer. He pointed out that they were not the sole educational agencies; that at least 40 per cent to 50 per cent of the engineers of the Dominion had not in the past, and were not likely in the immediate future to attend universities; that it was in connection with this 50 per cent that the inadequate system of preparation existed. The system of technical schools and technical institutes had been created chiefly for the purpose of giving to workmen a knowledge of the sciences underlying their daily work and it had been overlooked that this system was not an adequate preparation for the young engineer. It was this state of affairs, joined with a tradition that practice was more important than theory, which led boys to leave school, sometimes unfortunately even before matriculation, and to enter subordinate positions in the engineering world. They thought that they would be able to obtain the necessary theoretical training by attendance at night schools or by correspondence schools. Generally speaking the result was that they obtained a smattering of science rather than that adequate preparation and sound education which all thinking men agreed was necessary for the well-qualified engineer, able to compete with the engineers of other countries. Major MacDonald considered that the Association in British Columbia had already made a definite contribution to the welfare of the country in drawing attention to this state of affairs, and that the Council in 1931 by negotiations with various educational authorities in the province, had done something to correct this condition. The continued operation of the Engineering Act and the continued operation of the examination system now in force by the Profession would tend with increasing effect day by day to bring this deplorable condition to an end.

A. S. Gentles, M.E.I.C., the President-elect, dealt with Federation of the Associations and their relations with the Engineering Institute of Canada as follows:—

"When I appeared before you at this time last year I gave you a short account of the negotiations with The Engineering Institute of Canada up to that time. I detailed to you the objections we had to the methods adopted by The Institute on this important subject. As our President has advised you, we objected to the fact that the Associations, and particularly B.C., were inadequately represented on the bodies appointed to deal with this matter. The President has told you how we have overcome these objections during the year, and at last we are approaching the creation of a Dominion Council, actually representative of the associations throughout the Dominion. At the moment I cannot report to you that all the associations have appointed their representatives. British Columbia and Ontario and Alberta up to the moment, are the only provinces who have definitely done so.

"Very briefly, the recommendation of the so-called 'Committee of Four,' which to date has been accepted by British Columbia and Ontario and is at present being considered by the other provincial associations, is that an Interim Dominion Council is to be formed, each provincial association having one representative. This Council is to prepare the ground and work out the Constitution of an ultimate Dominion-wide body along certain suggested lines. Under the ultimate scheme the autonomy of ther povincial associations is preserved in every way and at the same time provision is made for the inclusion in the scheme of The Engineering Institute of Canada and other voluntary associations, whose interests are fully protected.

"The report of the 'Committee of Four' has been in the hands of the various provincial councils for the past two months. I am happy to advise you that the Council of The Engineering Institute of Canada have adopted the report in full and have promised their future support. As stated before, British Columbia and Alberta and Ontario have adopted the report and appointed their representatives to the Interim Dominion Council. The Manitoba Association have wired that they consider the report an excellent solution of the matter and are considering it at their next Council meeting. The Engineering Institute, in accepting the report, expressed the regret that a direct representative of The Institute had not been present on the 'Committee of Four,' but inasmuch as all four members of the committee were Institute men and as it is probable that all the members of the Interim Dominion Council will be Institute members, I feel that the interests of The Institute will be adequately cared for, as the whole thought underlying the deliberation of the 'Committee of Four' was that any scheme evolved, to be successful, must protect the interests of all concerned.

"Our Council feel that the actual formation and meeting of the Interim Dominion Council will be one of the greatest forward steps the engineering profession has taken in this country. Our Council also consider that the prime work of the associations is the development of their own acts provincially, and we propose in this province to go right ahead with our own work."

The elections resulted as follows:

President...............A. S. Gentles, M.E.I.C., Manager, Pacific Division, Dominion Bridge Company, Ltd.
Vice-President..........A. G. Langley, M.C.I.M.M., M.Inst.M.M.

Members of Council

Dr. V. Dolmage..................Representing Mining Engineers.
P. E. Doncaster, M.E.I.C..........Representing Civil Engineers.
A. C. R. Yuill, M.E.I.C...........Representing Electrical Engineers.
W. Rae.........................Representing Mechanical Engineers.

Helium in Canada from 1926 to 1931

There has been no material increase in the available supply of helium in Canada in the last five years despite the increase in the number of wells producing natural gas in Alberta, according to a recent advance report on helium in Canada, published by the Department of Mines, Ottawa. Samples taken from new wells in the Turner Valley field have not shown any appreciable helium content and a definite decrease for Canada as a whole is indicated.

The cost of producing helium is too largely dependent on the nature of the demand, whether fairly constant or intermittent, and the helium content of the natural gas to allow for a ready estimate. An United States Department of Commerce Bulletin reports that in June 1930 the Bureau of Mines at its Amarillo (Texas) plant produced helium at a net expenditure for operation and maintenance of $6.23 per thousand cubic feet of helium. This compares with an operating cost of $35.00 per 1,000 cubic feet reported by the Helium Company's plants in 1930. An estimate of $62 per 1,000 cubic feet has been made for Canada, based on a daily production of 100,000,000 cubic feet of natural gas with a helium content of 0.3 per cent. This quantity of gas however is not available.

The report is a compilation of all available information regarding helium, for the convenience of executives, engineers, aeronauts and others who may be interested in the subject. It may be had by application to the Director, Mines Branch, Department of Mines, Ottawa.

Report of Natcoflor Test

Natcoflor is a one-way reinforced floor slab construction using a specially designed tile unit in combination with concrete joints. The shape of the tile is designed to place a large proportion of its area where it will be of most use in resisting positive and negative compressive stresses.

The test structure consisted of a slab carried on three supports, the slab being continuous over the centre support and freely supported at the two outside supports.

Each span had a length of 18 feet centre to centre and the clear span was 17 feet. The overall depth of the slab was eight inches. There was no concrete on top of the tile.

The slabs consisted of six rows of tile at 13-inch centres, eight inches in depth with two-inch concrete joints. There was no reinforcing at the outside of the tile but the five centre joints were reinforced with one 7/8-inch round bar at the bottom with hooked ends at each end of each span. The reinforcing at the top of the slab consisted of one 7/8-inch round bar at each of the outside ends and one 7/8-inch round bar over the centre support in each of the five inside concrete joints. The top reinforcing in all cases was carried in for one-quarter of the span.

Compression test specimens of the concrete as poured gave the following results:

Age seven days.........Compressive strength 1,490 pounds per square inch.
Age twenty-eight days...Compressive strength 2,830 pounds per square inch.
3,400 pounds per square inch.

The reinforcing steel used in this structure was rerolled rail steel found to be in accordance with the Canadian Engineering Standards Association specification, and having a yield point of 54,090 pounds per square inch, an ultimate strength of 92,000 pounds per square inch and an elongation in eight inches of 20 per cent.

Five of the Natcoflor tile were tested for compression strength. The loading was applied parallel to the direction of the ends. The tile had a gross area of 88 square inches and a net area of 39 square inches. On the basis of net area the strengths ranged from 6,160 pounds per square inch to 7,600 pounds per square inch with an average strength of 6,810 pounds per square inch.

The loading of the panel was commenced on October 28th so as to make the final loading come on October 30th when the slab would be twenty-eight days old. The method of loading was that outlined in the City of Toronto Building By-law. The first loading applied was 110 pounds per square foot. The second increment of load of 90 pounds per square foot to bring the loading to twice the designed live load was applied on the second day. The total load on each span was then 19,485 pounds. The entire load was then removed and the recovery checked.

Deflections at 3/8 span from the outside supports as shown by the graph were measured by deflexometers.

	East Beam	West Beam
Deflection after once live load had been in place 24 hours:......................	0.161 inch	0.178 inch
Deflection after twice live load had been in place an additional 24 hours..........	0.367 inch	0.412 inch
Permanent deflection after removal of live load....................................	0.102 inch	0.114 inch

An attempt was then made to break the slab and loading was applied to 468 pounds per square foot and then stopped. The slab has carried this load to date without failure.

In conclusion, it would seem that the load applied to the slab and the deflections under the live load and twice the live load indicate that this type of construction is safe for the loads for which it was designed with a reasonable factor of safety and comparing favourably with results of tests that have been made on reinforced concrete slabs.

The fact that in this structure the compression is carried by tile and concrete is borne out by analysis and a full report of this test which was conducted by the Canadian Inspection and Testing Company, Ltd., at Aldershot, Ont., is available on request to the National Fireproofing Company, Toronto, Ont.

The American Board Builders' Association and the Highway Research Board are engaged on a joint investigation under the chairmanship of F. H. Jackson, Highway Research Board, Washington, D.C., of the compaction of earth fills as affected by the type and size of haulage and other equipment. The investigation, it is stated, includes the effects of both wheel and crawler types of haulage equipment on soils of various kinds in embankments, the action of resilient truck tires and steel tires, the relation of wheel diameter to area of contact, and optimum moisture content and thickness of layer to produce maximum compaction. Simple tests from samples to determine relative and absolute compaction will be outlined.

Preliminary Notice

of Applications for Admission and for Transfer

January 23rd, 1932

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, 1932.

R. J. Durley, *Secretary.*

* The professional requirements are as follows—

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

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

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

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

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

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

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

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

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

FOR ADMISSION

BRYDON—NOEL MORRIS, of Toronto, Ont., Born at Knutsford, England, Dec. 25th, 1900; Educ., B.Sc. (Civil and Mech.), St. Andrews University, Scotland; Assoc. Member, Inst. C.E.; 1916-19, 3 years pupilage (indentured), civil engr., J. H. Thompson, M.Sc., M.Inst. C.E.; 1923-24, asst. engr., Toronto Transportation Commn.; 1924-28, field engr., Foundation Co. of Canada; 1928 (Mar.-June), chief engr., Carswell Constrn. Co.; 1928-31, vice-president, Wilde & Brydon, Ltd.; at present, President and Gen. Mgr., Brydon Construction Co. Ltd., Toronto, Ont.

References: F. R. Ewart, J. B. Carswell, W. E. P. Duncan, A. R. Robertson, V. A. G. Dey.

FORGAN—DAVID, of Toronto, Ont., Born at Stirling, Ont., Sept. 17th, 1899; Educ., Technical College, Glasgow, 1906-10; 1905-10 apprenticeship, Caledonian Railway, Glasgow; 1910-11, asst. engr., with same rly.; 1911-14, res. engr., C.N.R.; 1919-31, asst. engr., H.E.P.C. of Ontario, Toronto, Ont.

References: A. V. Trimble, T. H. Hogg, G. P. MacLaren, J. J. Traill.

MUGAAS—HENRIK, of 2216 Souvenir Ave., Montreal, Que., Born at Evanger, Norway, Apr. 28th, 1894; Educ., 1917-19, Bergen Technical School; 1922-25, Technical College, Darnstadt, Germany; 1919-21, surveying and dfting., research work for a power plant; 1925-27, layout of a power plant in Norway; 1928-31, with the Shawinigan Engineering Company, work included dfting. and prelim. estimating and checking of location of steel towers for transmission line; chief of a survey party for transmission line; layout of excavations, etc., for a power plant.

References: S. Svenningson, C. R. Lindsey, C. Luscombe, S. S. Colle, E. S. M. Lovelace, D. McMillan.

ROAST—HAROLD JAMES, of Montreal, Que., Born at London, England, Nov. 21st, 1882; Educ., 3 years, City of London College, graduate 1902; 1903-04, chemist in charge, Canada Iron Foundries, Radnor Forges, Que.; 1904-07, works mgr., Canadian Carbonate Co., Montreal; 1907-14, gen. mgr., Canadian Magnesite Co., Montreal and Newark, N.J.; 1914-22, mgr., testing dept., The James Robertson Co., Montreal; 1922-26, vice-president and gen. mgr., and 1926-28, president, National Bronze Co. Ltd., Montreal; 1928, sold above company to Robert Mitchell Company; at present, Proprietor, Roast Laboratories Regd., Montreal, Que.

References: O. O. Lefebvre, C. K. McLeod, F. Newell, D. C. Tennant, A. Stansfield, G. St.G. Sproule, D. E. Blair.

SAMPSON—WILLIAM THOMAS, of Kirkland Lake, Ont., Born at Milton, P.E.I., Sept. 1st, 1889; Educ., Private study; Regd. Prof. Mining Engr., Prov. of Ontario; 1910-11, asst. transitman, City Engineer's Office, Saint John, N.B.; 1911-13, transitman, St. John & Quebec Rly. constrn.; 1913-15, underground surveyor, Hollinger Gold Mines; 1915-16, head surveyor, same mines; 1916-18, overseas, Can. Engrs.; 1919-25, asst. to mine engr., Hollinger Cons. Mines; 1925-27, mine supt., Argonaut Cons. Gold Mines Ltd.; 1927-28, mgr., Laval Quebec Mines, Massey, Ont.; 1928-29, mgr., Laval Quebec Mines, operating Rex Copper Mines, La Reine, Que.; 1929 to present date, chief engr., Wright-Hargreaves Mines, Ltd., Kirkland Lake, Ont.

References: D. R. Thomas, J. A. Reid, A. D. Campbell.

TACHE—GUY, of Chicoutimi, Que., Born at Quebec, Que., Aug. 29th, 1898; Educ., Night course, Technical School, Quebec; 1924-25, asst. engr., road constrn., Dept. of Roads, Quebec; 1925-30, junior dftsman., and 1930 to date, chief dftsman., Price Bros. & Co. Ltd., Chicoutimi, Que. (Seasons 1928-1929, professor of dfting., Technical School, Chicoutimi.)

References: J. P. B. Casgrain, J. F. Grenon, G. E. LaMothe, C. C. Lindsay, J. Joyal.

WEBSTER—CHARLES WILLIAM, of Dunnville, Ont., Born at Boston, Mass., Oct. 6th, 1893; Educ., 1913-16, Acadia Univ., Cert. in engrg. subjects; 1921, rodman, 1922-25, instr'man and gen. inspr. on pipe laying, rip-rapping, concrete culverts and surface gravelling, also office engrg., Nova Scotia Highways Board; 1925-26, asst. to S. W. Crowell, A.M.E.I.C., on water power surveys and land surveying in towns; 1927 to date, instr'man. and field engr., Ontario Dept. of Highways, Dunnville, Ont.

References: A. A. Smith, A. Hay, G. F. Hanning, H. C. Williams, S. W. Crowell.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

HUNT—WALTER GEORGE, of Montreal, Que., Born at Bury, Que., Apr. 19th, 1893; Educ., B.Sc., McGill Univ., 1917; 1911-15 (summers), house constrn., mill and lumber operations, and bridge shop, McKinnon Steel Co., Sherbrooke; 1917-18, hydrometric engr., Dom. Govt., Ottawa and Calgary; 1918-1921, constrn. engr. on mill and hydro-electric extension, Laurentide Co., Grand Mere, Que.; 1921-26, engr. and gen supt., Ross-Meagher Co., Gen. Contractors and Engrs., Ottawa; 1926-28, private general contracting in Montreal; 1928 to date, President and Managing Director, Walter G. Hunt & Co. Ltd., General Contractors and Engineers, Montreal, Que. (*S. 1916, Jr. 1919, A.M .1922.*)

References: E. B. Wardle, H. E. Bates, W. H. Wardwell, A. H. Milne, J. G. Hall, H. W. B. Swabey.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

DENNISON—GEORGE HENRY EDWARD, of 128 Upton Rd., Sault Ste. Marie, Ont., Born at Renfrew, Ont., Feb. 10th, 1900; Educ., Diploma, R.M.C., 1920; 1917 (May-Aug.), rodman on survey; 1920 (July-Dec.), coal foreman, i/c coal handling and preparation, coke ovens, Algoma Steel Corpn.; Oct. 1921, to May 1922, woods dept., Lake Superior Paper Co.; 1923-27, asst. hydraulic engr., Spanish River Pulp & Paper Mills, Sault Ste. Marie, Ont.; 1927-28, chief dftsman., Sturgeon Falls mill of same company; 1928-30, engr., Abitibi Power & Paper Co.; 1931 (Jan.-Feb.), instr'man., Dept. Northern Development; Feb. 1931 to date, dftsman., roll designing office, Algoma Steel Corpn., Sault Ste. Marie, Ont. (*Jr. 1926.*)

References: H. F. Bennett, R. A. Campbell, J. L. Lang, A. H. Russell, G. W. Holder, H. J. Buncke, J. W. LeB. Ross, G. H. Kohl, J. V. Fahey, A. L. Farnsworth, R. W. Arveson.

MACDONALD—ALBERT EDWARD, of Winnipeg, Man., Born at Halifax, N.S., Feb. 20th, 1900; Educ., B.Sc., N.S. Tech. Coll., 1920. M.S., McGill Univ., 1922; 1918-20, lecturer, mech. drawing and descriptive geom., Dalhousie Univ.; 1920-21, lecturer in civil engrg., Univ. of Alberta; 1923-30, asst. professor, and Sept. 1930, to date, associate professor in Dept. of Civil Engrg., University of Manitoba, Winnipeg, Man. During summers engaged on various engineering works. (*S. 1919, Jr. 1922.*)

References: J. N. Finlayson, H. B. Henderson, C. D. Howe, A. W. Fosness, E. V. Caton, E. Brown, F. R. Faulkner, H. W. L. Doane.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

OGILVY—ROBERT FORREST, of 3489 Atwater Ave., Montreal, Que., Born at Montreal, July 22nd, 1902; Educ., B.Sc., McGill Univ., 1925. Post-graduate work in Dept. Mech'l. Engrg., 1930-31; 1922-23 (summers), city engr.'s office, Hamilton, Ont.; 1924 (summer), instr'man., asst. to divn. engr., Belleville Divn., C.N.R.; 1925-26, res. engr. and inspr. on storm sewer tunnels, City engr.'s dept., Hamilton; 1926-27, engr. i/c of layout and inspn. of all outside pipe lines and conveyors for new mill of International Paper Co., Gatineau, Que.; 1927 (Aug.-Sept.), chief of party on Quinze River Survey, for Gatineau Power Co.; 1928-29, res. engr., La Quiebra Tunnel, Colombia, S.A., for Fraser Brace Engrg. Co. Ltd.; 1929-30, representative of same company to Canadian Bridge Co. Ltd., Walkerville; 1930 (Feb.-July), engr. for Fraser Brace on constrn. of copper refinery at Copper Cliff, Ont.; 1931 (Aug.-Dec.), asst. to res. engr. for the Northern Construction Co. on reconstrn. of Saint John Docks. (*S. 1922.*)

References: J. B. D'Aeth, W. L. McFaul, C. M. McKergow, C. A. Leighton, T. W. W. Parker, J. A. Coote.

SPARKS—WILBUR HAMILTON, of 829 East 14th Ave., Vancouver, B.C., Born at Belmont, Man., Dec. 24th, 1903; Educ., 1922-30, attended 4 years of 5 year course in civil engrg., Univ. of B.C. (Has sup. exams. to pass in 3rd and 4th years); 1926-27 (summers), Coast Quarries, Ltd., Vancouver, B.C.; Nov. 1929 to Apr. 1930, Dom. Water Power & Hydro. Service, Vancouver; 1928 (May-Oct.), 1929 (Apr.-Oct.) and from May 1930 to date, with the Water Rights Branch, Dept. of Lands, Vancouver, B.C., at present asst. hydraulic engr. (*S. 1928.*)

References: W. H. Powell, J. C. MacDonald, E. Davis, F. W. Knewstubb, C. E. Webb, E. G. Marriott, S. H. Frame.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of The Engineering Institute and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Vacant

SALES ENGINEER for promotion and inspection work by large Canadian company; permanent position with prospects for advancement. Must be university graduate in engineering, with knowledge of road construction; and speaking French and English fluently. Not over 30 years of age. Apply by letter, giving full particulars as to education, experience, sales ability. Apply to Box No. 793-V.

MECHANICAL ENGINEER, must be university graduate, not over 30 years of age, with sales ability and experience on lubrication, plant machinery, internal combustion engines, etc. Must be fluent in French and English and have good appearance. Good prospects for right type of man. Apply by letter, giving full particulars as to qualifications, experience and references. Apply to Box No. 794-V.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

DRAUGHTSMAN, experienced in design steam and ventilating plants, boiler layouts, hoisting and other machinery, and structural engineering. Good references. Present location Montreal. For interview apply Box No. 329-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing, or sales organization. Apply to Box No. 334-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., over thirty years experience in municipal and construction work, specializing in roadway work of all classes, wishes position; or will enter into a contract with a reputable firm of roadway contractors to act as superintendent and engineer. Capable of supervising large contracts with the most up-to-date construction methods. Available forthwith. Apply to Box No. 336-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available February 1st. Qualified Captain in military engineering. Apply to Box No. 377-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and moveable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, B.Sc., Jr.E.I.C., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

Situations Wanted

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.Q., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

CIVIL ENGINEER, B.A.Sc. Toronto '28. Experience, hydro-electric, building design, bridges and culverts, inspection and testing of materials. Married. Present location Montreal. Apply to Box No. 576-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Jr.E.I.C., five years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

CIVIL AND MECHANICAL ENGINEER, experienced in design, layout, installation and selling. Sixteen years association with largest Canadian industries manufacturing equipment particularly relating to pulp, paper and lumber and five years design and construction of sulphite mill, including electrolytic bleachmaking from salt. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes on year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door sub-station construction, as assistant engineer. Also geologival survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

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OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931. N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; students test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

CIVIL ENGINEER, graduate University of New Brunswick '31, in C.E. Experience consists of three seasons on a survey party. Available October 1st. Desires permanent position. Willing to go anywhere. Apply to Box No. 672-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

CIVIL ENGINEER, graduate, Jr.E.I.C., age 25, single. Experience includes mill construction, design and supervision. Also design of hydraulic structures, bridge foundation, rigid frames and caissons. Will go anywhere. Apply to Box No. 677-W.

RADIO ENGINEER. Graduate McGill Applied Science '30. Experience includes the design, development and production of broadcast receivers, as well as general radio laboratory practice. Apply to Box No. 680-W.

ELECTRICAL ENGINEER, graduated 1914, desires position with engineering firm or electric utility. Experience in design and layout of power houses and sub-stations, including automatic and supervisory control equipment; design of switchboards and switching equipment; manufacturing, testing, erection and operating of electrical apparatus of all kinds. Anywhere in Canada. Permanent position preferred. Apply to Box No. 681-W.

OPERATING ENGINEER, A.M.E.I.C. Operating superintendent or assistant. Age 44, married. Twenty years experience in industrial manufacturing, steel mills, power plants and quarrying operations, both large and small. Very successful with labour problems, cost accounting, etc. Will take any position with view to betterment. Available immediately in any location Apply to Box No. 682-W.

ELECTRICAL ENGINEER, B.Sc.E.E., University of Man. 1921, A.M.E.I.C., married. Two years Westinghouse test course, three years sales engineer, five years draughting and electrical design on hydro plants, transmission lines, etc. Apply to Box No. 687-W.

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ELECTRICAL ENGINEER, S.E.I.C., B.A.Sc. '31. Age 21. Three months undergraduate experience in electric railway substation. Five and a half months Canadian General Electric test course on induction motors and industrial control apparatus. Available on short notice. Location immaterial. Apply to Box No. 700-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

ELECTRICAL ENGINEER, B.A.Sc., graduate '28. Test experience D.C. motor and generator design, and industrial electric heating design experience. Single. Location immaterial. Apply to Box No. 709-W.

CIVIL ENGINEER, A.M.E.I.C., P.E.Q. Experience includes design and superintending construction of large reinforced concrete and steel mill buildings. Available at once. Apply to Box No. 712-W.

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CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experience in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

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CIVIL ENGINEER, B.Sc. (University of Alberta, '31), S.E.I.C., single, age 24. Experience consists of lumber manufacturing, chainman on subdivision survey, transitman on railway maintenance and assistant on highway right-of-way surveys. Available immediately for position anywhere. Apply to Box No. 724-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

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Structural Design and Erection of Maple Leaf Gardens, Toronto, Ont.

G. Townsend, A.M.E.I.C., Structural Engineer,

and

Charles W. Power, Toronto Manager,
Ross and Macdonald Inc., Montreal.

Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th, 1932.

SUMMARY—This paper deals with the problems involved in the design and construction of the Maple Leaf Gardens, a hockey arena in Toronto, which has a seating capacity for 13,000 persons at a hockey match and about 17,000 when the floor is available for seating purposes. An unobstructed view of the sports area is obtainable from every seat, due to the entire absence of columns. This is made possible through the use of a domed roof, the steel work of which comprises two three-hinged arch ribs spanning the rectangle on the 306-foot diagonals and carried on shoes at the four corners of the rectangle. The structure is tied together by a series of horizontal trusses which support the rafters carrying the steel deck roof. The dimensions of the building are 350 by 282 feet, the height being 146 feet to the highest point of the main roof. Seven hundred and sixty tons of structural steel were used in its construction. The first game of hockey was played just seven months from the date of instructions to the architects to prepare working plans.

The Mutual Street Hockey Arena in Toronto was built many years ago and for some time has been found to be wholly inadequate to provide for the requirements of the Maple Leaf Hockey Club.

During the winter of 1930-1931 the idea of building a sports arena began to take definite shape and in January the directors of the club authorized their architects to make preliminary sketches. The arrangements for financing the undertaking took some time, however, and it was not until two months later, after the architects had prepared further preliminary plans, and estimates of the cost of the structure, and after approximate estimates of cost had been obtained from three contractors, that the architects were instructed by the directors to proceed with the preparation of working drawings and specifications. This was the middle of April, and on May 15th working drawings and specifications were sent out for tenders to a selected list of ten contractors. Bids were received May 28th.

It is interesting to note that the spread between the low bid and the highest bid was only seventeen per cent of the high bid and that there was less than four per cent difference between the low bidder and the second low bidder, both of them being Toronto contractors. These facts are mentioned to show the efficiency of the modern methods of estimating which permit such close figuring.

The contract was let on May 29th. As it was absolutely essential that the ice sheet should be ready for play before the middle of November, this left only five and one-half months in which to erect a building capable of seating some seventeen thousand people.

The first game of hockey was played on the evening of November 12th, just ten months after the appointment of the architects, or seven months from the date of instruction to prepare working drawings. Of this seven months, the preparation of plans, figuring of work, and letting of contracts consumed one and one-half months, and the actual construction of the building five and one-half months.

Previous to the calling for tenders on the construction of the building, tenders for the wrecking of the twenty-five stores and dwellings were received and contract let on April 27th, so that before the contract for the construction of the building was let the ground had been cleared and made ready for the actual work of construction. In addition to the above mentioned twenty buildings which were wrecked, seven stores and dwellings and one church had previously been demolished for the widening of Carlton street, thus removing thirty-two buildings to make room for this one sports arena.

The building occupies a frontage of 350 feet on Carlton street and 282 feet on Church street.

On the inside, the height from the level of the ice sheet to the highest point of the ceiling is 145 feet.

The ice sheet itself is 85 feet wide by 200 feet long and is surrounded by tiers of seats, there being only one tier at each end of the ice sheet and three tiers of seats at the sides.

The ice sheet is so located that its longer dimension runs parallel to the width or shorter dimension of the building, which is a departure from the usual practice in buildings of this kind. There were several reasons for this. It seemed to be the only way to get the desired seating capacity within the limits of the property, and at the same time avoid the use of balconies or galleries which were considered to be undesirable. It seemed to provide the maximum number of seats in the most favourable location for viewing the game and the minimum number in the unfavourable locations. Lastly, it provided a means whereby all posts and columns which would otherwise occur in the midst of the seating could be eliminated and every seat could command an uninterrupted view of the entire ice sheet. This was the result striven for and it was accomplished in the following way:—

To gain access to the seats which rise in tiers on all sides of the ice sheet, it was necessary to provide a number of flights of stairs, and these were grouped in four stair towers, one at each corner of the building, as indicated on the plan (Fig. 3). The right-hand half of this plan is looking down at the seating and the other half looking up at the roof framing.

The four interior corners of the stair towers furnished four points of support which might be utilized for carrying the roof structure, but these four points of support were 225 feet apart one way and 207 feet apart in the other direction. This condition determined the structural problem insofar as the roof structure was concerned. It

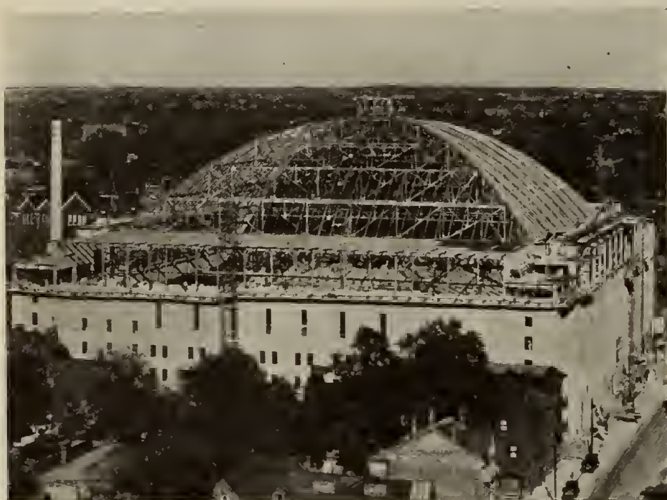

Fig. 1—View of Roof Framing.

was—to roof over a space 207 feet wide by 225 feet long with only four points of support located at the four corners.

It very soon became apparent that structural steel was the most suitable material to employ. Reinforced concrete construction was investigated, but rejected as being too heavy and costly, and above all as requiring too much time for the erection of the form work, pouring and setting. Wooden construction, such as the Lamella system, could not be employed because it did not fulfill the requirements as regards fire resistance.

Fig. 2—View of Interior.

A number of different methods of roofing this space were considered. The most obvious way would have been to span across between the points of support with trusses or girders, which in turn would support typical roof trusses carrying purlins and rafters.

It was estimated that this construction would require about 25 pounds of steel per square foot of roof area, whereas the use of bowstring trusses or steel arches with tie rods in place of the transverse roof trusses would involve the use of about 23 pounds and 20 pounds of steel respectively per square foot of roof area.

Another suggestion made was to span diagonally across between the four points of support, a distance of approximately 306 feet, by means of two three-hinged arches, which would intersect each other at the centre hinge and the thrust from which would be taken into four horizontal trusses tying together the four points of support. Fig. 3 shows these arches and trusses in plan.

The diagonal arches support purlin trusses spaced closely enough together to carry economically beams or channels, acting as rafters and spaced just far enough apart to support the roofing material.

At first it was thought that this construction would required a greater quantity of steel per square foot of roof than the other methods, but a preliminary estimate showed that the weight of steel per square foot was considerably less than for the other type of roof framing. It was found that only about seventeen pounds of steel per square foot of roof were required, including the steel needed for a relatively small amount of framing not actually a part of

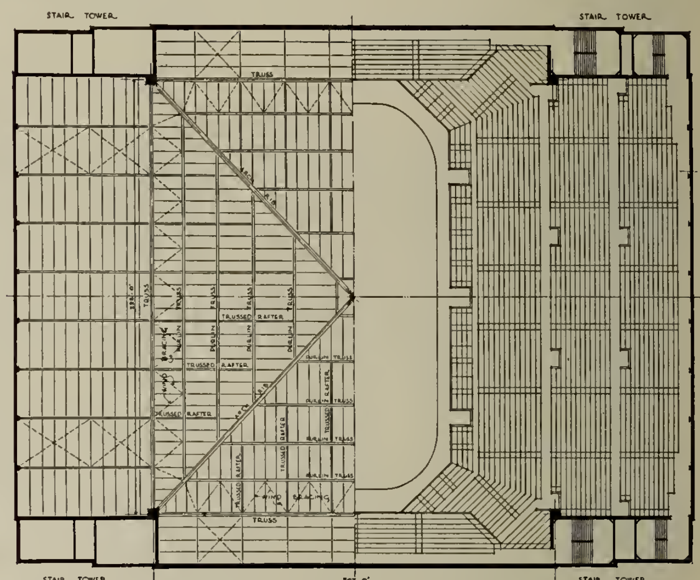

Fig. 3—Plan of Seating and Roof Framing.

the domed roof structure itself, such as the cupola which surmounts the roof, the hanging grid platform for operation of lighting fixtures and framing for flat portions of the roof.

Once it was determined that the three-hinged arches would be economical, the next thing to do was to determine their size and shape. The architectural requirements as regards height suggested that an approximately parabolic shape would be suitable, and as this seemed to work out in a satisfactory way from the structural viewpoint, it was adopted.

The depth of the arch at the support was determined by the depth required for the trusses which tie the four points of support together. These trusses have a span of 225 feet and 207 feet respectively, and their depth was fixed at 22 feet. The depth of the arch at the crown was fixed at 10 feet.

The shape of the arch at the support was determined largely by architectural requirements, having in mind its appearance as well as structural considerations. The other dimensions were determined so as to establish a reasonable span of about 22 feet for the rafters and at the same time keep the web members at a reasonable inclination with respect to the top and bottom chords, and so as to give the whole arch as pleasing an appearance as possible.

The rafters, which are spaced approximately six feet apart, are supported on purlin trusses which span across the four spaces between the four segments of the two diagonal arches. There are five of these purlin trusses in each quadrant of the roof, including the trusses at the eaves spanning across between the supports. The roof structure consists of steel plate roofing material, which is ribbed or corrugated, and which is secured to the purlins by means of steel clips specially made for the purpose, and so designed as to provide a rigid connection between the steel plate roofing and the purlins.

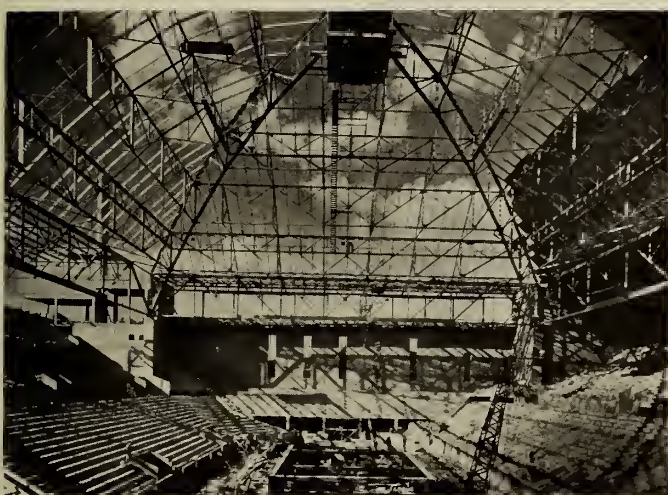

Fig. 4—Interior Looking North from Carlton Street.

The steel plate roofing was used because it added the minimum of dead weight to the roof structure.

On this roofing rests the fibre board insulation and the roofing material, which is what is known as N.I.S. roofing, specially adapted for use on steeply sloping surfaces, and comparatively light in weight.

The dead load from the roofing, including an allowance of three pounds for the rafters, was taken as ten pounds per square foot of actual roof surface.

The live load, or in other words the snow load, was taken as 20 pounds per square foot of horizontal projection of the sloping roof surfaces and 40 pounds per square foot at the top of the curved roof where the surface is nearly horizontal.

The wind load was taken as 30 pounds per square foot of the vertical projection of the sloping roof surfaces and reduced as provided for in the Toronto Building By-Laws (Duchemin's Formula) to a load normal to the sloping surfaces varying from 20 pounds to 29 pounds per square foot of actual roof surface.

The rafters and the purlin trusses were designed for these loads, the rafters being generally nine-inch channels spaced about six feet apart, with ten-inch channels for the flat portion of the roof at the extreme top. For the more steeply sloping portions of the roof, the proportion of the total stress in the rafters due to wind was very high, averaging some 60 per cent of the total stresses.

The load due to wind pressure is transferred by the steel plate roof structure and by the rafters to the purlin trusses which carry the vertical component of this wind pressure while the horizontal component of the wind pressure is assumed to pass into the steel plate roof structure and the rafters and to be transferred by them to the bottom or eaves of the curved roof surface—one-half to the eaves on the windward side of the roof and the other half to be transferred by the roof structure right across and down to the eaves on the leeward side.

These wind concentrations are picked up at the eave line on the four sides of the curved roof surface by four wind bracing trusses which lie in approximately horizontal planes.

The chords of these trusses coincide with the chords of the two lowest purlin trusses (see Fig. 3). They may also be seen by a careful examination of the left-hand side of the photograph shown in Fig. 4.

The wind pressures are thus transferred to the points of support at the four corners, where they are taken into the main arch ribs and pass into the supporting piers.

In order to enable the roof structure to distribute the wind pressure safely to the purlin trusses and to the horizontal wind bracing trusses at the eaves, each quadrant of the domed roof is provided with six lines of angle iron bracing in vertical planes parallel to the rafters and perpendicular to the purlin trusses, the chords of the purlin trusses being thus braced together at intervals of approximately 25 feet.

The three hinged arches are considered to be loaded at alternate panel points of the top chord (where the purlin trusses intersect them) with a variety of possible distributions of the snow and wind loads as follows (see Fig. 7):—

A. Dead Load over the entire roof area.
B. Snow Load over the entire roof area.
C. Snow Load on two adjacent quadrants giving a

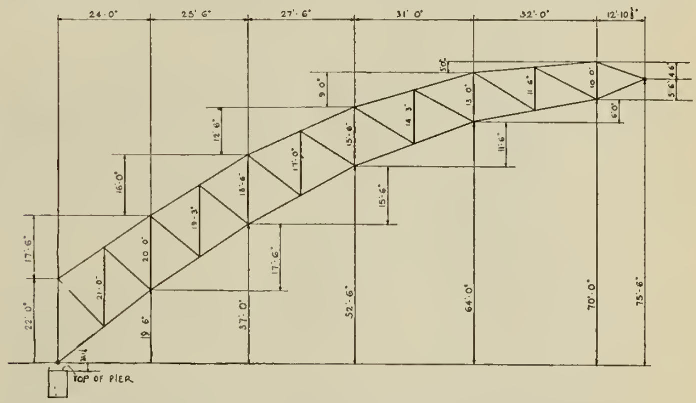

Fig. 5—Outline of One-Half of Three-Hinged Arch.

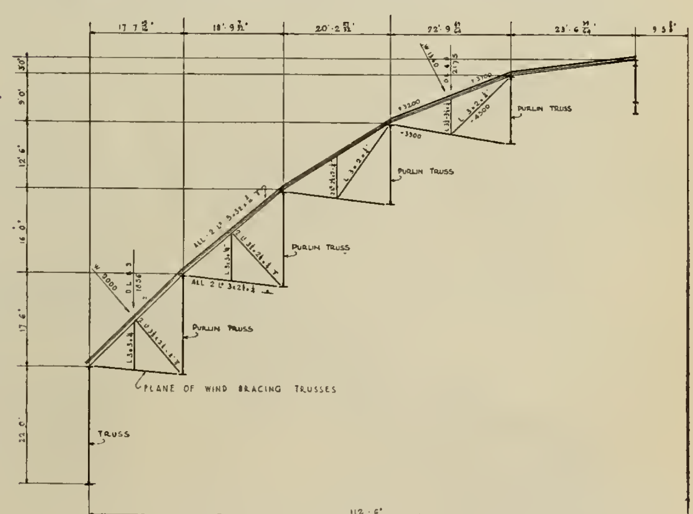

Fig. 6—Trussed Rafter in Section.

full snow loading of one segment of one arch and half snow loadings of the two segments of the other arch. (See Fig. 7C.)

D. Wind load on two adjacent quadrants considering the wind to be blowing in a direction parallel to one arch rib and approximately perpendicular to the other arch rib so that one segment of one arch receives full wind loading while the two segments of the other arch both receive one-half wind load. (See Fig. 7D.)

These conditions were assumed to include all the possible variations of loading which might occur and the arch members were designed for the combination of them which causes maximum stresses.

It was assumed that both snow and wind load could occur together on any one quadrant of the roof surface.

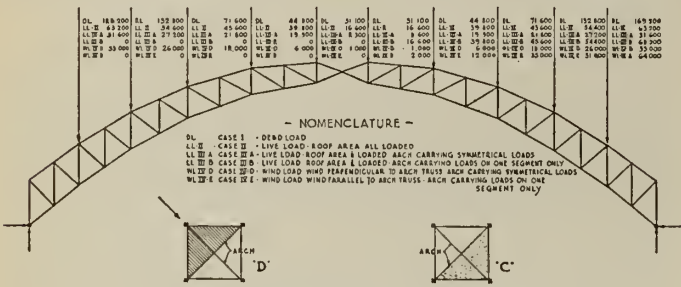

Fig. 7—Loading of Arch Ribs.

Fig. 8 shows on one side the maximum stresses developed in the members of the three-hinged arches and on the other side the sizes of the material used for these members. The stresses were determined graphically in the usual way.

The effect of expansion and contraction of the steel framework due to changes of temperature was given careful consideration. At each of the four supports the arch rib rests on a shoe or bed plate and the structure is allowed to expand by sliding on three of these bed plates, the fourth point of support being fixed. It was assumed that the expansion or contraction would take place at the three points of support as indicated in Fig. 9.

As the structure is supported on top of concrete piers some 65 feet high, it was important that the horizontal thrust at the supports should be reduced to a minimum. The thrust from the arch ribs themselves was eliminated by tying the four points of support together through the lower chords of the purlin trusses, but there still remained the thrust due to expansion and a corresponding pull due to contraction, the amount of which depends upon the friction between the shoes at the ends of the arch ribs and the base plates which rest on the top of the concrete columns. In order to realize as near an approach as possible to a frictionless condition at the supports, "Lubrite" bearing plates were used and it was assumed that the friction was reduced to a maximum of ten per cent; that is, that the horizontal force applied at each support due to expansion or contraction of the steel framework was equal to not more than ten per cent of the vertical reaction.

It was felt that nests of rollers would not prove satisfactory at the supports and the "Lubrite" bearings were considered as an improvement on the sliding shoe plates of bronze which would otherwise have been used.

The bearing consists of a base slab secured to the masonry and a sliding shoe secured to the arch rib, between which the "Lubrite" liners are inserted. To the underside of the sliding shoe is tap-bolted a comparatively thin bronze

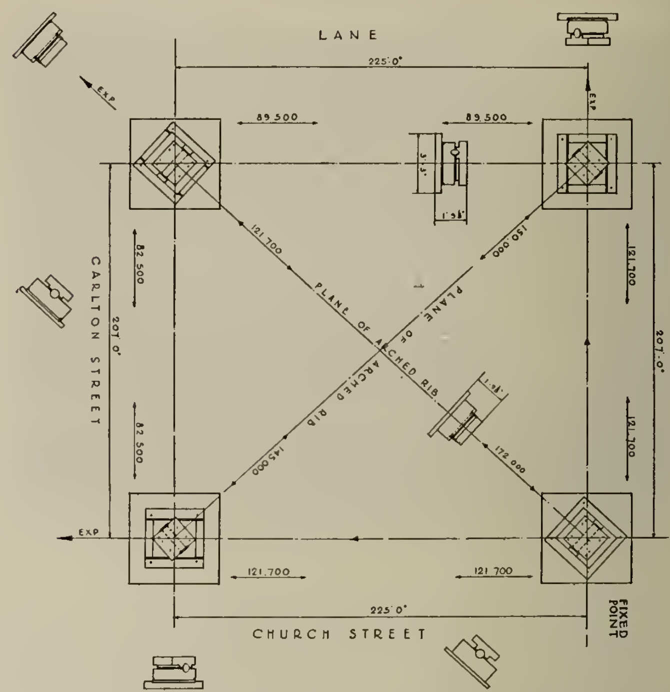

Fig. 9—Diagram showing Direction of Expansion.

plate called a "Lubrite" liner, the underside of which has a lubricating substance placed in grooves in the plate and of such a nature that it will not lose its lubricating value with the passage of time.

The Lubrite liner plate slides on a polished steel saw plate, which is placed on top of the base slab in a recess especially prepared to receive it. The combination of these two plates constitutes the nearest approach to a frictionless bearing which it was practical to use in this case.

The sliding shoes are attached to the end posts of the arch ribs, but as will be seen in Fig. 9, the sliding movement at each support must be restricted in direction so as

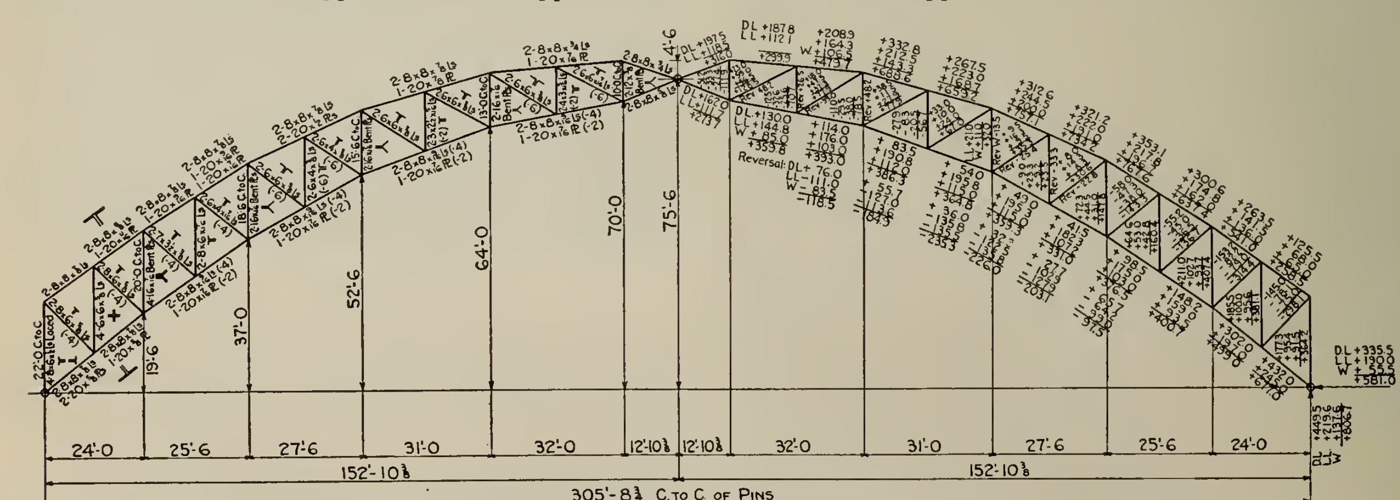

Fig. 8—Stresses and Material in Arch Rib.

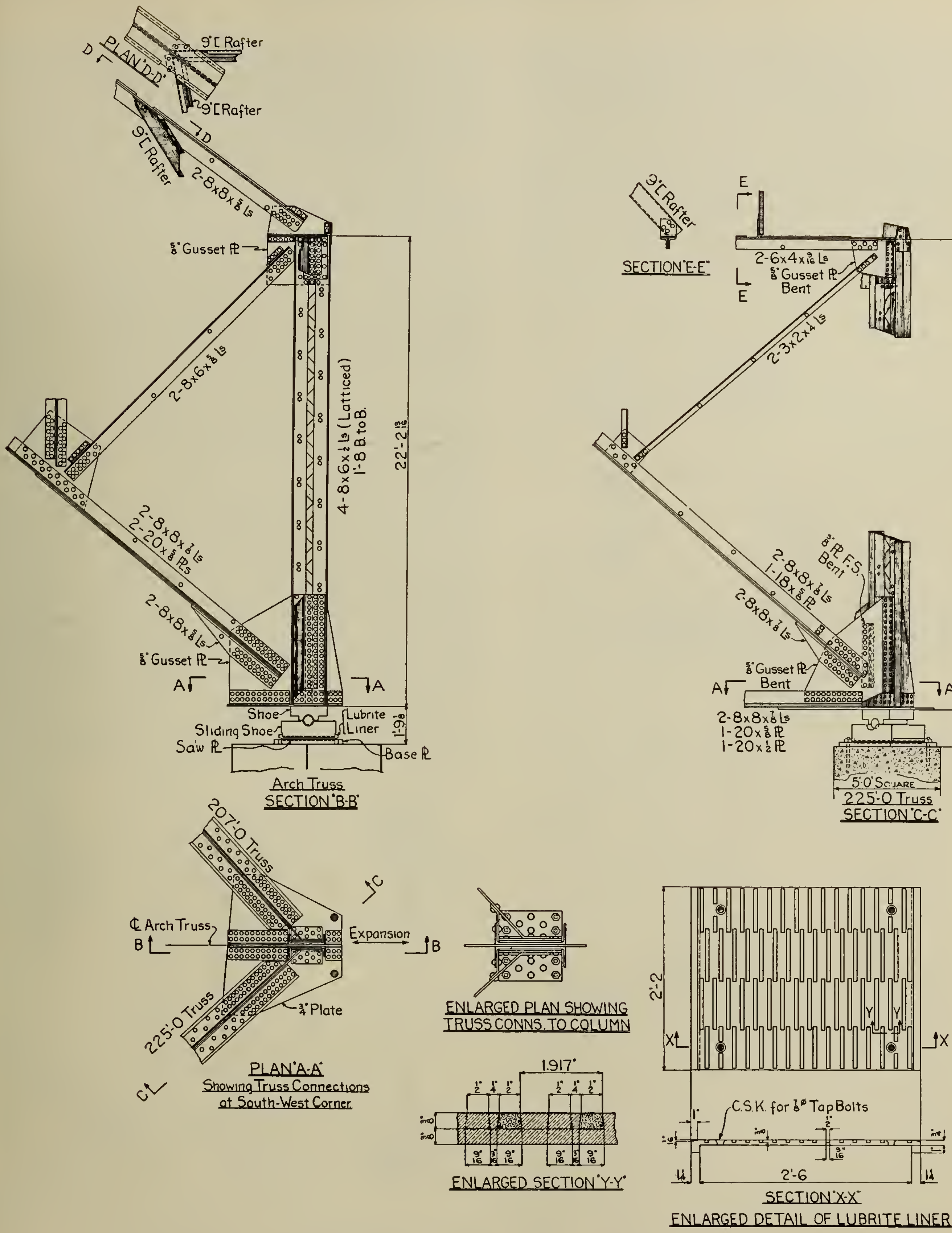

Fig. 10—Details of Arch Ribs at Supports.

to radiate from the fixed support. At the support diagonally opposite to the fixed point, the shoe must be free to slide only in a direction parallel to the plane of the arch. At the other two supports the movement must be confined to a direction at an angle of approximately forty-five degrees with the plane of the arch rib and parallel with the planes of the purlin-trusses. This means that in two cases the sliding shoes must be skewed with respect to the upper slabs and the pins, as indicated in Fig. 9.

Fig. 10 shows details of the end posts of the arch ribs and of the bearings at the supports. It will be seen that the pin forming the hinge is placed between two thick steel slabs, one above and one beneath the pin, and the location of the Lubrite liner on the underside of the sliding shoe slab is shown. The shoe slabs are so designed that the arch rib is quite free to move around the hinge and to adjust itself to conditions of loading and temperature as required.

This figure shows a detail of the Lubrite liner plate, illustrating the arrangement of the grooves which are filled with the lubricating material. It also shows the connection between the end post of the arch rib and the two purlin trusses which come into it at an angle of forty-five degrees. The connections of the rafters to the top chords of the trusses are also shown. It will be noted that the bottom chord of the purlin truss is in tension due to the load on the purlin truss itself and carries an additional tension that acts in resisting the outward thrust of the arch rib.

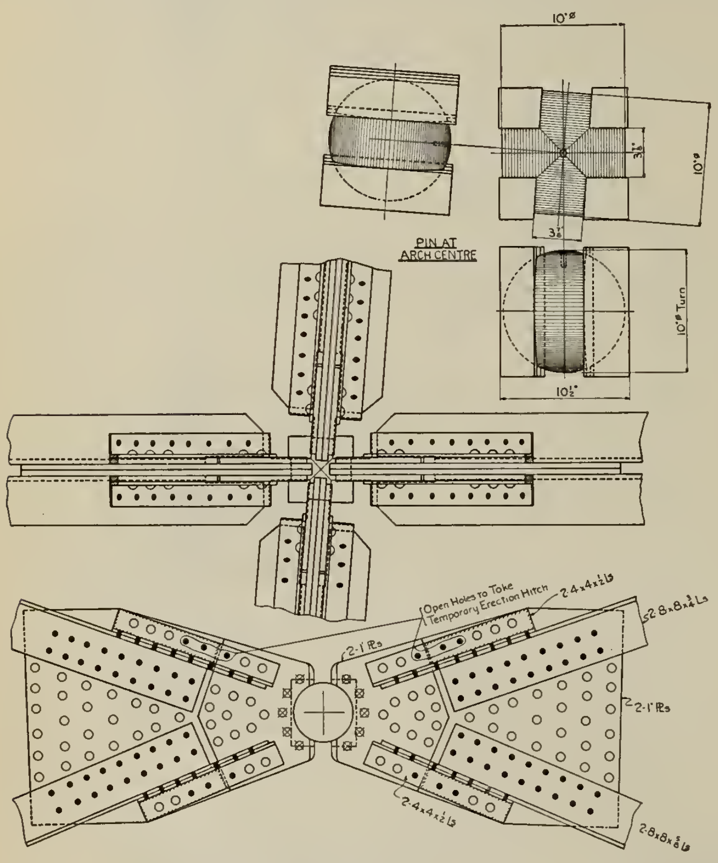

Fig. 11—Central Hinge in Detail.

The two three-hinged arches intersect each other at the centre hinge, that is, at the highest point of the roof, and at this point they must pass each other. At first it was thought best to provide two hinges, one above the other, and each acting independently, but finally it was decided that there would be only one central hinge which would be made common to the two arches.

As these hinges usually take the form of steel cylinders with the axis in each case at right angles to the plane of the arch, it was necessary to make a piece whose finished surface would correspond to that of two intersecting steel cylinders. To accomplish this, a piece of hard steel roughly in the shape of a cube was prepared and in four faces of this cube, opposite to each other, there were cut grooves or channels, leaving in each case at the bottom of the groove a finished cylindrical surface against which the gusset plates at the ends of the four arch segments could take a bearing. This is shown in Fig. 11.

The web members of the arch ribs are generally composed of angles, but at the points where the purlin trusses intersect and are supported by the arch ribs, the vertical web members which receive them are composed of two plates bent to an angle of approximately forty-five degrees so that the outstanding legs will lie in the planes of the purlin trusses. These bent plates are stiffened by the use of filler plates and short lengths of angles riveted between the two bent plates at intervals.

The vertical reaction at each of the four points of support is approximately 1,200,000 pounds and to carry this load a reinforced concrete column five feet high was provided.

The four columns are located at the corners of the four stair towers (see Fig. 3) and the interior walls enclosing these towers are also of reinforced concrete and serve as buttresses to brace the columns for their full height. The walls are made 18 inches thick, reinforced with steel rods and are further stiffened by the concrete construction of the stairs and stair landings and the floor slabs inside the stair towers. The presence of these four braced towers of concrete behind the four supporting columns is necessary to resist the horizontal thrust or pull due to the expansion and contraction of the steel roof structure, which is transmitted to the tops of the supporting columns through the bearing plates.

It was assumed that the use of the "Lubrite" sliding shoes would reduce these horizontal forces to a maximum amount of ten per cent of the vertical reactions from the arch ribs, and the concrete columns, walls and foundations were designed accordingly. The maximum horizontal force acts at the fixed support, being the resultant of two forces parallel to the two sides of the building, and was assumed to be equal to ten per cent of the vertical reaction multiplied by the square root of two (see Fig. 9). The columns have one-half of one per cent of vertical reinforcing and both columns and walls are of rich concrete of 1:1½:3 mix.

The footings are designed to transmit to the soil a pressure not exceeding 8,000 pounds per square foot and the footings for the columns and the adjacent walls were poured together so as to form one combined footing at each corner tower. These footings are shaped like the letter "L."

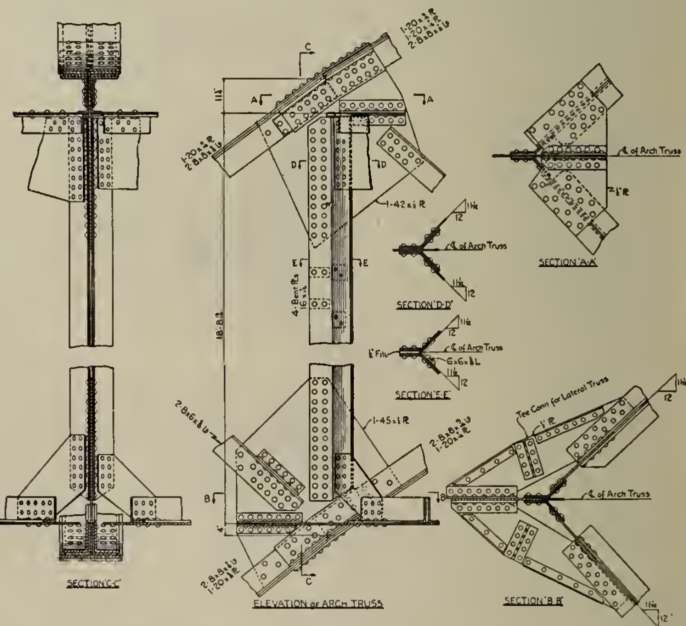

Fig. 12—Details of one of the Web Members of the Arch Rib.

The centre of gravity of all the loads corresponds very closely with the centre of gravity of the combined L-shaped footings, but the thrust and the pull acting at the top of the concrete column some seventy feet above the bottom of the footing causes an eccentric load on the foundations, which had to be given due consideration.

The stepped floors for the seating which rise from each side of the ice sheet and extend from the edges of the ice sheet to the exterior walls of the buildings are supported on reinforced concrete columns and sloping girders of the same material. Fig. 13 shows in section one of these sloping girders and the columns.

The risers of the steps form concrete beams spanning between the sloping girders and are reinforced with steel rods.

The treads of the steps are of stone concrete, forming slabs between the above mentioned riser-beams and are reinforced with steel wire mesh.

Expansion joints are located at each side of each of the stair towers, ledges and brackets being provided on the interior concrete walls enclosing these towers. Underneath the sloped seating there is room for the various lounge rooms, toilet rooms, offices, etc., and the floors of these rooms are of reinforced concrete construction of the ordinary beam and slab type.

It has been stated that five and one-half months elapsed between the time when the work was started June 1st and the date of the opening game of hockey November 12th. To build the forms, place the reinforcing steel and pour the ten thousand cubic yards of concrete and to erect the seven hundred tons of structural steel roof framing in that short space of time was a difficult task.

The work was accomplished in the following manner:—

June 1st saw two steam shovels and eighteen trucks at work, and on June 4th there were three shovels and twenty-five trucks. All shovels and trucks worked in day and night shifts from June 1st on. Steam shovel excavation was completed June 16th, approximately 22,000 cubic yards of earth having been removed in sixty shovel-days of ten hours, averaging 366 cubic yards per shovel-day.

Hand excavation for foundations started June 4th—four days after the commencement of work with the shovels. This work extended over a considerable period of time so as to keep the excavation just ahead of the pouring of concrete.

Work on concrete forms started on June 6th.

The foregoing dates are repeated to illustrate the dovetailing of the different part of the work the one into the other. Shovel excavation started June 1st. Hand excavation started June 4th. Formwork started June 6th.

The general contract did not include the steelwork and therefore from the very start of the job the general contractors were required to work in conjunction with the contractors for the steel work.

This, of course, is a condition common to all buildings of composite concrete and steel design, but in this particular case even more co-operation was necessary because of the peculiar type of construction both in steel and in concrete and because of the very limited time in which the work must be completed.

Dates for completion of a job are always set, but very seldom is there definite knowledge at the start of the job of the day on which the structure positively must be complete. In this case, the National Hockey League had already set their schedule for the following season, which called for the opening game in Toronto on November 12th, and to be one day or even a few hours late on the completion meant very serious inconvenience to the owners and also very material monetary loss to them.

The steelwork had to be rushed, which meant that the maximum amount of work must be done in the shop. The trusses of the dome portion of the roof were all of such dimensions that they could not be assembled completely in the shop. This feature required a very great deal of careful planning in advance. The dimensions of the site are 350 feet frontage on Carlton street and 282 feet on Church street. With this area it would seem that all of the room necessary to construct anything would be available, but as the seats covered the entire area except the ice sheet (85 feet by 200 feet) this job was more congested than is customary. In an ordinary building, such as an office, hotel, loft or store building, after a floor is complete there is almost immediately space available for the different trades to work, but in this case the sloping seats made the floors constructed underneath them particularly inaccessible, and therefore practically all of the work had to be done on the ice area, as otherwise a portion of the seating floor would have to be held up. The holding up of any part of the work was the last thing that anybody wanted; therefore, the general contractors would not consent to the holding up of any portion of the work unless they were shown the absolute necessity for doing so. Room had to be left for the carpenters to make their forms, and for the erection equipment for the steelwork, and also for the storing of the steel in proper sequence so as to be available for erection. The amount of steel thus to be stored had to be predetermined and also the exact amount of space required to permit it to be stored.

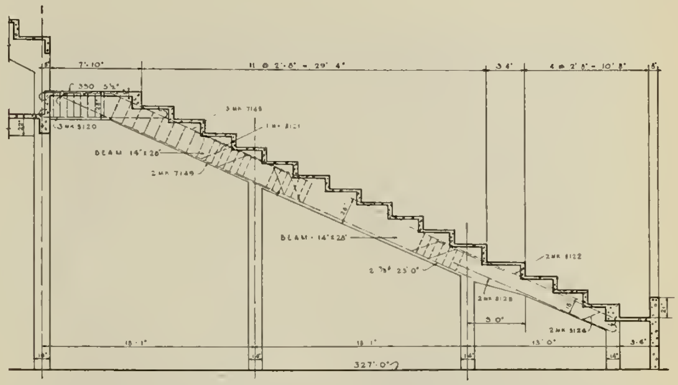

Fig. 13—Sloping Girders Supporting Seating.

The plans for the delivery and the erection of the steel were changed three times before the final scheme was arrived at. At first it was decided to start on the west side and bring the steel in on that side, but difficulties arose which made it impossible for this to be done and then it was decided to commence on the east side. This likewise was found impossible due to job conditions—and eventually one full bay of the seating on the south end had to be left out temporarily to permit the steel to be brought in to the job from Carlton street. To make conditions a little more interesting, the construction of the new sewer, the paving of Carlton street and the widening of that street with the consequent removal of public utilities, was all being carried on at the same time, and this also had to be taken into consideration.

The net result of all this was that the general contractors constructed the concrete walls around the corner stair towers first of all and then formed up and poured the two top tiers of seats on the east side, so as to bring the construction out even with the corner towers, the pouring of which preceded the construction of the seating floors.

This concrete was poured in six operations:

1st: The foundation walls and the exterior walls, together with the columns and slabs on the ground floor.
2nd: The second floor framing.
3rd: The mezzanine floor framing.
4th: The third floor framing.
5th: The second tier of seats.
6th: The top tier of seats.

The concrete for this portion of the seating and the concrete for the corner stair towers on the east side was completed on August 10th.

The concrete was mixed by two mixing plants of the "inundation" type, one located at the east side of the building and one at the west side. These plants were located in the basement so that the sand and gravel were dumped directly into hoppers from which they flowed into measuring hoppers and from there into the mixer. From the mixer the concrete flowed into buckets which were hoisted and the concrete conveyed through chutes to another hopper and wheeled in buggies from there to the forms.

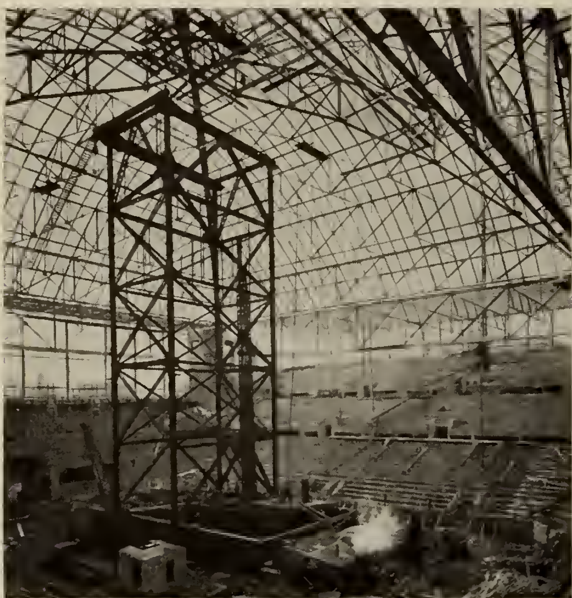

Fig. 14—Erection Tower.

While the foregoing work was in progress, the contractors for the structural steelwork started their preparations for the erection of the steel framework.

The unusual design of the roof framing necessitated a very careful study of the field operations. The chief difficulties involved were as follows:—

(1) Practically all the trusses were of such a size that they would require to be sent to the job in knocked-down condition, but available space for field assembly was very limited and there was only the one entrance to the site which could be used for bringing in the steel.

(2) It was imperative that the two intersecting arches should be supported until final closure.

(3) The great height of the central hinge, one hundred and forty feet above the floor level, presented a problem in equipment.

(4) All the trusses and the arch ribs had Tee-shaped chords and therefore would be very flexible and hard to handle.

(5) Simultaneous contact on the crown pin by the four arch segments at closure was essential.

(6) It was necessary that the erection and assembly should be accurate so that erection of the steel in the last quadrant could be done without difficulty.

(7) The great speed required.

The erection scheme finally adopted involved the use of a steel tower to support the four segments of the arches and to carry the erection booms (see Fig. 14).

This tower consisted of four braced columns, forming a structure rectangular in plan, 27 feet by 37 feet on centres of columns, and 108 feet high, mounted on a base consisting of two plate girders 8 feet 4 inches deep and 76 feet long, each weighing 17 tons, placed 37 feet apart, and braced by timber frames. This gave, with the blocking, a height of 120 feet for the tower.

On top of the tower were placed two braced timber bents forming a wooden tower 12 feet high, on each of the four corners of which was placed a 50-ton jack to receive and support the four segments of the main arch ribs.

On each of the longer sides of the tower, about 50 feet above the base, a girder of two 28-inch beams was installed, with timber supports from the plate girder base. These girders were to receive the boom foot pins at each corner of the tower. At the top of the tower, gudgeon pin supports at each corner were installed. The booms had an overall length of 137 feet and were equipped with a single runner line in addition to the load falls. The booms were fitted with bull rings, operated by swinging engines on the ground. These engines and the three-drum 10 by 12 engines were located at each end of the tower base.

The tower was always operated with both booms on one side and four 1¼-inch guys always on the opposite side. For this purpose two anchors for two guys were concreted into the foundations of each of the four corner stair towers at the base of the piers supporting the arches.

The approximate capacity of these derricks, boomed out, was 20 tons. The great length of the booms required that they should be trussed in the horizontal and vertical planes.

While this centre tower was being erected, the steel was being fabricated and the several parts assembled in the shop, delivered to the job in the proper sequence, set up on the ground by a Dominion Gopher tractor crane and assembled as completely as possible ready for hoisting into position.

While the above work was in progress, wooden towers were being made in the yard of the structural steel contractors, shipped to the job in sections, and these towers erected in place ready to receive the disconnected ends of the trusses. The towers were 10 feet square and 100 feet high.

On the east side, both the northeast and southeast arched ribs had to be erected in two pieces, while the large truss spanning from the southeast concrete tower to the northeast tower had to be erected in three pieces. Two of the wooden towers were used to support the outer ends of the corner ribs, and two for supporting the outer ends of the east truss. This easterly truss was erected in three pieces starting from the northeast concrete stair tower and progressing in a southerly direction, the corner ribs having been set in place in advance of this truss (see Fig. 15).

The next operation was the erection of the trusses spanning from this large truss over to the Church street wall, so that they might serve to brace the large truss. Following this, the two additional purlin trusses spanning between the two corner ribs were erected, as illustrated in Fig. 16, which shows the four stages of the work of erecting the roof framing.

This was all of the steel which could be erected at this time and now the boom mounted on the southeast corner of the central erection tower had to be moved to the northwest corner. While the steel on the east side was being erected, the steel for the north side was being delivered and assembled, which operation was continued during the transfer of the boom from the southeast to the northwest corner of the tower.

The next operation was to erect the exterior wall columns on Wood street, the large truss spanning from concrete tower to concrete tower on this side and the beams connecting same to the Wood street wall columns. Following this, the remaining portion of the northeast corner rib had to be erected. Then the northwest corner rib erected, and the purlin trusses spanning from rib to rib set in place. The upper ends of the segments of the main arch ribs rested on the jacks, which had been set up on top of the four corners of the erection tower.

The steel on the west side was erected in the same sequence as the steel on the east side. In order to do this, the boom erected on the northeast corner of the central tower had to be moved to the southwest corner. After this portion of the steel was erected, the boom on the northwest corner of the central tower was moved to the southeast corner and all of the remaining steel was erected with the booms on the south side of the tower.

Very careful study was necessary in laying out the assembly of the steelwork to met the time schedule, as the small space available made the ground assembly and swinging into place of the steel unusually difficult. It was found necessary to assemble the trusses and arch ribs in tiers on the ground, having due regard to the sequence of operations, so that the right truss was uppermost when required. Practically all of the ground assembly was done by the tractor crane, only a few of the heavier members being lifted by the tower booms. This left the tower booms free for erection purposes. All trusses and segments of the arch ribs were assembled flat and some difficulty was anticipated in raising them to a vertical position and hoisting them into place on account of the Tee-shaped chords. Two of the trusses lifted had a length of 190 feet. By the exercise of care in balancing these trusses from the two booms and with the assistance of the tractor crane no great difficulty was experienced. When the connections were made, and whilst the two booms held the truss, the single runner line on the boom tips was utilized to erect sufficient bracing to ensure stability of the truss.

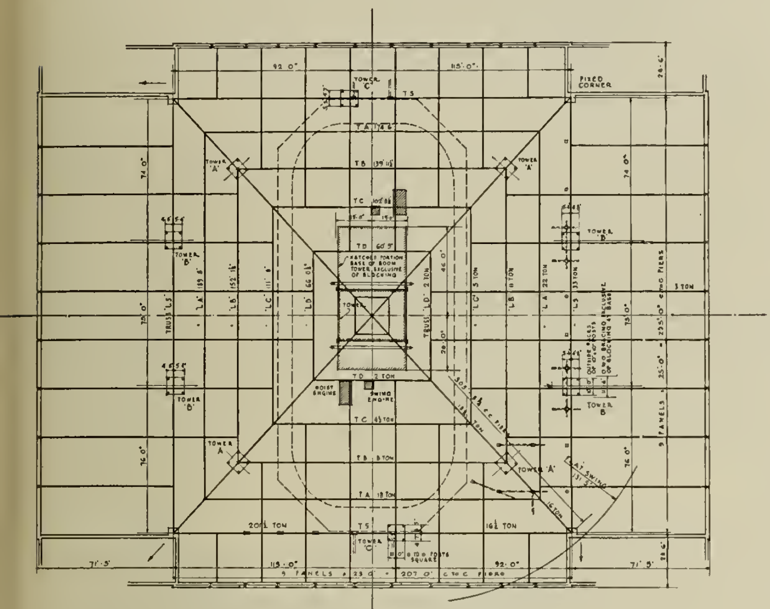

Fig. 15—Steel Erection Plan.

After all bracing and rafters had been erected on September 24th the final closure of the four segments of the two arch ribs was made. This was probably the most interesting item of the erection programme and was accomplished by bringing the four segments or half arch ribs to a dead level at an elevation about 1½ inches higher than the final elevation by means of the four 50-ton jacks situated on the top of the central erection tower at panel points of the arch ribs, approximately 13 feet from the pin centre. The pin gusset plates were temporarily attached to the pin itself, connection holes for the top and bottom chords being left blank. The pin was then set up on its true centre and the holes marked on the pin gusset plates through the holes in the ends of the top and bottom chord sections. The pin with the pin gusset plates still attached to it was then removed and returned to the shop for drilling instead of having the holes drilled in the field in order to speed up the operation and to enable the pin to be replaced the same day it was removed.

After the pin was placed, the joint was quickly riveted up and the jacks were slowly, but evenly, backed off. A deflection of one inch was noted and this left the pin about half an inch above its final calculated elevation with some dead load still to be applied.

When the concrete of the west side had been poured ready to receive the steel, it was not possible to proceed with the complete forming and pouring of the bottom tier of seats, owing to the fact that the space occupied by this tier of seating was required by the steel men for the storing of the steel yet to be erected on the east, west and south sides.

The seats of the lowest tier nearest the ice were formed and poured piecemeal as conditions permitted. Had the steel work been erected complete on each side as the work proceeded, the booms would have been tied in so that the one could not have been used for taking down and setting up the other, and this, of course, would have meant manhandling and serious delay. Actual time consumed in erection and riveting was thirty-six working days, and this was accomplished without any of the men employed being even seriously injured.

During the time the steel was being erected, the work in connection with plumbing, heating, ventilating, electrical work and refrigeration was being proceeded with. The erection of the steel plate roof deck was started as soon as the riveting of the flat portion of the roof on the east side was completed.

The main tower used in the erection of the steel was removed on October 1st. The general contractors' gang started immediately to grade the ice area and spread the cinders under the concrete slab; the concrete slab was poured October 3rd—two days after the removal of the erection tower.

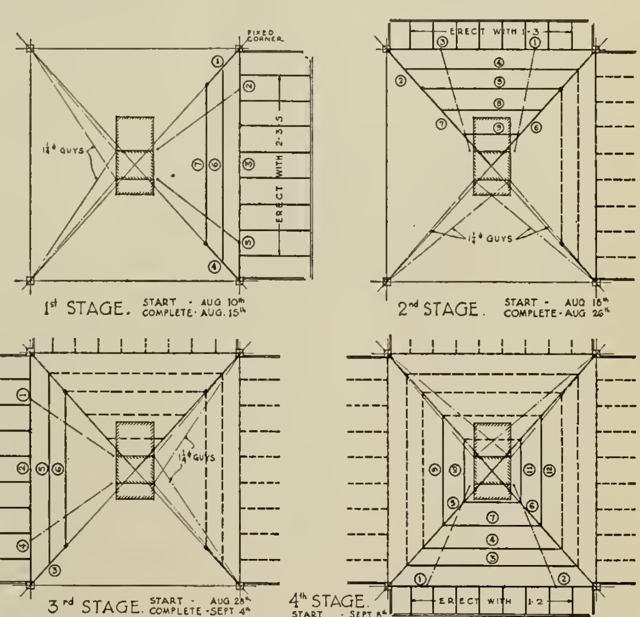

Fig. 16—Successive Operations in Erection of Roof Framing.

This under slab was coated with pitch, and two layers of cork board, each two inches thick, were placed on the slab set in hot pitch. On the cork board were laid two layers of heavy building paper, which was covered with soapstone, on which was laid a continuous layer of sheet zinc. On the sheet zinc were laid steel chairs in the form of tees to receive the refrigeration pipes and hold them in position. The refrigeration pipes were 1¼-inch extra heavy, spaced 4 inches on centre, laid in grooves cut in the steel chairs. The pipes came to the job welded together in 40-foot lengths, which were laid in position and welded, making a continuous pipe from header to header, the headers being located at the north and south ends of the ice area. There were just under ten miles of this 1¼-inch pipe laid in the floor. The pipe was embedded in a 4½-inch slab of concrete, the pouring of which was started at 7.30 a.m. October 17th and was completed by 8.00 p.m. the same day, including the ¾-inch of cement finish.

Weekly meetings were held in the job office, at which every contractor and sub-contractor was present, and discussed with the architects and general contractor his difficulties and explained what was holding up his work, if anything; thus the way was cleared and promises obtained as to when certain portions of the work would be completed, so that the contractor for the next portion of the work might lay out his plans to follow up and complete his work for the man who was to follow him, and so on. These meetings not only served to pave the way for the work to follow but also act as "get together meetings," where the different trades have an opportunity of learning about the problems of the other fellow. Minutes were kept of these meetings and each week every man was met with his promise of the previous week and an explanation forthcoming if the promise was not lived up to. Such meetings are undoubtedly a very great help in expediting the work.

The building as conceived by the architects could not have become a reality, and above all could not have been designed and built within the time available, had it not been for the co-operation of the contractors and their engineers.

Acknowledgment is due to the general contractors, Messrs. Thomson Bros., of Toronto, to the Dominion Bridge Company, Ltd., contractors for the structural steelwork, and to the Truscon Steel Company, contractors for the reinforcing steel.

The authors also wish to express their thanks to the engineers of the above mentioned companies for the assistance rendered by them in connection with the preparation of this paper.

The New Pumping and Filtration Plant at Niagara Falls, Canada

General Description and Special Features

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SUMMARY.—The paper describes the new water works plant of the city of Niagara Falls, designed for a population of 19,000 with provision for future extension. After investigation it was decided to provide a plant with an initial rated capacity of 10,000,000 gallons per day, so arranged as to be capable of extension in the future to four times this amount. There is a single supply main, concrete with steel core, 27 inches in diameter and over 11,000 feet long. In the future it is intended to install a 1,000,000 gallon elevated steel storage tank. The raw water is taken from the Niagara river above the falls, where the Welland river joins it, and the plant includes the necessary provision for coagulation, pumping the raw water, mixing, sedimentation, filtration and chlorination. Provision is also made for chlorination of the raw water if required, and for the necessary washing of the filter beds.

Since being placed in operation, examination has shown that the plant is giving the desired results and that leakage is negligible.

Prior to placing the new water works plant at Chippawa in operation, Niagara Falls was supplied with chlorinated water pumped direct from the Niagara river to the city distribution system, through the agency of a pumping station located at Table Rock near the crest of the Horseshoe falls. Originally, the point of intake for the pumping station was just above the falls, but changes in the flow of the river at this point, due to recession of the crest-line and other causes, finally destroyed the efficacy of this intake, and of recent years the water supply has been taken from one of the conduits of the Ontario Power Company. There were no means provided to reduce the sediment in the water, and down-lake gales on Lake Erie frequently produced a condition of turbidity, which, coupled with heavy chlorination, at such times rendered the water supply to the consumer almost unfit for use.

Furthermore, the pumping station had become obsolete as to equipment, and was so situated, in the centre of the Victoria Park area, that there were no satisfactory or permanent means of extension or of adding facilities for sedimentation or filtration.

Confronted with this situation, which had already approached an acute stage, the Board of Water Commissioners decided about two years ago to have the problem analysed from all angles, with the ultimate object in view of removing once and for all the various disabilities which prevailed, and of obtaining for the city an adequate and assured supply of raw and filtered water, through the agency of a water-pumping and treating plant, which would meet all requirements of supply, operation and demand for many years to come.

The problem resolved itself, first, into a study of existing conditions; second, an analysis of existing demand and distribution, together with a projection of the possible trend of future demand; third, a study of the Niagara river for the purpose of selecting the best point of intake available within reasonable distance of any freehold property which would be suitable as a site for a pumping and filtration plant; and fourth, the design and layout of the plant itself and the selection of the proper equipment.

The general location plan, Fig. 1, shows the old pumping station and the supply mains leading to the distribution system. It also shows the location of the booster station which was necessary in order to maintain an adequate pressure at the south end of the city, especially in case of fire. The location of the pumping station at an elevation more than one hundred feet below the southern section of the distribution system, together with a main direct to the lower northern levels, caused excess pressures at the lower end when attempting to maintain normal pressures at the high levels with the main pumps. Both sections of the city were fed by means of small separate mains in which the friction loss was excessive under conditions of peak demand. These mains were interconnected at the pumps, which arrangement, together with the small capacity of the two riser mains, necessarily gave rise to a certain amount of wasteful throttling at the station and the consequent requirement of a booster for serving the higher levels. Furthermore, the water works system was not equipped with a storage tank which could function as a pressure regulator, or as a source of reserve supply, and it was therefore necessary to operate the pumps always at a rate to correspond with the rate of consumption.

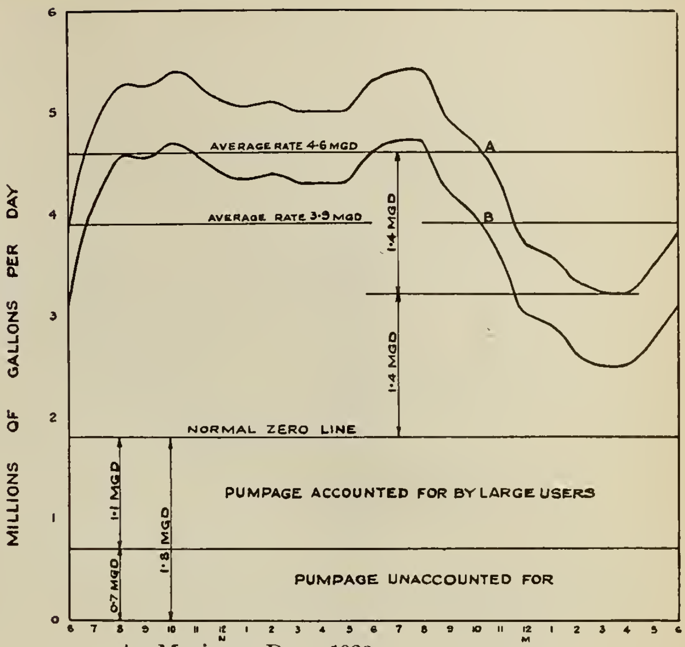
The analysis of the service demand brought out several interesting facts which are clearly illustrated on the curve sheet, Fig. 2.

On this sheet curve A is the actually recorded maximum day's pumpage for the year 1928, showing an average of 4.6 m.g.d., or at the abnormal rate of 240 g.p.d. per unit of population. This abnormal per capita rate is definitely accounted for by the unusually high rate of night use shown by curve *A*. Normally, a daily pumpage curve, with maximum and average rates as shown respectively on the curve sheet, would have a line of zero pumpage at about where a rate of 1.8 m.g.d. shows actually on the curve sheet, Fig. 2. This condition is partially accounted for by the fact that there were three customers whose demands were greatly in excess of that of a like class of consumer in an average city of 19,000 population. These were the border terminals of the Canadian National Railways, the Queen Victoria Park System and the American Cyanamid Company. These three consumers alone accounted for an average maximum demand rate of 1.1 m.g.d., but even so, this amount deducted from the originally unexplained discrepancy of 1.8 m.g.d. still left a balance of 700,000 g.p.d., which could only be rationally accounted for by excess leakage.

A subsequent pitometer survey revealed a leakage waste approaching 1,000,000 g.p.d., one major leak alone accounting for 500,000 gallons of this total.

After taking into account the more or less constant demands of the park and the railway, and assuming the residual maximum pumpage of 1928 to represent the *normal* demand which is subject to an increase proportional to population, the probable average pumpage for the maximum day worked out as follows, after allowing for the elimination of 700,000 g.p.d. of wastage.

Year	Maximum Day's Average
1933	4,600,000 gallons
1938	5,250,000 gallons
1943	6,000,000 gallons
1948	6,750,000 gallons



A—Maximum Day—1928.
B—Same Day with Excess Waste Corrected.

Fig. 2—Daily Pumpage Curves.

The above estimated figures take into account only the city of Niagara Falls proper, and do *not* include the possible annexation of surrounding villages and populous centres which are well within economical reach of the new plant, and which must be considered as logical future users of filtered water from the Niagara river. Much of this area is at present served from wells and springs which are approaching the limit of their capacities and the quality

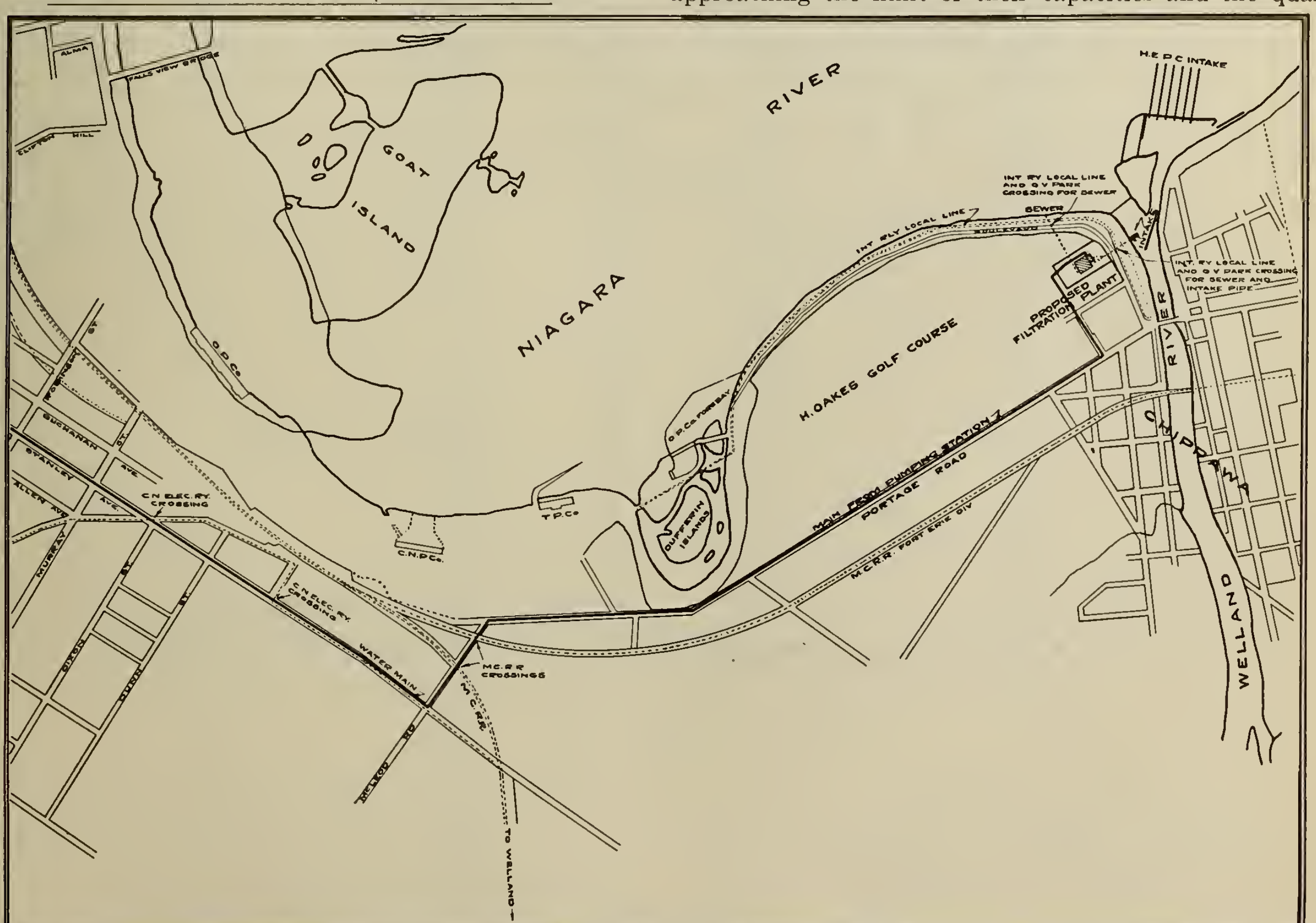


Fig. 1—General Plan Showing Location of Plant.

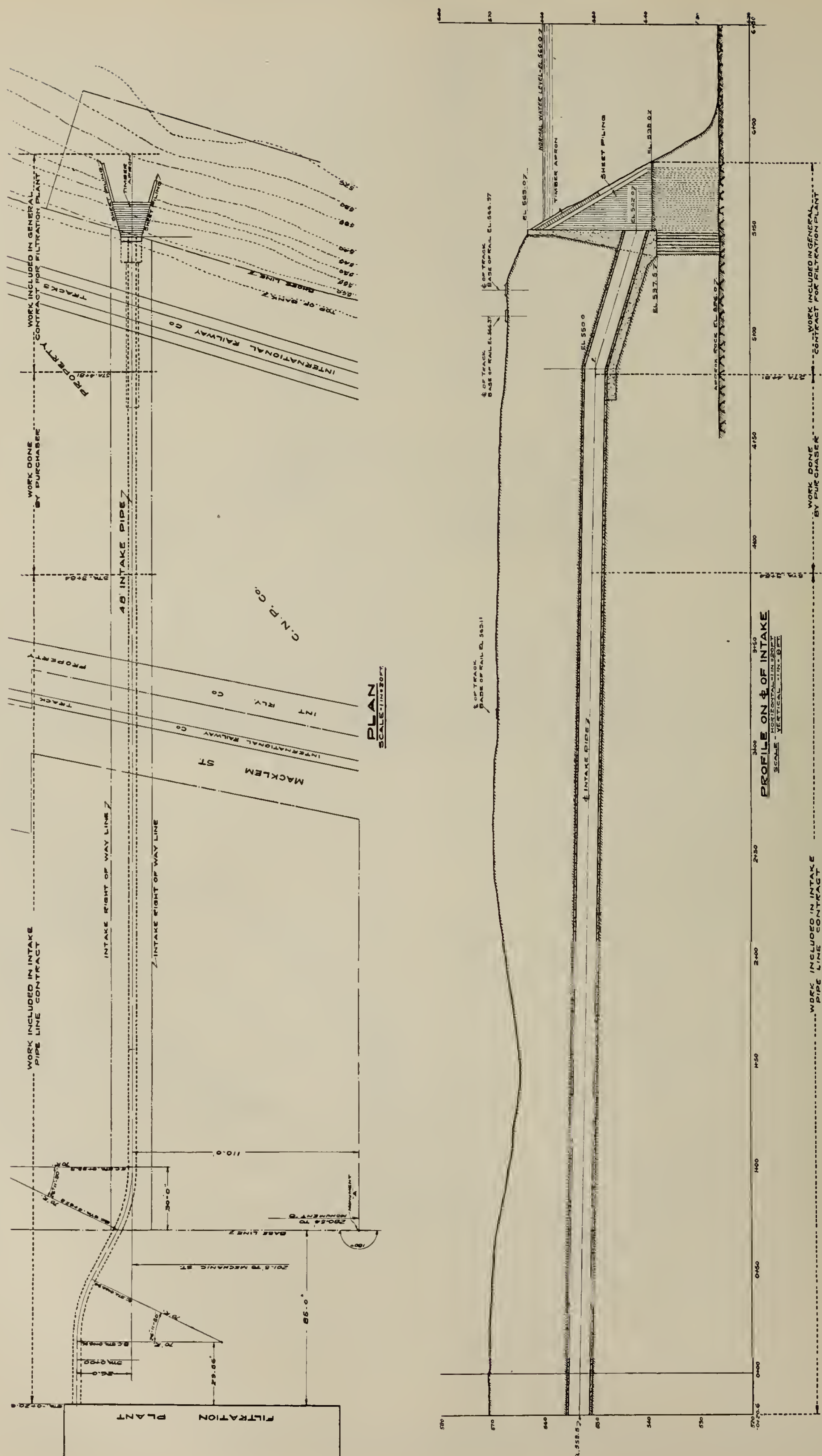


Fig. 3—Plan and Profile of Intake Pipe.

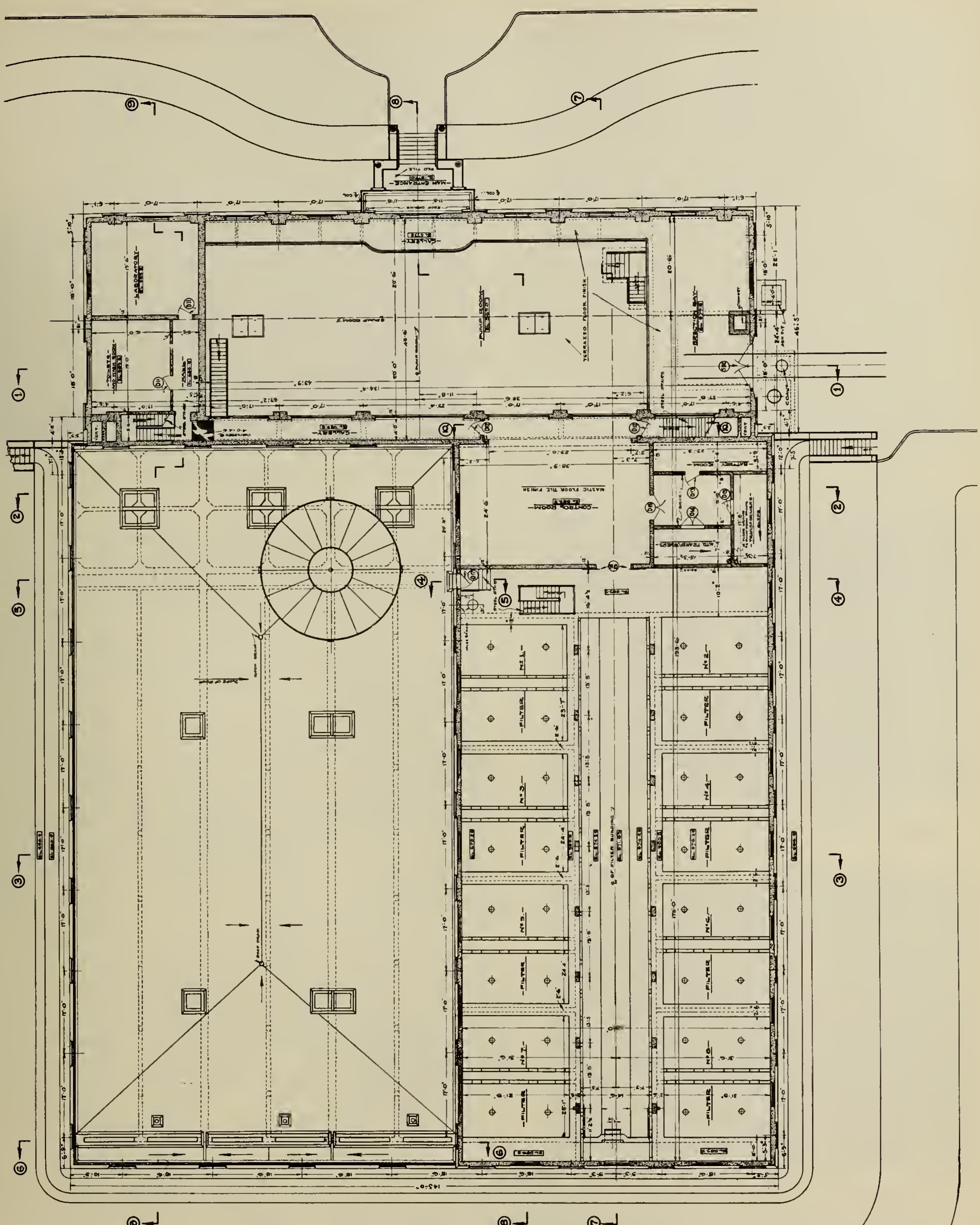


Fig. 4—General Arrangement of Filtration Plant.

of the water is such that the economy of its use is questionable.

Based on the conditions above explained, it was primarily decided that a site be chosen which was suitably located to obtain good intake conditions and to serve properly not only the city itself but the surrounding district.

It was then recommended (*a*) that the initial pump and filter installation should have a maximum rated capacity of 10,000,000 gallons per day, with provision for expansion to four times this capacity; (*b*) that the plant and city be connected through a single steel-core concrete supply main feeding into the distribution system at the then existing booster plant; and (*c*) that an elevated steel tank of at least 1,000,000 gallons capacity be erected at the booster station site or at some point along the extension of the supply main in the city. All of these recommendations were accepted but the actual purchase and erection of the tank has been deferred for the time being.

A study of the general plan of the district and the conformation of the Niagara gorge showed conclusively that any water supply must come from the south, and that unless that part of the Niagara river bank between the crest of the Falls and the mouth of the Welland river, or the north bank of the Welland river itself, proved totally undesirable, the location of the intake and plant should be fixed within these limits. Previous studies carried on during the preliminary work of power development, and records taken over years of power plant operation, gave ample evidence that the most suitable location for a water works intake, both from the standpoint of quality of water and freedom from ice and floating debris, was to be had at the mouth of the Welland river. The same conclusion was reached by the engineers of the Hydro-Electric Power Commission before choosing the intake site for the Chippawa-Queenston development. It was decided, therefore, to locate the mouth of the new intake on the north bank of the Welland river just inside the protecting works of the Hydro-Electric Power Commission's intake, and safely upstream from the outflow of any part of the local Chippawa sewage system. This location has the advantage of water drawn from the deepest part of the Niagara river and is protected from floating river ice and debris by the concrete intake structure and diversion wall of the Power Commission. Furthermore, the mouth of the intake is only about five hundred feet from a freehold site of sufficient area to accommodate a pumping and filtration plant of much greater capacity than 40,000,000 gallons per day, and one at the same time affording excellent foundation conditions for structures at such elevation that there will never be any danger of contamination either from the surface or raw river water. The general plan, Fig. 1, shows clearly the location of the plant, with the intake inside the main power intake, and the wash-water drain discharging into the Niagara river below the intake.

Fig. 3 is a general plan and profile of the intake as built. The intake extends from the water's edge, at a point 18 feet below water level, and 16 feet above the bottom of the Welland river, to the north-east corner of the pumping station, where it discharges into an intake chamber.

The concrete breast wall, in which is embedded the mouth of the intake pipe, is placed at the water's edge

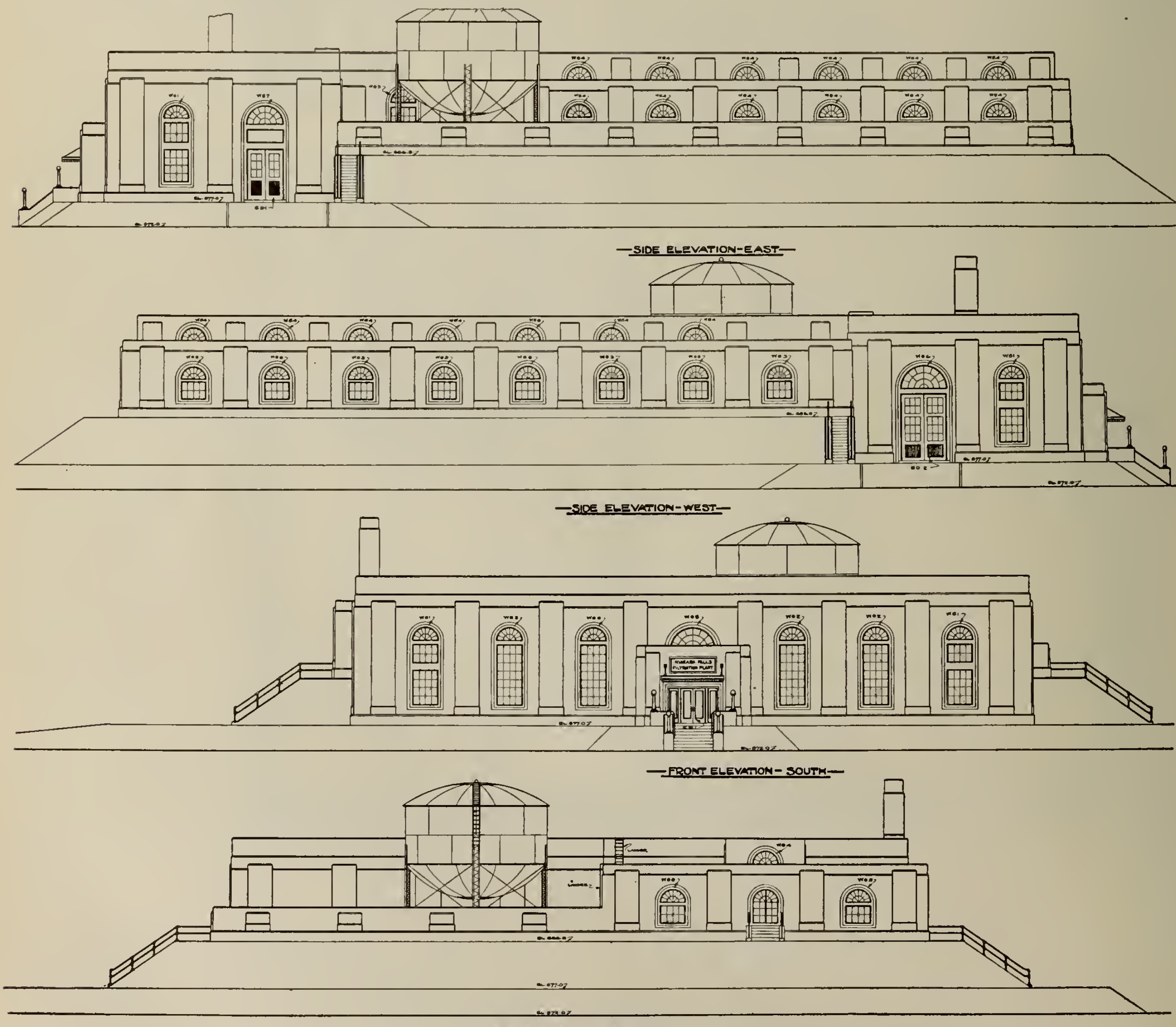


Fig. 5—Exterior Elevations of Superstructure of Filtration Plant.

and is supported on timber piles driven to rock. The river bank is excavated in front of the wall to provide an entrance to the intake mouth. This excavation is protected at either side by sheet steel piling driven to rock and cut off at the top to conform to the natural contour of the bank. A creosoted timber apron, placed across the top of this opening between the rows of piling, serves as a protection to the intake against floating debris and at the same time acts as a support for the top ends of the piling. The intake pipe itself is a forty-eight-inch reinforced concrete pipe with grouted joints laid in gravel.

Fig. 6—View of Plant showing Pump Room and Sedimentation Basins.

The dimensions of the intake as a whole are such that the plant can be extended to double the original installed capacity without further increasing the intake facilities, and the velocity at the intake mouth and through the pipe-line will be sufficiently low that there will be no danger of diverting any appreciable amount of foreign matter from the main stream of the river.

The design of the plant was not influenced by any peculiarities of the site or general location and it was possible, therefore, to work, unhampered, toward clear lines of flow and to produce a layout exceedingly simple, containing all of the elements necessary for the proper treatment and delivery of the water. As previously mentioned, the plant has been arranged and equipped to allow expansion to four times the initial capacity with a minimum of future cost, and all parts have been placed so as to be easily accessible for operation, inspection and repairs. All materials and equipment can be delivered into the building by truck at grade level, and practically every piece of equipment can be reached by either one of the cranes. No attempt was made to incorporate anything unusual in the plant, and standard equipment and arrangement were used throughout, except in a few instances where there were obvious advantages to be gained by deviation from this policy. Standard pipe and fittings, with no specials, were used in every case, and all operations which could be carried on without the use of moving machinery were so arranged. The few instances wherein deviation was made from standard and accepted practice are listed below and explained later in this paper.

1. Special discharge valves.
2. Spiral flow mixing chambers.
3. Specially dimensioned pumps.
4. Special pipe joints.
5. Ejector pump for wash water.
6. Crane and removable floor for pipe gallery.
7. Steel core reinforced concrete pressure main.

The plant is of reinforced concrete throughout, and has been designed and proportioned to house the equipment, basins and filters in the most compact manner possible, with a central control room from which all of the main elements of the plant are either actually within view or readily accessible. The plan, Fig. 4, shows clearly the general arrangment and layout, and Fig. 5 shows the exterior elevations. The filter and sedimentation section can be extended both longitudinally and laterally, maintaining the same general arrangement and appearance, while the pumping section, which has been designed as a permanent front and entrance to the whole, has all of the elements of a 40,000,000-gallon-per-day plant.

Having regard to practical utility and efficient operation, buildings of this type do not lend themselves to comprehensive architectural treatment within the usually prescribed limits of cost, and recourse must be had to the simpler elements of line and perspective, and to the conception of simplicity combined with enduring strength, to achieve anything approaching an aesthetic effect. An attempt has been made to realize this conception in the lines and mass of the exterior front elevation of the pump room, as shown by Fig. 6, by the superimposed arches of the operating and observation galleries shown in Fig. 7, and by the combination of line, perspective and space in the filter gallery, as illustrated in Fig. 8. These results were of course mainly due to the use of reinforced concrete.

The course of the water through the plant from the point of entrance is roughly in the form of a circle. The low-lift, or raw-water pumps raise the water from the river elevation to the mixing chambers from which it flows down one side of the plant through the settling basins, and back along the other side through the filter section to the high-lift pumps, which are located in the same room as the low-lift pumps. All of the treatment is applied within this circle.

Fig. 7—Interior of Pump Room showing Control Room and Galleries.

Fig. 8—Filter Operating Floor from Control Room.

Raw water enters the plant from the intake pipe which discharges into an intake chamber located at one end of the pump section of the building. Reference to Figs. 9 and 10, showing the horizontal and vertical sections through the structure, will assist in following the course of the water and locating the various items mentioned. The intake chamber is adjacent to and separated from the screen chambers by a concrete partition in which are openings for the passage of the river water to the screens. The screens, of which there will ultimately be two, are placed in separate chambers arranged so that either can be dewatered for inspection or repairs. The screens are of the revolving type, motor-driven and provided with high pressure sprays for removal of all debris which may collect on the surfaces. The cleaning water and debris are carried, by means of a steel trough, to an auxiliary removable bucket type screen which retains the solids and allows the water to flow back to the intake chamber. Each screen has sufficient capacity to allow the passage of water at the rate of 20,000,000 gallons per day without exceeding a velocity of two feet per second. After passing the screens the water flows through openings in another partition wall to the adjacent suction chamber. Each of four entrance and exit openings to the screen chambers is provided with a heavy cast iron brass-fitted sluice gate which is operated from the screen room floor level through a spindle, gears and hand-wheel.

The suction chamber is immediately below the room which houses the alum machines and sump pumps. The floor of this room forms a cover for the chamber and serves as the foundation for the alum machines, which are so placed that alum is dropped directly from the machines into the screened raw water as it leaves the suction chamber to pass into the low-lift pump suction header. This floor is approximately 12 feet below the outside grade level and the chemical is delivered to the storage room, directly above the machine room, by truck, from which it is dumped into the machine hoppers and passes by gravity to the point of application.

The alum machines are of the dry-feed type, motor-driven and hand-regulated. They are equipped with hoppers extending through the ceiling of the room to the storage room above. Each machine can be regulated to feed alum at a rate as high as five hundred pounds per hour. Fig. 11 clearly illustrates the above description.

The pump suction headers are placed beneath the basement floor of the pump room. Each is located under the line of pumps which it serves and runs longitudinally of the pump room. The vertical and horizontal sections in Figs. 9 and 10 show the positions, extent and cross-section of each and the location of the connections to the pump suctions. The raw-water header is fed from the suction chamber after receiving its dose of alum, and the clear-water header is fed from the outlet of the clear-water reservoir. Both headers have a capacity sufficient for a plant of 40,000,000 gallons per day, and a twenty-four-inch interconnection, with valve, is provided so that the filters can be by-passed in emergency. Each header has three steel outlets of sufficient size to serve the pumps contemplated for the ultimate station installation. These outlets are positioned directly under the pump suction opening, thus making straight suction connections. No valves are provided in the suctions to the low-lift pumps since these units are above the high-water level of the river. The high-pressure pumps are under pressure from the filtered water reservoir, and each suction is therefore controlled by a gate valve operated from a stand on the pump room floor through universal joints.

The pump room occupies the major part of the entrance building and the main floor, which has the same elevation as the floor of the alum machine room, is open to view from the control room and galleries connecting the various parts of the plant. Six pumps have been provided, three each for the raw and filtered water respectively. They are supported in two rows on beams which in turn are carried by columns to the basement floor. The floor, beams, columns, pump connections, etc., have all been arranged to receive the largest pumps which it is expected the plant will ever require. The existing pumps are placed in the fixed suction locations and the discharge and series piping designed to meet the dimensions of the larger pumps. This arrangement did not affect the design of the single-stage raw-water pumps, but it was necessary to specify a definite length between the centres of the two halves of the two-stage pumps in order that the scheme could be carried out, the object being to eliminate further floor cutting or complications in piping when the demand necessitates the installation of larger pumps.

As mentioned, the pump room contains six pumps. All of the low-pressure pumps are new. They are of the single-stage, bottom double-suction volute type driven by squirrel cage motors. They operate against a total head of 35 feet and two have a normal capacity of 6,000,000 gallons per day, while the third has a capacity of 3,000,000 gallons per day. Motors have been provided with ratings in excess of those required to drive the present pumps, so that an increase in pump capacity in the near future will not necessitate the purchase of additional drives.

The layout of the station included three two-stage, bottom double-suction volute type high-pressure pumps with capacities corresponding to the three low-pressure pumps. Two pumps were available, however, from the old station, and these have been installed at Chippawa. The installation of these old pumps did not affect the permanent layout except that the piping was necessarily somewhat more complicated and the floor openings misplaced. One new pump was purchased having a capacity of 6,000,000 gallons per day against a head of 265 feet, and the characteristics of the old pumps were changed to meet the new conditions.

For priming, each pump is connected through a valve to a main vacuum pipe located beneath the pump room floor. This pipe is exhausted by means of a vacuum pump situated at the north end of the pump room. For emergency, the system can be exhausted by an ejector which receives its power water from the high-pressure main and discharges into the main sump.

The pumps are controlled on the main floor, each having a control pedestal upon which are mounted the discharge and suction gauges, an emergency light and a push-button start and stop switch. There is also a push-button switch on each pump panel of the main switchboard. The control pedestals for the high-pressure pumps also carry the control for the discharge valves.

These valves are of the Larner-Johnson balanced hydraulic type and are combination stop and check valves. They are constructed on the principle of the needle valve, giving stream-line flow conditions and are operated by means of the pressure differential between the integrally cast opening and closing chambers. The rate of closing or opening is readily adjusted to meet the conditions of operation. Normally, the valve closes when the pressure on the pump side is lower than that on the header side, and tends to open as the pressure is built up in the pump upon starting. The valve has a further function in protecting the headers, piping and pumps against the shock of flow reversals such as might occur upon power failure. In case of an emergency of this kind, the valve, having previously been adjusted to the local condition, is tripped through relays and a solenoid causing it to close at such a rate as to completely, or nearly so, cushion the water-hammer due to the wave action in the long column of water in the main, thus preventing any appreciable rise of pressure at the station. It was felt, in choosing the valves

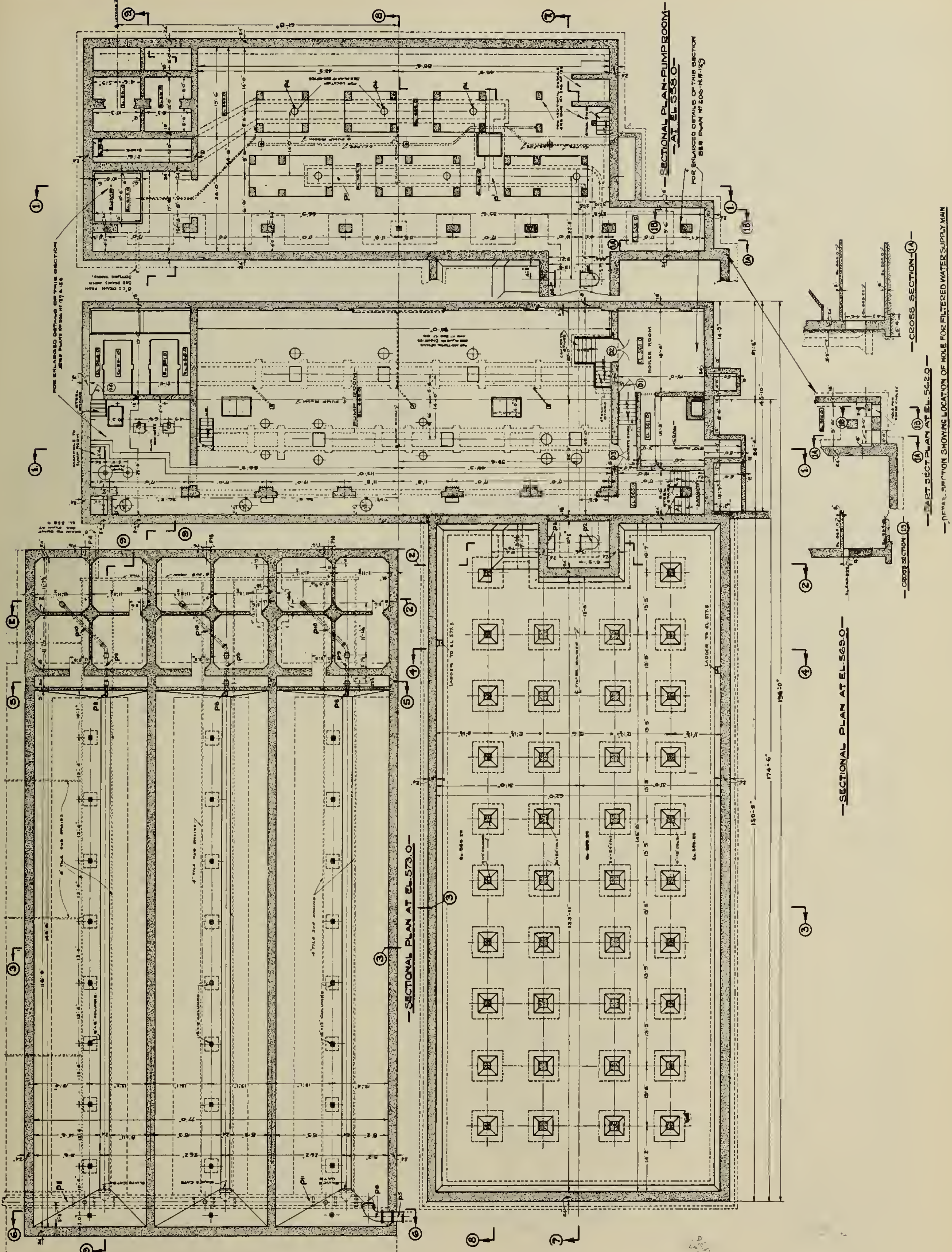


Fig. 9—Typical Horizontal Sections of Filtration Plant.

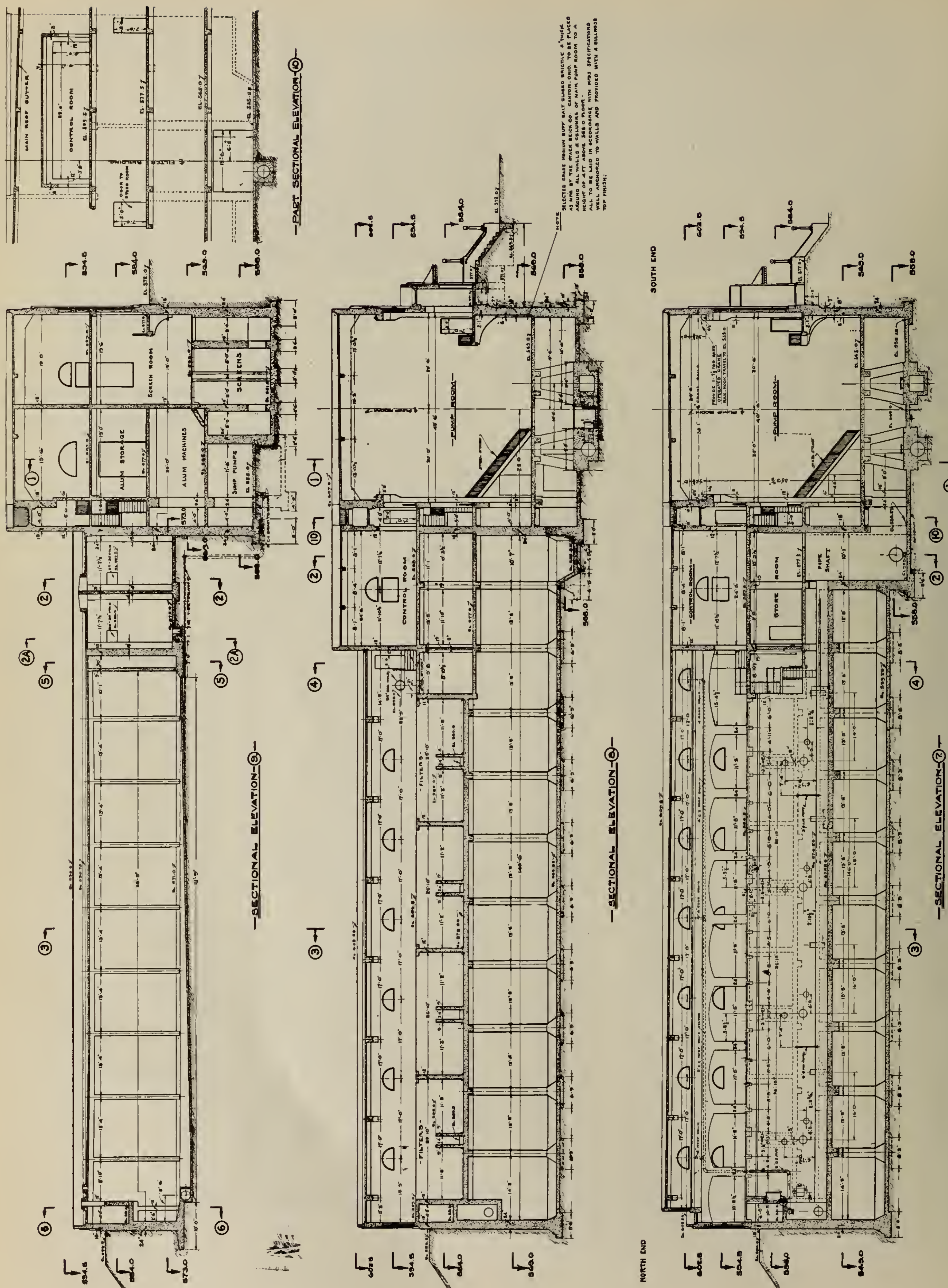


Fig. 10—Typical Vertical Sections of Filtration Plant.

for this station, that the above described type was far superior to the ordinary disc check valve and afforded a protection to the station, the need for which could not be overlooked in view of the 12,000-foot discharge main and the velocities which would eventually prevail therein. This main has no branches in its entire length and it has been calculated that, under certain conditions, water-hammer pressures would attain a magnitude of three hundred and eighty-five pounds per square inch. The valves have been in operation for some months and their

Fig. 11—Alum Machine Room showing Machines and Sump Pumps.

action under both normal and emergency operating conditions fully justifies their additional cost.

The discharge valves for each low-pressure pump are two in number. One is the conventional gate valve with gears and off-set spindle, operated from the main floor by means of a floor stand, and the other a low-pressure disc-type check valve.

Fig. 12 shows the layout of the pump room and also the arrangement of the low and high-pressure discharge headers. The high-pressure header is constructed partly of lap-welded steel pipe and partly of a built-up riveted pipe. It was designed for a maximum pressure of four hundred pounds per square inch and all flanges, elbows and nozzles are of extra heavy cast steel.

The header has a capacity sufficient for a plant of 40,000,000 gallons per day, to the wall of the building, where it is divided into two twenty-four-inch branches. One branch is blanked and the other passes through the foundation wall, terminating in a valve chamber just outside the building. The Venturi tube and station cut-off valve are placed in this outside length. The first measures the discharge from the filtered water pumps and the second serves to disconnect the station from the supply main which leaves the plant from the valve chamber. The meter register is located on the pump floor near the high-pressure pumps.

The low-pressure header is of class "A" cast iron pipe with Victaulic joints. The header proper has a capacity of 40,000,000 gallons per day. It branches, however, to two lines of half this capacity at a point beyond the last pump connection. One of these branches is blanked, while the other rises and crosses the basement to the dividing wall between the pump section and the three mixing chambers, where three twenty-inch connections are made to pipes which rise along the wall through the pump room floor. Each of these pipes enters one of the mixing chambers and can be shut off by means of a hand-operated gate valve located above this same floor. The Venturi meter, which measures the raw-water pumpage, is located in the cross-over pipe between the header and the mixing chambers, and the register is on the operating floor above. This pipe line also carries a specially constructed hydraulic gate valve which serves the purpose of a regulator for the flow of raw water to the filters by its throttling action on the low-pressure pumps, and is controlled by means of a pilot valve located in the gallery at the pump floor level. The pilot valve in turn is actuated, through suitable mechanism, from a float which rests in a tank placed above the pilot valve at the level of the water in the flume which connects the sedimentation tanks with the filters. A direct connection between the flume and tank is made by means of about 150 feet of two-inch pipe. As the water level varies in the flume the valve is closed or opened slightly by means of this control and the level is maintained constant within close limits. The long pipe-line connecting the flume and tank has the effect of a choke, thus preventing any hunting action. The pilot valve is reset to neutral position by means of a "floating" lever and connections to the main valve tailrod.

After the alum application at the entrance to the suction header, the water and coagulant receive a thorough and violent mixing as they pass through the raw-water pumps. The next step in the treatment occurs in the mixing chambers, where the mixture is kept in constant motion through the agency of its own velocity and the design of the chamber. The period of retention here is from twenty to forty minutes depending upon the rate of consumption. The capacity of the chambers is such that three of them will handle water at the rate of 20,000,000 gallons per day with a retention period of approximately twenty minutes. During this period the coagulant makes contact with and collects suspended foreign matter to form the "floc" which is necessary for efficient sedimentation and filtration. From each mixing chamber the water and suspended floc pass to the stilling chamber, which is merely an open space behind a partition wall in the sedimentation basin, so placed as to still the velocity of outflow from the mixing chamber and cause the water to begin its progress along the sedimentation basin at a low velocity which is uniform over the whole cross-section. This is accomplished by allowing the water to pass through the stilling wall by means of a large number of small openings suitably spaced over the whole wall. Thus the water moves along the basin in true lines, without disturbance or eddies, at a rate which will allow the settling-out of the major part of the solid matter before the two-hour period of retention is passed. The capacity of the three basins, as built, is 10,000,000 gallons per day. The additional capacity, to conform to that of the mixing chambers, will be attained by lengthening the basins. From the basins the water passes over weirs to the flume which carries it to the filter section of the plant.

Each mixing chamber is divided into four equal parts by vertical partition walls. Water is brought into one of these four parts by means of the discharge piping from the low-lift pumps. This discharges at floor level, parallel to and along one side wall. The action of the water flowing in this manner imparts to the whole body of water a circular motion. Water flows out of this quarter of the chamber, at the top, through an opening positioned so as not to interfere with the direction or velocity of this motion. Thus the water, after entering, moves slowly through the section of the chamber with an upward spiral motion to discharge into the top and along one side of the second section. The action in each of these is the same as already described, except that in the second and fourth sections the spiral motion is downward. The layout of the chambers has been found to impart a motion to the mixture of water and coagulant which affords a thorough contact at velocities which allow a good formation of floc without excessive settling in the chambers themselves. Provision for cleaning has been made by the installation of open underdrains to the sedimentation basins. Free inter-flow during normal

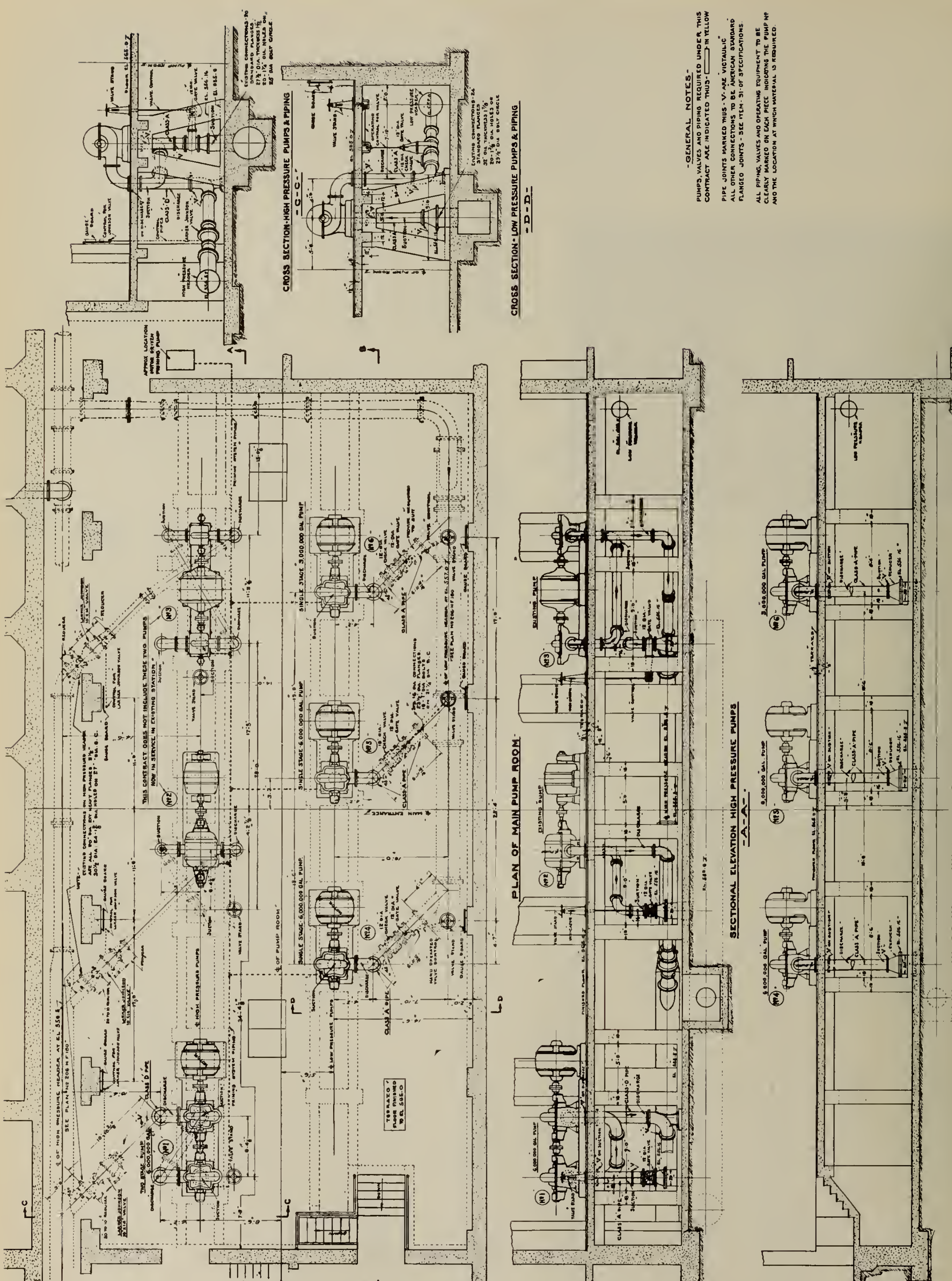


Fig. 12—Layout and Connections for High and Low Pressure Pumps in Main Pump Room.

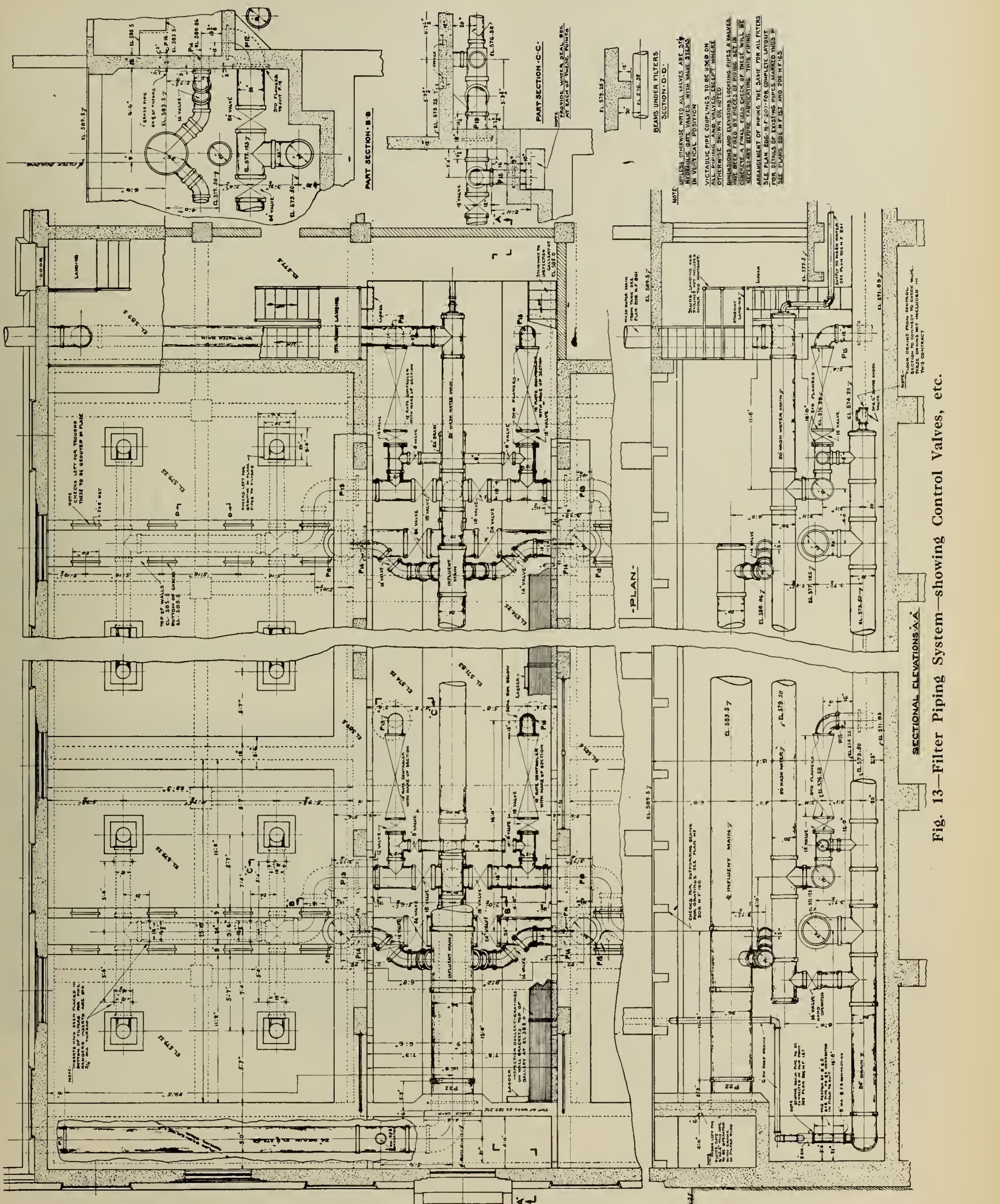


Fig. 13—Filter Piping System—showing Control Valves, etc.

operation is prevented by a weighted flap valve at the sedimentation basin end of the drain.

The stilling walls are shown on the plan, Fig. 9, and sectional elevation Fig. 10.

No description of the sedimentation basins is required other than a reference to the above mentioned figures. Provision for cleaning is made by means of sloping floors to a central gutter which in turn slopes to an opening to the main sewer at the discharge end of each basin. This opening is controlled by a cast iron sluice gate operated from the roof of the basins. A pressure water line supplies the water necessary for flushing. The outside walls of the basins are protected by an embankment built to the water level and the roof is insulated by a one-inch covering of impregnated fibre-board surmounted by a standard bonded tar and felt roof.

The over-flow weirs are supplied with an angle iron lip placed at an elevation six inches below normal water level in the filters, and stop-logs are provided to prevent a reversal of flow when any basin is shut down for cleaning or inspection.

After passing over the weirs from the sedimentation basins, the water crosses to the filter room by way of a concrete flume built along the end of the plant. The flume has sufficient cross-section to carry 20,000,000 gallons per day at a velocity not in excess of two feet per second, and extends the full width of the plant in order to meet extension requirements. An outlet, circular in section and forty-eight inches in diameter, is provided at the centre of the filter room. This is controlled by means of a sluice gate and leads into the filter influent main. The flume is clearly indicated on Figs. 4 and 10.

Fig. 4 shows the general arrangement of the filter beds and their relation to the rest of the plant. Fig. 13 gives the detail of the piping in the pipe gallery and to and from the filters.

Each filter bed has an area of 504 square feet and a nominal capacity of 1,250,000 gallons per day. The beds, as shown, are each divided into two sections by the central gullet walls. It is between these walls that the water enters the filter unit and also where the wash water leaves after having passed through and performed its function on the beds themselves. The influent enters through a fourteen-inch pipe from the influent main and the wash water passes out the bottom of the gullet through a twenty-four inch opening to the main twenty-four-inch cast iron drain which is located on the floor of the pipe gallery and extends under the sedimentation basins to the outside thirty-six-inch concrete drain. Each filter bed has eight cast iron wash water troughs, supported at one end by the gullet wall and at the other by adjustable hangers fastened to the filter side walls. The under-drainage system for each filter is composed of two-inch cast iron pipe laterals, spaced six inches apart and interconnected by a central cast iron header equivalent in capacity to an eight-inch pipe. Holes, drilled in pairs, are located in the underside of the pipe lateral, one on each side of a vertical diameter and at forty-five degrees to it. The headers also have openings to provide for an even distribution of filtration and for completely draining the bed. The capacity of the underdrain system is such as to allow back-washing at a rate equivalent to a twenty-four-inch per minute rise in the bed.

The filtering material is placed in layers as tabulated below:—

Layer	Depth	Material	Size
Bottom	6″	Gravel	3″—1¼″
2nd	4″	"	1¼″—¾″
3rd	3″	"	¾″—⅜″
4th	3″	"	⅜″—$\frac{3}{16}$″
5th	2″	"	$\frac{3}{16}$″—$\frac{1}{16}$″
Top	27″	Sand	—

The filter piping system, with its complement of valves, controllers, etc., is best illustrated by referring to Fig. 13 and Fig. 14. The mains are shown in a single vertical plane near the centre of the gallery. The influent main occupies the top position, in line with the outflow opening in the flume from the settling basins. The wash-water main occupies the intermediate position and the drain rests on saddles on the floor of the trench. The two upper mains are supported on hangers attached to the steel floor system above the gallery. All pipe and fittings are of cast iron and, as previously mentioned, all fittings are standard.

One feature of the piping at the filters, as well as all piping throughout the plant, should be specially noted. On all of the sizes above eight inches in diameter, Victaulic joints have been installed. These joints were specified in order to insure freedom from leaks, rapid assembly of the piping with a minimum of labour and tedious fitting, flexibility, and the ready removal of any length of pipe, fitting or valve without the necessity of disturbing any adjacent piece. Two of these joints were placed in the vertical sections of each pump suction and discharge in order to provide flexibility.

Besides the mains, each filter has in its own individual pipe system, a fourteen-inch influent pipe, a twenty-four-inch drain pipe, an eighteen-inch wash-water pipe which connects with the under-drain system, a twelve-inch-effluent pipe, which connects the under-drain system to the twelve inch rate controller, and an eight-inch cross-connection for filter re-wash. Each of these pipes is controlled by a gate valve of corresponding diameter, and those in the first four mentioned are actuated hydraulically from a high-pressure header which runs along the gallery. The control for all of the hydraulic valves in each filter unit is centred in an operating table placed opposite the filter on the floor above the gallery. The re-wash valve is hand-operated.

Pressure water for the valve operating header is taken from the main discharge header at the high-lift pumps. As an auxiliary source of operating energy, an accumulator tank is installed which floats on the line and can be used

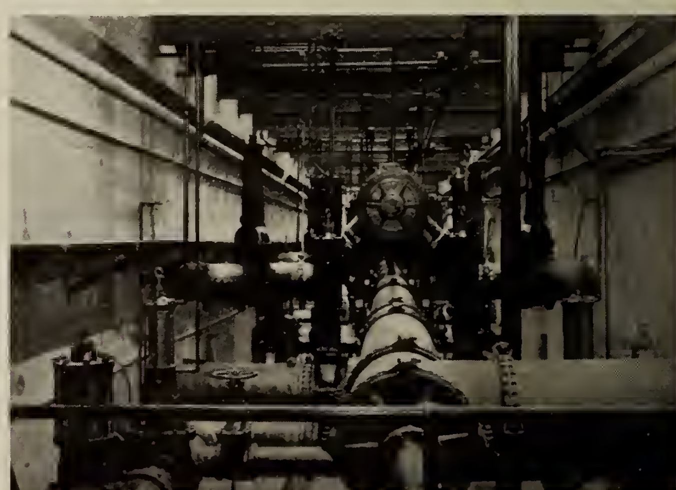


Fig. 14—Filter Pipe Gallery from Pump Room End.

to operate all of the valves in the plant in case of loss of pressure in the main. A suitable valve system and an automatic motor-driven pump insures full pressure in the accumulator tank at all times.

Wash-water is stored in an elevated steel tank placed on the roof of the sedimentation basins. The tank has a storage capacity of 70,000 Imperial gallons which is sufficient for washing two beds. An eductor placed over the outlet pipe from the filtered-water reservoir discharges into the wash-water system at a rate sufficient to fill the tank in two hours. Pressure water is received direct from the high-pressure main. This provides a simple arrangement for supplying wash-water, and, while lacking somewhat in efficiency, eliminates the evils of maintenance and shut-downs inherent in moving machinery. A gauge installed on the wall above the eductor control valve indicates the water level in the tank. An alarm bell is also provided to warn operators when the tank is full.

Fig. 8 shows the arrangement and equipment of the filter operating floor. Each filter has its individual operating table equipped with loss-of-head and rate-of-flow gauges and the necessary operating valves and indicators for the filter gate valves. The floor is an open grating supported by steel beams and a sufficient number of sections are removable so that the hand-operated travelling crane can reach any piece of equipment in the pipe gallery. The open floor admits light to the gallery and makes good ventilation possible.

After passing through the rate controller, the filtered water drops through the floor of the pipe gallery into the filtered-water reservoir. The reservoir occupies all of the space beneath the filter section and has a storage capacity of 800,000 Imperial gallons. Its outlet is thirty-six inches in diameter and is located near the pump room wall. A short run of welded plate steel pipe and a thirty-six-inch hydraulic valve serve to connect the outlet with the filtered-water pump header.

Chlorine is applied at the reservoir outlet, just as the water enters the pipe. Provision is also made for chlorination of raw water at the entrance to the low-pressure suction header. This latter treatment will only be used if it is necessary in emergency to by-pass the filters and pump raw water to the distribution system.

The chlorine room is located just beneath the electrical control room and contains two vacuum type chlorinators with scales. The chlorine dose is regulated manually, and a valve and piping system is provided so that either or both machines can feed to either or both points of application.

Other features which might be mentioned as component parts of the plant, aside from the major elements already described, include automatic and manually-operated sump pumps, automatically controlled emergency lighting, auxiliary direct current control power from storage batteries, store-room and machine-shop space, laboratory and office space, and a unit steam heating system.

Electric power is supplied through an outdoor substation erected adjacent to the building. The station consists of a bank of three 650-kv.a. transformers with necessary disconnects, oil breakers and main leads. All electrical operation is centred in a control gallery overlooking the pump-room floor, and all operations in connection with starting and stopping the pumps are effected by automatic parallel push-button switches from the pump-room floor or from the central gallery.

Power is available over two separate lines and from three alternative sources of supply.

In order to connect the new plant with the existing mains at Falls View it was necessary to install 11,822 feet of new through main without off-takes. Being thus a solid unbroken water column, it was subject to surge pressures which, under a certain combination of circumstances, could reach a maximum value of 385 pounds per square inch.

Under such circumstances, the physical properties of cast iron were obviously not in harmony with the service conditions to be anticipated, and it was realized that while the installation of mains in duplicate would, to some extent, reduce the risk, such an expedient could not by any means remove the disabilities inherent in the material itself. The real solution of the problem, therefore, lay in the making use of a material, or combination of materials, having physical properties which approximated, as closely as possible, those of the ideal medium; namely, fibrous strength, elasticity, impermeability, resistance to corrosion and tuberculation, and one hundred per cent joint efficiency.

The nearest approach to such a specification is a steel reinforced concrete pipe with a continuous central steel diaphragm. Incidentally, it was found that a twenty-seven-inch diameter pipe of this type could be purchased and installed for the sum included in the original estimates for a twenty-four-inch cast iron pipe. Also, taking into consideration the higher value of the coefficient C associated with concrete pipe, this twenty-seven-inch steel-concrete pipe has about the same maximum carrying capacity as a thirty-inch cast iron pipe, for equivalent total head loss.

The bell and spigot ends of the pipe sections are of rolled steel, deeply enmeshed, and caulked with oakum and lead. After caulking, the joint is covered with a wide collar of reinforced concrete which enables it to develop a strength comparable with that of the body of the pipe.

This pipe was placed in operation at the same time as the rest of the plant, and there is so far no evidence whatever of leakage at the joints or elsewhere.

An important characteristic of this type of pipe is that it is not subject to sudden pressure-releasing fracture under the impact of surge pressures which are beyond the designed limit of its resistant strength. Under such a condition the pipe walls may develop spurting or spraying leaks during the period of impact, but these close up immediately when the excess pressure falls off, with none of the serious resultant damage which is usually associated with a similar failure of cast iron pipe.

In the matter of leakage and seepage, attention is called to Fig. 7. There are five arch bays shown along the left rear of this view of the pump room. The clear-water reservoir extends across the two nearer bays and the water level normally stands, back of the partition wall, about 10 feet above the pump-room floor. Across the three bays in the rear of the view the water level in the mixing chambers and sedimentation basin normally stands about 23 feet above the pump-room floor, or two feet below the top gallery floor. Beyond a very small amount of initial sweating, which soon cleared up, there has been no leakage through these partition walls and they are entirely dry, as the view indicates.

As to leakage and seepage generally, the behaviour of the main sump indicates it to be negligible, as the station operators report that it is only a "dribble," of such small volume that no records of it are kept. Inasmuch as the whole structure is underdrained, the negligible amount of drainage into the sump is a fairly reliable indication of water-tightness.

Petroleum Testing

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Paper presented on September 18th, 1931, before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada (Ottawa Section, Royal Aeronautical Society).

SUMMARY—The paper describes the methods of testing which have been developed to judge of the practical suitability of gasoline and lubricating oil for internal combustion engines. As regards gasoline, the tests include those to determine volatility, freedom from knocking, deterioration during storage, and freedom from gum. In the case of lubricating oil, the discussion covers stability, the tendency to form sludge and carbon deposit in an engine, and the lubricating properties both with a hot and a cold engine. The author points out that the specifications for gasoline and lubricating oil now accepted are nearly all based on actual engine tests, and that as a result the products now in use are generally superior to those formerly furnished.

The question of fuels and lubricants for internal combustion engines is one that has received a great deal of study, not only from governments such as the British and American, but also from the leading oil companies and motor manufacturers. Millions of dollars have been spent testing different fuels and lubricants and as a result of such investigations a number of tests or specifications have been set which serve to standardize the quality of fuel, which at the present time is gasoline, and the lubricant, which is nearly always a mineral oil.

Most of the experiments which the oil companies have carried out have been done with motor car engines and naturally what has been developed in this work has been applied to the operation of aeroplanes, the only difference being that more care is exercised and a higher quality demanded both for the fuels and lubricants recommended for aeroplane service.

The discussion which follows and which deals entirely with the quality of the fuel or lubricant will only include the better known specifications as set by the British Air Ministry and the United States army. Other nations may have done as much work as these, but complete information is not available. An explanation will be given as to the purpose of these tests and what their relative significance is from actual experimental data obtained by testing a motor under controlled conditions.

It is well to remember that nearly all tests as applied to gasoline and lubricating oil are physical and empirical in nature, that is to say, the tests indicate that an oil has certain characteristics, but not of what it is composed, and these characteristics are only of value when compared with the same characteristics of another oil which in turn has proved to be of value in actual operation in an internal combustion engine. Many tests or specifications that have been applied to either gasoline or lubricating oil have had to be discarded because it has been found that under practical conditions they not only have no significance but led to erroneous and misleading conclusions. Because of the great amount of experimental work that has been done under very carefully controlled conditions during the last few years, the tests used today by the governments and the large oil companies are of more value than they were a few years ago, but even yet they are far from perfect.

What are the requirements of a gasoline as demanded by either a motorist or pilot of an aeroplane?

First, the gasoline must be sufficiently volatile, that is, enough of it must vaporize in the combustion chamber of the engine so that the motor will start easily even in cold weather. After a large number of experiments were conducted under all kinds of conditions and with a great many types of motors, it was found that the ease of starting as related to the gasoline could be determined by the amount of gasoline that would evaporate during a distillation carried on under conditions established by the American Society for Testing Materials (Serial D 86-26T) up to a vapour temperature of 150 to 160 degrees F. Of course the quantity which must evaporate at the above temperature in order to give the best starting conditions will vary with the kind of motor and the conditions under which it is operated. It must be borne in mind that the evils of vapour-lock will appear if the fuel is too volatile. This means that under the influence of the reduced pressure engendered by the inductive stroke, the gasoline may fail in the carburetor and the jet will become vapour-locked. A balance must be struck. However, it is of great importance to know how to correct a fuel in order to obtain easy starting.

Second, the fuel must not cause a knock or ping in the motor even when extra work is demanded of the engine. A tremendous amount of work has been done on this subject during the last ten years not only in order to eliminate the knocking of existing engines but because it was early discovered that a fuel which would not knock permitted the use of a higher compression engine. At this time it was claimed that a fuel of low knocking tendency would give more miles per gallon of gasoline and greater power in the engine. Unfortunately the motoring public has sacrificed a possible fuel economy by travelling faster, so that today they are obtaining fewer miles per gallon of gasoline than with the old lower compression motors. With aeroplanes, of course, it is only a question of power, so that a gasoline which will not knock is extremely important for this service.

The motors used for determining what is known as the anti-knock properties of a motor fuel have been so altered and improved during the last few years that the equipment used in the various testing laboratories has had to be changed every few months, and what has been worse, the method or scale used for defining the anti-knock properties of the gasoline such as benzol equivalent, numerous knock-rating scales, hexane-benzol equivalent, etc. have so involved the whole anti-knock question that everybody breathed a sigh of relief when the octane scale was proposed. The octane scale was developed by determining the knock suppression tendency of various percentages of iso-octane and normal heptane. The percentage of these two materials varies from 0-100, and the more iso-octane used in the mixture, the better the knock suppression tendency. With this as a standard, it has been easy to classify gasolines with respect to their anti-knock properties. Ordinary fuels have an octane number between 55 and 60 while the better fuels are around 70 and the premium fuels around 80. Some cheap fuels may be as low as 50. With an ordinary motor the difference between 60 and 70 octane number can be readily noticed but it requires a high compression engine to distinguish the difference between 70 and 80 octane number.

Third, there must be good fuel economy and this is noted by maximum power in an aeroplane or by miles per gallon in a motor car. Fuel efficiency simply means that the gasoline is completely burnt in the explosion chamber of the engine. There are a great many factors which contribute to fuel efficiency and probably the most of them are mechanical. Low knock rating gasolines have also helped and it is possible that in high compression engines the final boiling point of the gasoline plays some part, but this has never been proved. To be on the safe side, however, aeroplane fuels have a comparatively low final boiling point.

Fourth, the fuel must not change in character even after long storage and this applies particularly to aeroplane fuels where loss of life may result from a faulty fuel. A gasoline can change in two ways during storage.

In the first place if the gasoline is exposed to the atmosphere there will be a gradual evaporation of low boiling constituents, as a result of which the gasoline will lose some of its anti-knock properties, the result being that the motor will be more difficult to start. The only way to overcome this difficulty is to be sure that all small containers filled with gasoline are tightly sealed at all times. The second and more serious change which takes place in the gasoline is the gradual formation of gum, which if present in excessive amounts when used in an engine, results in a gumming of the feed lines and intake valves of a motor.

Great care has been taken by the oil companies to insure that excessive gum does not develop in gasoline and a number of tests have been devised which indicate stability in this connection. The most satisfactory test that so far has been developed is what is known as the "break-down test," and without going into details it is sufficient to state that the gasoline is heated under pressure in the presence of oxygen and the time noted which elapses before there is a rapid absorption of oxygen by the gasoline.

This test serves to indicate the time that a gasoline can be stored before an appreciable quantity of gum is formed. The amount of gum that is in a gasoline at any particular time can always be determined by evaporating the gasoline under standard conditions in a porcelain dish over a steam bath. Experiments have indicated that a gasoline may contain from 10 to 15 milligrams of gum per 100 c.c.'s before any trouble will be encountered in a motor car engine. In this connection it may be interesting to refer to the well-known copper dish test for gum which has persisted in certain gasoline specifications for a great many years although it has no practical value whatever and has at last been discarded by the United States government on specifications for aviation gasoline.

Lastly, there are a number of specifications which have little if any value as far as the quality of the gasoline is concerned. The first is the sulphur specification, which for years has been set at 0.1 per cent, although nobody has ever proved that two or three times as much sulphur would do any harm, in fact there is a lot of evidence to the contrary. The second is the corrosion test, which is made by heating a strip of copper in gasoline for a definite period of time, and it may have some value in preventing corrosion in the feed lines and gasoline tank of a car or aeroplane, but the complement of this test, which is known as the doctor test and is used to determine the presence of mercaptans (organic sulphur compound) in gasoline is only of value in that it insures a sweet smelling gasoline. Recent work has proved this test has no practical significance and it will probably be discarded even for aeroplane gasoline within the next few years. In fact, it has already been discarded for most motor gasolines.

The foregoing covers the most important properties of a motor fuel and all important specifications are based on actual engine performance. The same thing applies to the lubricant and the latest and most important specifications can be briefly summarized as follows:

In the first place, and most important of all, the lubricant must at all times reduce the friction in the engine to a minimum and in this connection there has been a great controversy in scientific circles as to whether or not a mineral oil is as good a lubricant as liquid fats such as castor oil or olive oil, and while certain laboratory tests that have been conducted under very high pressures have indicated less friction with certain vegetable oils, this has never been proved to be the case with motor engines, probably because the pressures were not so sustained or great.

As practical experiments have never proved that vegetable oils were superior to mineral oils and because the latter are much more stable and in the long run cheaper than the former, mineral oils are used in preference to vegetable oils for the lubrication of internal combustion engines and their use is recommended both by the British Air Ministry and the United States army for the lubrication of aeroplane engines.

Next to reducing friction the stability of the lubricating oil is most important and this is where highly refined mineral oils excel. There are two properties which come under the heading of "Stability," the first is—the property that certain oils have of not increasing in viscosity even under severe service. Increase in the viscosity of a lubricating oil can be due either to a chemical change which takes place in the oil itself and which only occurs to any large extent in poorly refined oils, or to some faulty mechanical feature of the motor, or to the fact that some lubricating oils are composed of a wide range of boiling constituents, which under operating conditions results in distilling off the light viscosity fractions from the cylinder walls of the engine leaving the higher viscosity fractions in the crankcase. This latter characteristic of certain oils will be dealt with in more detail under the discussion of oil consumption.

Contrary to public opinion oils do not become lighter in viscosity during service. When such a condition occurs, which frequently happens, it is due entirely to the dilution of the lubricating oil with the gasoline that for some reason has not been burned in the combustion chamber and which runs down past the piston rings into the crankcase resulting in the dilution of the lubricating oil.

Another change which takes place in a lubricating oil during service as the result of oxidation at high temperature, is the formation of acidic compounds and carbonaceous materials. This results in the formation of sludge in the crankcase and a deposit of gum on the piston heads and the exhaust valves of the engines. While it is true that the mechanical condition of an engine is nearly always responsible for the failure of the motor due to excessive sludge and gum formation, nevertheless, oils do vary in their resistance to oxidation at elevated temperatures. Many laboratory tests have been devised to determine the stability of motor oils but probably the best for high grade oils such as are used in aeroplanes is that developed by the British Air Ministry. In the first place a severe oxidation test is run at elevated temperatures under controlled conditions and in order to pass the specifications the viscosity of the oil must not be more than two times greater than the original viscosity. The oil before and after oxidation is then distilled off at a very high temperature (1,020 degrees F.). The coke which remains in the capsule is weighed and the quantities must not exceed 0.65 per cent. for the original oil and after oxidation it must not exceed the original Coke No. +1. The British Air Ministry test for oxidation and coke is extremely severe and only the most highly refined lubricating oils will meet their specification.

Oil consumption is a feature which every motorist and probably every pilot watches with the greatest care and this is certainly sound practice as no motor ever seized that was supplied with oil. At the same time there should always be some consumption of oil as the very fact that oil is being used insures that the oil is getting up to the places where it is most needed.

The excessive consumption of oil, however, can be caused either by the condition of the engine or the oil. If a car, for example, is driven at twenty-five miles per hour, the consumption of oil should be about one quart to every fifteen hundred miles, while if the same car is driven at sixty miles an hour, the consumption of oil may increase so that a quart will be consumed for every one hundred and fifty miles.

Again, if the pistons are loose and the exhaust valves are warped, oil consumption will be high no matter what kind of oil is used. Excessive consumption that is due to the quality of the oil is caused either by too light an oil under the conditions which the engine is operated, or the oil is made up of too wide a boiling range, with the result that when the engine heats up, the lighter constituents will boil off the cylinder walls of the explosion chamber and be burnt with the gasoline.

The use of too light an oil is not a serious condition and it is certainly true that the trend in lubrication today is to the use of lighter oils in all services. Engine designers are taking this factor into consideration so it is therefore probable that in the next few years all classes of motors will be using lighter oils than they are today, for it is perfectly true that other conditions being equal, the lighter the lubricating oil the better will be the lubrication.

Oil consumption that is the result of the distillation of the light boiling constituents of the lubricating oil from the cylinder walls of the engine is on the contrary very serious, as not only is the consumption of oil high but the oil which remains in the crankcase is frequently too viscous to lubricate the motor properly. In order to avoid this condition the best grades of lubricating oils have a comparatively narrow boiling range which is indicated by a relatively high flash point for a given viscosity at 210 degrees F.

Another important property that an oil must have and which has caused a good deal of trouble both in motor cars and aeroplanes is that property of an oil which permits a cold engine to be turned over with sufficient speed so that the motor will start. This trouble, of course, is most apparent in cold weather.

Again many factors contribute to this problem but there are two properties of a lubricating oil which influence the ease with which the starter can spin the engine with sufficient speed to start the motor and at the same time insure enough oil reaching the bearing surfaces so as to prevent the engine from seizing while it is still cold.

The first is known as the viscosity-temperature relationship which can be briefly described by saying that for two given oils with the same viscosity at 210 degrees F. one may be three times as viscous as the other at 32 degrees F. and as it is claimed that an oil must have a viscosity not greater than 20,000 seconds in order for the average starter to spin the motor fast enough to insure ignition, the importance of this relationship is readily apparent.

The other property of the oil is the temperature at which it will solidify and which is called the cold test. This property does not interfere with the starting of the engine but because the oil in the crankcase and lines of the engine becomes solid at temperatures below its cold test the cylinders of the engine may seize due to lack of oil before the oil in the crankcase has a chance to circulate.

Unfortunately it frequently happens that oils which are good in one of these properties are poor in the other. Therefore a compromise has had to be made on the high grade oils so that the best viscosity-temperature relationship is selected which is consistent with low cold test. It is in this connection that the A.P.I. gravity of the oil has some significance, as an indication of the viscosity-temperature relationship can be determined if one knows the viscosity of the oil at 210 degrees F. and its A.P.I. gravity. The A.P.I. gravity is a hydrometer reading with a slightly modified Baumé scale for liquids lighter than water and the accepted method of expressing this hydrometer reading for petroleum products is to call it "A.P.I. gravity."

There are two other specifications for an oil which have some value, colour and bloom for example. It was only a few years ago that all lubricating oils had to be dark red in colour and have a good deep bloom. Today the higher grade oils are all pale oils, that is, light yellow in colour, and practically all have been distilled overhead. While the bloom of the new oils should be green, particularly with the heavier grades, it is much less intense than with the old red oils. Good colour certainly indicates stability and the future trend in this connection will be towards still lighter coloured oils and some may be even colourless.

There are two kinds of acidity which may be present in lubricating oils, mineral acidity, the presence of which indicates poor refining, and organic acidity, which is present to a slight extent in all oils. There is a general feeling that organic acid in an oil is detrimental but it is doubtful if this is true, although large quantities of acid might possibly cause emulsion troubles in the crankcase. All oils in service develop acid so that a slight initial acidity probably has no significance.

The foregoing is a resumé of the latest tests or specifiations which have been developed for both gasolines and lubricating oils and are nearly all based on actual engine tests, so that they are far superior to those tests that were used a few years ago, which were frequently based on certain assumptions and not on practical experiments.

It is certain that still further improvements will be made in gasoline and lubricating oils but any marked improvements can only result from co-operation between the motor manufacturers in the design of their equipment and the oil companies in standardizing and improving the quality of their products.

Newly-Elected Members of The Council of The Engineering Institute of Canada

E. G. Cameron, A.M.E.I.C.,
Councillor,
Niagara Peninsula Branch,

A. B. Normandin, A.M.E.I.C.,
Vice-President,
Zone C.

L. H. Robinson, M.E.I.C.,
Councillor,
Moncton Branch.

P. L. Pratley, M.E.I.C.,
Councillor,
Montreal Branch.

J. B. deHart, M.E.I.C.,
Councillor,
Lethbridge Branch.

F. Newell, M.E.I.C.,
Councillor,
Montreal Branch.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

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The Interchange of Professional Knowledge

Anyone who studies the objects of The Institute as set forth on the cover of The Engineering Journal or in the By-laws of The Institute will be struck with the emphasis laid on its educational functions. The "acquirement and interchange of professional knowledge" is one of the basic ideas on which The Institute was founded; this purpose really underlies our activities both at Institute and Branch meetings, and is also served by our publications.

At our General Professional Meetings papers are presented and discussed most of which deal with major engineering works, or give the results of engineering investigations. At the meetings of our Branches, which are perhaps less formal, papers of more local interest can be given and there are opportunities for communications treating of work perhaps of lesser cost and extent, but in one sense of equal importance, because they are undertakings in which a great number of the younger members are directly concerned. In meetings of both kinds, however, if discussion is lacking, the educational value of the proceedings is greatly lessened. Discussions thresh out difficulties and contentious points, require speakers to have clear ideas, afford opportunities for criticism of the author's statements, and give to many of our members a chance to speak in public, which is of special benefit to the younger men.

The educational value of the publications of The Institute, and particularly The Engineering Journal, does not depend on our supply of news items informing members of Branch, social, or personal matters, although these are largely read and appreciated. It depends on the extent to which The Journal, for example, is able to bring the professional work of those who contribute papers to the knowledge of their fellow engineers. For the last fourteen years The Journal has recorded the majority of the important engineering work carried out in this country, and it is upon records of this kind, widely circulated, that the high reputation of the Canadian engineer is principally based. It is not generally realized that our Journal travels far afield and has readers not only in Britain and the United States, but in practically all the principal countries of the world. The diversity of the contents of the technical columns of The Journal reflects the great variety of engineering work done in this country, and has the advantage that it tends to keep our members from dealing too exclusively with their own special lines of work, and aids them in taking a broad view of their great profession.

It is interesting to note that our members are beginning to inquire whether The Institute's organization and facilities are being as fully utilized as possible for the dissemination of professional knowledge. Is their educational value to members what it should be? For instance, to what extent do the technical contents of The Journal really give a cross section of engineering work in Canada? From some criticisms recently presented at a meeting of the Vancouver Branch, it appears that its members feel that something is lacking in these respects. At the meeting in question a paper was presented which dealt with a project which is comparatively small and inexpensive, but whose design and construction was carried out under conditions which required special precautions and a good deal of ingenuity. In referring to the fact that not many papers on work of this character have appeared in The Journal, the speaker remarked, "That large body of engineers whose work, interest, and difficulties lie outside the compass of big and costly engineering works and industrial projects can find but limited interest, help, or inspiration in articles and discussions on such of these as are from their very nature restricted in application to the few who are directly in contact with them. It is not suggested that ample advantage should not be taken, as in the past, of opportunities for presenting the fullest possible reports, papers, and discussions on these major projects, but, in some of these, there would seem to have been more than a tendency to omit mention or detail of much in the way of difficulties met and overcome, or expedients evolved, which would make valuable reading and study for that large body of engineers previously referred to............

"Apart from the larger and more costly works, there remains that immense field of engineering activity which embraces an innumerable number and variety of smaller works initiated, projected, and carried to successful completion by those who constitute the majority of our membership. Though smaller, less costly, and less in the public eye, these works frequently present unusual features and limiting conditions as to cost, equipment, and treatment which cannot be met and solved in as ready a manner, perhaps, as those difficulties encountered on major works. Would it not be possible and distinctly an advantage to our membership to have The Journal re-vamped to serve not only as a medium for the preservation of records of our major engineering works, but, equally, as an exchange for ideas, records, and experiences on those minor works which present the workaday and workanight problems for ten out of twelve engineers responsibly engaged in engineering works across Canada; also, we might add, for those in less responsible capacities on the major works."

The discussion which followed supported the speaker's views, and included a good deal of helpful criticism. It is obvious that the growth and development of The Institute as a live organization is largely dependent on the interest shown in Institute affairs and resulting in discussion of this kind, and it is encouraging to note that during the past year quite a number of Branch meetings have been devoted to the discussion of Institute affairs, a circumstance which in itself promises well for The Institute's future.

Let it be said at once, however, that the point raised during the discussion at Vancouver is well taken, and that the Branches have not been getting nor has The Journal received, a sufficient number of papers dealing with the many engineering works which are of minor importance but of live interest to younger members. The question is, what causes this inadequate supply, and how can it be remedied? The cause is a regrettable but very real inactivity on the part of the membership whose work The Journal is available to record. It is not necessary to "revamp" The Journal to permit of its including material of the kind referred to, but it is necessary for our members to supply the material, so that it can be printed. We have all heard of the days of silence observed by Mr. Gandhi. and these are apparently worth his while, as they have real publicity value for him. Many members of The Institute apparently observe not days but years of silence during which they fail to tell their fellow engineers anything about their work. For them, this habit of reticence has no publicity value, quite the reverse, and one of its results is the absence from our records of much valuable professional information for the presentation of which there is a real need. Those who have served on Branch papers committees know the difficulty often experienced in persuading members to prepare papers, and the even greater difficulty in arranging for their adequate discussion. This reluctance to make a public appearance, either in writing or orally, is what has probably led to the legend of the "inarticulate" engineer. When asked to present a paper or discuss a paper presented by some one else, a member usually replies that he is too busy, in view of which it is remarkable to find that our best papers are often presented by our busiest men. The real cause of the difficulty is, in many cases, merely inertia. We may remind those who cannot or will not write papers, but have some message to communicate, that they have the correspondence columns of The Journal open to them, a privilege of which too little advantage is taken.

The plea that "my work is not of general interest" is sometimes heard, but the discussion at the Vancouver meeting shows that this idea is, in many cases, a mistaken one. It is true that one's daily work in design, construction or supervision may become so familiar as to seem unimportant and uninteresting, but if reflection shows that a paper on the subject would give information helpful to a man who has to carry out a somewhat similar job the effort should be made. Papers which are simply descriptive of a finished piece of work are, of course, not without value, but they cannot compare in value with those discussing methods of overcoming economic or industrial difficulties, or giving data based on the knowledge and experience gained from the writer's work.

In a recent editorial in The Journal reference was made to the work of The Institute's Papers Committee, which has now been re-organized on a more widely representative basis, so that the Papers Committee in each Branch can keep in touch with the activities of similar committees elsewhere. The machinery thus set up is intended not only to aid Branch executive committees in providing better and more varied programmes for Branch meetings, but also to obtain the very result suggested in the Vancouver discussion, namely, to awaken our members in general to the need for their individual efforts in communicating to fellow members the results of the professional experience they have gained. Some take comfort from the idea that though they personally do not contribute anything in the way of papers or discussions, this does not really matter, because other people do so. If these members would think of the inevitable result of a general acceptance of the principle "Let George do it," it is certain that their attitude towards the work of their local Papers Committee would change. If papers of the kind the membership is asking for are lacking at our Institute and Branch meetings, obviously they cannot be published in The Journal.

The Forty-Sixth Annual General and General Professional Meeting

Convened at Headquarters, Montreal, January 14th, 1932, and adjourned to the Royal York Hotel, Toronto, Ont., on February 3rd, 1932

Annual General Meeting at Institute Headquarters

The Forty-Sixth Annual General Meeting of The Institute was held at Headquarters on Thursday, January fourteenth, nineteen hundred and thirty-two, at eight twenty p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair.

The Secretary having read the notice convening the meeting, the minutes of the Forty-Fifth Annual General Meeting were submitted, and on the motion of F. A. Combe, M.E.I.C., seconded by D. C. Tennant, M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of P. E. Jarman, A.M.E.I.C., seconded by H. Massue, A.M.E.I.C., Messrs. H. B. Montizambert, A.M.E.I.C., and H. W. B. Swabey, M.E.I.C., were appointed scrutineers to report the result of the Officers' Ballot.

Appointment of Auditors

On the motion of J. A. McCrory, M.E.I.C., seconded by A. Duperron, M.E.I.C., Messrs. Riddell, Stead, Graham and Hutchison were appointed auditors for the ensuing year.

There being no other formal business, it was resolved, on the motion of G. B. Mitchell, M.E.I.C., seconded by G. E. Templeman, M.E.I.C., that the meeting do adjourn to reconvene on Wednesday, the third day of February, nineteen hundred and thirty-two, at ten o'clock a.m., at the Royal York Hotel, Toronto, Ontario.

Adjourned General and General Professional Meeting at the Royal York Hotel, Toronto

The adjourned meeting was called to order by President S. G. Porter, M.E.I.C. at 10 o'clock a.m. on Wednesday, February 3rd, 1932. After placing before the meeting the letters and telegrams of regret from members and guests unable to be present, the Secretary announced the membership of the Nominating Committee, appointed to nominate the officers of The Institute for 1933, as follows:

Nominating Committee 1932

Chairman: T. H. Hogg, M.E.I.C.

Branch	*Representative*
Halifax Branch	C. H. Wright, M.E.I.C.
Cape Breton Branch	W. C. Risley, M.E.I.C.
Saint John Branch	H. F. Morrisey, A.M.E.I.C.
Moncton Branch	F. L. West, M.E.I.C.
Saguenay Branch	G. F. Layne, A.M.E.I.C.
Quebec Branch	P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	J. A. Bernier, A.M.E.I.C.
Montreal Branch	E. A. Ryan, M.E.I.C.
Ottawa Branch	G. G. Gale, M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	Wm. Casey, M.E.I.C.
Toronto Branch	J. J. Spence, A.M.E.I.C.
Hamilton Branch	J. Stodart, M.E.I.C.

London Branch.................F. C. Ball, A.M.E.I.C.
Niagara Peninsula Branch.......C. G. Moon, A.M.E.I.C.
Border Cities Branch...........O. Rolfson, A.M.E.I.C.
Sault Ste. Marie Branch........J. H. Jenkinson, A.M.E.I.C.
Lakehead Branch...............F. C. Graham, A.M.E.I.C.
Winnipeg Branch...............C. T. Barnes, A.M.E.I.C.
Saskatchewan Branch...........W. G. Worcester, M.E.I.C.
Lethbridge Branch.............G. S. Brown, A.M.E.I.C.
Edmonton Branch...............R. W. Ross, A.M.E.I.C.
Calgary Branch................Thos. Lees, M.E.I.C.
Vancouver Branch..............C. T. Hamilton, A.M.E.I.C.
Victoria Branch...............A. L. Carruthers, M.E.I.C.

Award of Medals and Prizes

The awards of the various prizes and medals of The Institute were next announced, and the President stated that the formal presentation of these honours would take place at the Annual Dinner of The Institute. The prize list was as follows:

The Past-Presidents' Prize to A. W. McQueen, A.M.E.I.C.

The Gzowski Medal to G. O. Vogan, A.M.E.I.C., for his paper on "The Design of the Chute à Caron Diversion Canal."

The Plummer Medal to Dr. G. S. Hume, for his paper entitled "Structure and Oil Prospects of the Eastern Foothills area, Alberta, between Highwood and Bow Rivers."

The Leonard Medal to Dr. W. S. Dyer, M.C.I.M.M., for his paper on "The Lignite Deposit at Onakawana Moose River Basin."

The John Galbraith Prize to D. E. Bridge, S.E.I.C., for his paper on "Electric Furnaces as Applied to Industrial Heating."

The Phelps Johnson Prize to Eric G. Adams, S.E.I.C., for his paper on "Some Economic Problems Confronting the Wider Application of Railroad Electrification in America."

The Martin Murphy Prize to C. I. Bacon, S.E.I.C., for his paper on "Exhausting a Vacuum Tube."

Report of Council

The Secretary having read the Report of Council, the President remarked that a number of the topics on which it touched would come up in connection with subsequent reports of committees, at which time discussion on them would be in order. With this understanding, on the motion of Professor C. M. McKergow, M.E.I.C., seconded by G. R. Duncan, A.M.E.I.C., the Report of Council was adopted.

Report of Finance Committee and Financial Statement

In connection with the report of the Finance Committee and the Financial Statement, Col. Duncan MacPherson, M.E.I.C., drew attention to the reduction in pay of The Institute's staff and expressed the appreciation of the membership of the action of the staff in accepting this. Professor McKergow, on behalf of the members of The Institute, desired to thank the chairman of the Finance Committee, the Treasurer, and the Secretary for the service they had rendered The Institute during the past year during a period of considerable difficulty. There being no further discussion, on the motion of J. L. Busfield, M.E.I.C., seconded by Col. MacPherson, the report of the Finance Committee and the Financial Statement were adopted.

Following this the President delivered his retiring address, which is published elsewhere in this issue, pages 171-174.

In complimenting the President on his very interesting and inspirational address Mr. Duncan felt that he was voicing the unanimous opinion of the meeting, which was indicated by the general applause.

The Secretary having read the report of the Scrutineers appointed to canvass the Officers' Ballot for 1932, on the motion of Mr. Busfield, seconded by E. H. Darling, M.E.I.C., the following officers were unanimously declared elected:

President.........................Charles Camsell, M.E.I.C.
Vice-Presidents:
Zone B.......................A. H. Harkness, M.E.I.C.
Zone C.......................A. B. Normandin, A.M.E.I.C.
Zone D.......................S. C. Mifflen, M.E.I.C.
Councillors:
Cape Breton Branch.........J. R. Morrison, A.M.E.I.C.
Moncton Branch.............L. H. Robinson, M.E.I.C.
Quebec Branch..............H. Cimon, M.E.I.C.
Montreal Branch............F. Newell, M.E.I.C.
P. L. Pratley, M.E.I.C.
Ottawa Branch..............J. McLeish, M.E.I.C.
Peterborough Branch........R. L. Dobbin, M.E.I.C.
Toronto Branch.............J. J. Traill, M.E.I.C.
Hamilton Branch............F. W. Paulin, M.E.I.C.
Niagara Peninsula Branch....E. G. Cameron, A.M.E.I.C.
Sault Ste Marie Branch......A. E. Pickering, M.E.I.C.
Winnipeg Branch............J. W. Porter, M.E.I.C.
Saskatchewan Branch........C. J. Mackenzie, M.E.I.C.
Lethbridge Branch..........J. B. deHart, M.E.I.C.
Calgary Branch.............B. Russell, M.E.I.C.
Victoria Branch............F. C. Green, M.E.I.C.

Induction of Newly Elected President

Following this election, Mr. Porter asked P. B. Motley, M.E.I.C., and F. P. Shearwood, M.E.I.C., to conduct the newly elected President to the chair, which was done amid the applause of the meeting.

President Camsell, in expressing appreciation of the honour conferred upon him, remarked that in looking over the long list of past-presidents he noted that only one or two had at the time of their presidency been actively engaged in the mining engineering branch of the profession. He took his own election as a compliment to that branch of the profession, and was glad that mining engineering had been recognised in this manner. He was sure that he would receive the full co-operation of all members of Council in the same way as this had been accorded to his predecessor.

Professor C. R. Young, M.E.I.C., drew attention to the able way in which the retiring President and the retiring members of Council had performed their duties through the past difficult year, and moved that the hearty thanks of The Institute be accorded to the retiring President and the retiring members of Council in appreciation of their services. Professor Young's motion was seconded by Col. MacPherson, and on being put to the meeting was carried with hearty applause.

On the motion of A. F. Macallum, M.E.I.C., seconded by A. B. Gates, A.M.E.I.C., a vote of thanks was accorded to the scrutineers, and it was ordered that the ballot papers be destroyed.

The Secretary announced that the first meeting of the newly elected Council would be held on February 10th, 1932, in Ottawa, following a luncheon meeting to be held by the Ottawa Branch on that day in honour of the newly elected President.

Report of Papers Committee

This report was presented by the chairman, R. B. Young, M.E.I.C., and Mr. Busfield drew attention to the very effective work which had been accomplished, largely as a result of the complete reorganization of the committee which had taken place under Mr. Young's chairmanship. Mr. Busfield pointed out the special difficulty in getting speakers and organizing meetings experienced by the smaller branches, and suggested that some arrangements might be possible whereby the assistance of the larger branches might be enlisted to provide for this difficulty. Definite co-operation, for example, between the Montreal Branch and the Saguenay Branch might be a very great help to the latter in this respect. After further discussion, on the motion of Mr. Young, seconded by H. A. Lumsden, M.E.I.C., the report of the Papers Committee was accepted.

Report of Membership Committee

The report of the Membership Committee was presented by Brig.-Gen. C. H. Mitchell, M.E.I.C., who remarked that under existing conditions he thought that it was gratifying to note that the total membership of The Institute showed even a slight increase during the year. The Membership Committee had hesitated to embark upon a general and active campaign for new members, since The Institute's relations with the Professional Associations throughout the country, and the proposals of the Committee on Development would have an important influence on our conditions of membership, and that both these matters were at the present time under consideration by committees. The Membership Committee would continue to work actively through the branches, but he did not think that more than this could be done until the important questions he had named had been dealt with more definitely. Discussion was continued by W. McG. Gardiner, A.M.E.I.C., who drew attention to the fact that in some provinces a considerable proportion of the members of the Associations of Professional Engineers were not members of The Institute, and thought that the Membership Committee might take steps to interest more of the members of the Professional Associations in The Institute. After further discussion, on the motion of General Mitchell, seconded by Dr. O. O. Lefebvre, M.E.I.C., the report of the Membership Committee was received and adopted.

The following reports were presented by the Secretary:

Board of Examiners and Education
Employment Service Bureau
Library and House Committee
Honour Roll and War Trophies Committee

With regard to the first of these Professor McKergow drew attention to the item in the report of the Board of Examiners for 1931 urging the desirability for The Institute to take steps to aid younger men who have not the opportunity of taking engineering courses of university standing, but who are ambitious and earnest, and for whom there are practically no facilities for advanced evening courses in Canada at the present time. The Secretary gave instances of a number of cases of this kind which had come to his knowledge, and spoke in support of Professor McKergow's suggestion.

As regards the Employment Service Bureau, the Secretary summarized the report and pointed out that the figures given must not be taken as complete as far as the general membership of The Institute was concerned, since he believed that there were a considerable number of members of The Institute who are looking for positions, but who have not registered with the Bureau.

In regard to the report of the Library and House Committee, in the absence of the chairman, the Secretary remarked on the considerable increase in the use by members of The Institute's information service. He explained the committee's policy as regards the expenditure of funds available for periodicals and books.

With reference to the Honour Roll, the Secretary announced that the checking of the names for the War Memorial had been completed and that the Bronze Tablet would shortly be ready for erection.

At this point the President announced that having been called away to Ottawa, and having to leave almost immediately, the chair would be taken by Vice-President A. H. Harkness, M.E.I.C.

The Secretary then presented the report of the Committee on Biographies and of the committee on the work of the Canadian Engineering Standards Association and the report of the Legislation Committee, giving brief explanations regarding them, after which, on the motion of B. S. McKenzie, M.E.I.C., seconded by P. L. Pratley, M.E.I.C., the reports of the following committees were unanimously adopted:

Board of Examiners and Education
Employment Service Bureau
Library and House Committee
Honour Roll and War Trophies Committee
Committee on Biographies
Canadian Engineering Standards Association
Legislation Committee

The meeting then adjourned at one o'clock p.m., to resume at two fifteen p.m.

Reports of Branches

On resuming at the afternoon session the chairman drew attention to the fact that the reports from the various Branches had all been printed and were in members' hands, and that they were contained in the February issue of The Journal, pages 98 to 114. On the motion of H. W. B. Swabey, M.E.I.C., seconded by W. McG. Gardiner, A.M.E.I.C., the reports of the Branches were taken as read and accepted.

Proposal for Amendment to By-laws

At the request of the chairman the Secretary explained the significance of the proposal made by Council for the amendment of Section 37 of the By-laws, pointing out that in accordance with the By-laws this proposal was open for discussion at the Annual General Meeting, but would be finally decided upon by letter ballot of the corporate members of The Institute. He remarked that if accepted the effect of the amendment would be a very considerable simplification of the office work and correspondence at Headquarters with regard to the collection of arrears, and a marked reduction in the sum outstanding at any given time. Mr. Busfield considered that the result of the present by-law was unsatisfactory, in that a considerable number of members permit their indebtedness to increase until payment of their arrears becomes almost impossible for them, and he also drew attention to the proposed change in the wording of the paragraph dealing with Life Membership. In the amendment, the wording now proposed was intended to make it clear that a member could not claim a Life Membership as a right, simply because he had attained a certain age or had been a member for so many years, but that the granting of this privilege was entirely within the discretion of Council. In supporting the proposed amendment, J. J. Traill, M.E.I.C., stated that he had met with a number of cases where members who had been dropped for nonpayment of arrears were prevented from applying for reinstatement by the very considerable amount of their indebtedness. After considerable further discussion, during which Mr. Pratley questioned the appropriateness of the words "as a privilege," it was resolved, on the motion of Mr. Busfield, seconded by Geoffrey Stead, M.E.I.C., that the meeting approve of the proposed change in Section 37 of the By-laws as presented by Council, and that the proposal be issued to the membership for vote by ballot in due course.

Annual Meeting 1933

The Secretary submitted an invitation from the Winnipeg Branch to hold the Annual Meeting for 1933 in that city, and pointed out that as a rule decision on the location of the Annual Meeting was ultimately taken by Council, after consideration of the invitations received. In this case the chairman felt that any opinion expressed by this meeting would have considerable weight with Council, but that the question of holding a meeting in Winnipeg was not easy to decide, on account of the difficulty and expense connected with transportation to that point. Past-President Porter supported the invitation from the Winnipeg Branch, but felt that ultimate decision in this matter should be left in the hands of Council. E. M. Proctor, M.E.I.C., inquired whether it would be possible to arrange the meeting in Winnipeg as a General Professional Meeting in June instead of February, as he felt that a much larger attendance might be anticipated. Dr. Lefebvre supported Mr. Proctor's view, and it was recalled that a General Professional Meeting had been held in this way in Winnipeg in September 1922. Finally, on the motion of Past-President S. G. Porter, seconded by M. B. Atkinson, M.E.I.C., the question of the acceptance of the invitation from the Winnipeg Branch was referred to Council for consideration.

Committee on Development

The chairman pointed out that a committee whose work would have a very important influence on the future of The Institute was functioning under the chairmanship of Mr. Busfield, and asked whether, as chairman of the Committee on Development, he would like to give to the meeting an account of the progress the committee had made. Mr. Busfield observed that the committee in question had been appointed as a result of discussions at the Plenary Meeting of Council held in September 1931, its purpose being to consider lines along which The Institute should be developed, having regard to the steps taken by the Associations of Professional Engineers in co-ordinating their activities, and having regard also to the manner in which conditions have changed since the policy and organization of The Institute was last reviewed in 1922. This Committee on Development differed somewhat in form from that usually adopted and consisted of a small working group of three members, Vice-President O. O. Lefebvre, M.E.I.C., and Treasurer W. C. Adams, M.E.I.C., being associated with him in this way, with an advisory group consisting of nine past-presidents of The Institute. The small group were formulating and discussing proposals, which were then being submitted to the past-presidents for comment and modification. He hoped that a report of the committee would be available for the Plenary Meeting of Council this year, so that, if approved, its recommendations might be placed before the Annual Meeting of The Institute in 1933.

The committee had begun by examining the objects of The Institute as set forth in Section 1 of The Institute's present By-laws, and would propose modifying their arrangement in such a way as to indicate that the acquirement and interchange of professional knowledge should be considered the first or principal object of the organization. As a result the number of objects outlined would be reduced from eight to six. His committee had next discussed the changes in classes of membership which seemed desirable to carry out those objects. Bearing in mind that it is probable that some day there will be a complete co-ordination of the work of the Professional Associations, so that all questions connected with professional qualifications will be carried out by the Associations under a unified policy, the committee felt that the mass of The Engineering Institute should be made up of one class known as Members, and that their technical qualifications should be measured by the requirements of the Associations of Professional Engineers. His committee therefore proposed to recommend that the technical qualifications for Membership in The Institute should be either membership in an Association of Professional Engineers, or graduation from a recognized school of engineering with a definite period of engineering experience after graduation, and that in order to take care of men not qualifying in either of these ways, but who have entered the engineering profession by the road of experience, his committee would suggest that they should have at least eight years experience in an engineering position, during which they should show to the satisfaction of Council a real advancement in the profession, and they should be called upon to prove that they have attained an educational standard comparable to that of those entering as members of an Association or as university graduates. Admission to The Institute under any one of these heads would, of course, also require a favourable report from the Branch concerned, and from five responsible sponsors, and the approval of Council. His committee were also of opinion that for admission into The Engineering Institute a man should have the personal backing of some corporate member in the form of a signed proposal.

In order to afford opportunity for recognizing eminence in engineering work his committee would suggest that a limited class, to be known as Fellows, be established, admission to which would be only by appointment by Council, the numbers being limited, to, say, two per cent of the total membership in The Institute. They thought that the present class of Honorary Members should be retained, but that this distinction should be reserved entirely for men of eminence who are not practising engineers. It would, further, be necessary to provide, as at present, for the younger men who are still students at college or who have very recently graduated, and for this his committee was of opinion that the class of Junior should be retained. Finally, in order to take in men who by their occupations and pursuits are qualified to co-operate with engineers, and to provide for those technical men who have not received systematic engineering training, but who are doing engineering work in subordinate positions, it would be proposed to establish a class of "Associates," including men who are in minor engineering positions, as well as those who by the nature of their occupations or callings are qualified to associate and co-operate with engineers. Mr. Busfield felt that the proposals of the committee might form the basis of a complete reconstruction of The Institute, leading to a very much greater activity and greater usefulness than had ever been attained in the past.

Mr. Atkinson complimented Mr. Busfield on his interesting explanations, and hoped that there would be no attempt to put through such important changes hurriedly, or without the amplest opportunity for further discussion by members. He pointed out that there were at present two schools of thought amongst the membership, one desiring to exclude everybody but university graduates, and the other desiring to leave the door open somewhat widely. Mr. Atkinson felt that the committee's scheme, after presentation to the Plenary Meeting of Council, should be fully set forth in the columns of The Journal, and that comment should be invited from the membership throughout the country previous to any discussion at an Annual Meeting.

Professor Young drew attention to the necessity of insuring the high professional standing of the individual member of The Institute. If there were any welfare work to be done, or if there were legislation to be secured, this should be done by the Associations. The service that The Institute can render to the profession should primarily be on the technical side. The attainments of the individual member of The Institute should be such as to impress the general public, and if this were the case The Institute would fill a definite need quite apart from the achievements of the Professional Associations.

Dr. Lefebvre believe that the work of the Committee on Development was a necessary consequence of the efforts being made by the Professional Associations to co-ordinate their requirements, these efforts having resulted from the work done during the last few years by The Institute's committee headed by Past-Presidents S. G. Porter and H. H. Vaughan. He believed that the present work of the Committee on Development would result in an organization which would greatly simplify our relations with the Professional Associations when these Associations shall have put their own houses in order. Dr. Lefebvre considered that the arrangements proposed for the class of Associate were deserving of very sympathetic examination and consideration, as the Associates, while not voting members of The Institute, would no doubt have voting privileges respecting the affairs of their particular Branches, and the admission of this class would contribute materially to the Branch activities in regard to the dissemination of technical information and experience. After further discussion, during which the desirability of simplification and the reduction of the number of classes of members was urged, E. G. Cameron, A.M.E.I.C., was doubtful whether the proposals of the Committee on Development, as explained by Mr. Busfield, would have the desired result.

H. G. Thompson, A.M.E.I.C., drew attention to the necessity of providing arrangements which would be attractive to all groups of engineers, as he felt that in the past there had been a tendency for electrical, mechanical and mining engineers to regard The Institute primarily as an institute for civil engineers.

R. K. Palmer, M.E.I.C., supported the idea of having all engineers joining The Institute under one classification, that of Member, and urged the reduction of the number of classes. Dr. Lefebvre and Mr. Shearwood pointed out the necessity of providing a place in The Institute for men who could perhaps not be considered as fully trained engineers, but whose work was undoubtedly of an engineering nature. Professor McKergow hoped that the committee would bear in mind the utility of The Institute and its meetings as a means of contact between younger and older engineers, so that the younger men may receive the benefit of their seniors' experience, and will make contacts of value to them in their future careers.

After further discussion the chairman remarked that the suggestions made during the discussion would undoubtedly receive close attention from the committee, and in his opinion the membership would be safe in leaving the further development of the report in the hands of the committee. Its report would receive close criticism from the Plenary Meeting of Council, and he thought should then be held up for a sufficient time to provide for ample discussion and the communication of the views of the membership before its proposals could be submitted to an Annual Meeting. He was sure that Mr. Busfield, and the other members of the committee, would welcome communications from members making such suggestions as those that had been made during the discussion.

The Institute and the Professional Associations

The Secretary presented a brief report from Mr. H. H. Vaughan in regard to the activities of the committee under his chairmanship which had been appointed by Council to keep in touch with the committee of the Professional Associations dealing with the question of their co-ordination. This report had been received too late to be included in the printed sheets of reports. The chairman suggested that in Mr. Vaughan's absence Past-President Porter would perhaps present some remarks on this report. Mr. Porter outlined the events which had led up to the present situation, and remarked that at this time the Provincial Associations were themselves organizing a body to discuss and promote the co-ordination of their special work as regards the requirements for admission to the profession, the mutual recognition of qualifications to practise, and so on. He pointed out that the decisions reached in this connection would naturally have a bearing on the work of Mr. Busfield's Committee on Development. The recognition of membership in a Provincial Association as one of the qualifications for membership in The Institute was, in his opinion, a very proper decision, and he hoped that the way was being paved for a definite working arrangement whereby every registered engineer in Canada would be enabled to receive the benefit of the services, and the educational and technical information, that The Engineering Institute is in a position to give. He felt that the action of the Council of The Institute in offering whatever co-operation and assistance The Institute could give in the work of the Associations' Committee of Four was a proper one, and he would draw attention to the resolution passed by the last Plenary Meeting of Council to the effect that "the Council of the Engineering Institute of Canada wishes to express its appreciation of the efforts of the Committee of Four appointed by the Provincial Associations to consider ways and means of co-operation between them, and to express the hope that these efforts will be continued to a successful conclusion. The Council of The Institute will continue to co-operate with the Associations to the fullest possible extent, and gladly offers to the committee all the facilities at its disposal."

Mr. Porter moved that this meeting endorse the resolution passed at the Plenary Meeting of Council in regard to this matter.

C. C. Kirby, M.E.I.C., explained briefly the procedure followed by the Committee of Four, and pointed out the many difficulties that had to be faced in arranging co-ordination between the eight Provincial Associations themselves. These difficulties would not be quickly solved, but he believed that substantial progress had been made.

E. P. Muntz, M.E.I.C. having seconded Mr. Porter's resolution, it was put to the meeting and carried unanimously, after which, on the motion of Dr. O. O. Lefebvre, seconded by Col. E. G. M. Cape, M.E.I.C., Mr. Vaughan's report was adopted.

Standard Form of Construction Contracts

Col. Cape drew attention to the Standard Form of Construction Contract which had been drawn up by the Canadian Construction Association, and which, in an earlier form, had been considered by the Council of The Engineering Institute of Canada, who had at that time not felt able to adopt the form. Since then the contract form had been formally adopted by the Royal Architectural Institute of Canada, and Col. Cape wished to draw attention to the utility of this document and to the great assistance which it had already rendered, not only to contractors, but also to architects and those in charge of construction work. He desired to move the following resolution:

> "Whereas it has been called to the attention of The Engineering Institute of Canada that Standard Forms of Contracts for construction work have been developed and agreed upon by The Royal Architectural Institute of Canada and the Canadian Construction Association, and
>
> Whereas these standard forms have been in use for some time and have been found of the greatest value to all concerned, be it resolved
>
> That the incoming Council be requested to study these contract forms with a view of their adoption by this Institute."

Col. Cape's motion was supported by B. S. McKenzie, M.E.I.C., who stated that the Canadian Engineering Standards Association was ready to co-operate with the

Canadian Construction Association, The Royal Architectural Institute of Canada, and The Engineering Institute of Canada and any other interested bodies in preparing a document which would obtain general recognition in Canada. He had great pleasure in seconding Col. Cape's motion.

Mr. Pratley explained that the action of Council two years ago in declining to adopt the standard form of contract was not because they disapproved of it, but because it was thought inadvisable to give formal adoption to any one set of contract forms. It had, however, been felt that the form submitted should have the sympathetic consideration of all practising members of The Institute, and that they should be asked to use the forms for all work for which they might be considered suitable. After further discussion Col. Cape's motion was put to the meeting and carried unanimously.

On the motion of Dr. O. O. Lefebvre, seconded by Mr. E. G. Cameron, a very hearty vote of thanks was extended to the members of the Toronto Branch for their hospitality and for their very excellent organization in connection with this Annual General Meeting of The Institute.

Col. W. L. Malcolm, M.E.I.C., drew attention to the committee which had been formed last year in reference to an arrangement between the Military Engineers' Association of Canada and The Engineering Institute of Canada. Col. Malcolm inquired whether any conclusion had been arrived at in this matter. The Secretary reported that the action taken by the Council was to suggest that closer association between the Military Engineers' Association and The Institute might be achieved if Military Engineering Sections of our Branches were formed at points where there were a sufficient number of engineer officers to make this feasible. Council had also given directions that The Engineering Journal should be sent regularly for the use of Engineer Officers' Messes at various centres. The Secretary pointed out that the Military Engineering Sections of our Branches could embrace in their membership, like the Aeronautical Sections, not only members of The Institute who are also members of the Military Engineers' Association, but also members of that Association who are not yet members of The Institute. Col. Malcolm thought that the action of Council should be endorsed by the meeting, and moved that the action of Council in recommending the formation of Military Engineering Sections of our Branches should be re-affirmed at this meeting. On being seconded by J. S. Armstrong, M.E.I.C., and put to the meeting, the resolution was carried unanimously.

There being no further business the Annual General Meeting then terminated.

Social Functions

On Wednesday, February 3rd, the Toronto Branch were hosts at a luncheon held in the Banquet Hall of the hotel, at which Colonel C. S. L. Hertzberg, M.E.I.C., took the chair. A welcome was extended to the ladies and members present by His Worship the Mayor of Toronto, Mr. Stewart, and by Colonel Hertzberg, whose humorous touches were greatly appreciated.

In the afternoon a reception and tea was given for the ladies in the Roof Garden, and at 8 o'clock p.m. a smoking concert was held in the Concert Hall under the chairmanship of W. E. Bonn, A.M.E.I.C. A very excellent programme of music and vaudeville was presented which was greatly enjoyed by the large audience.

The ladies committee, under the chairmanship of Mrs. C. H. Mitchell, arranged for a theatre party for the visiting ladies, which took place at the same time as the smoking concert.

On Thursday, February 4th, there was no formal luncheon, but members and friends met informally in the Banquet Hall, and in the evening the Annual Dinner of The Institute took place in the Ball-room.

President Charles Camsell, M.E.I.C., took the chair and was supported at the head table by the Hon. G. S. Henry, Premier of Ontario, the Hon. Leopold Macaulay, Provincial Minister of Highways, Past-Presidents Grant, Butler, Fairbairn, Mitchell and Porter, and by representatives of the Royal Architectural Institute of Canada, the Canadian Institute of Mining and Metallurgy, and a number of the Provincial Associations of Professional Engineers. The Mayor of Toronto was represented by Commissioner Harris.

After dinner the prizes and medals of The Institute were presented, and this ceremony was followed by a thoughtful address by Dr. W. Hamilton Fyfe, Principal of Queen's University, Kingston, Ont.

In his address Dr. Fyfe urged the broadening of the cultural side of the engineer's education, and the need in the Faculties of Applied Science for an atmosphere favourable to the development of engineers who can write well and speak well, appreciate beauty in many forms and give wise opinions on many subjects. Engineers should come out, said Dr. Fyfe, and help in playing a larger part in the solution of the social and political difficulties which now hamper their activities both as engineers and as men. The speaker did not believe that the mechanization of the age, due to the activities of engineers, was in itself inimical to social welfare, and held that the trouble lay rather in the use that industrial finance had made of machinery. There had been as yet no effective attempt made to apply a scientific treatment to the problems of social, political and financial control, and it was in this direction that Dr. Fyfe looked for advance in the future.

The Dinner was followed by a Reception and Dance which was largely attended, the members and guests being received by President and Mrs. Charles Camsell and Colonel and Mrs. C. S. L. Hertzberg.

First Technical Session

The first professional session was held on Thursday, February 4th, the papers presented being as follows:

In Hall C., under the chairmanship of Professor R. W. Angus, M.E.I.C.,

"The Central Heating Plant of the Toronto Terminals Railway Company," by J. A. Shaw, M.E.I.C., general electrical engineer, Canadian Pacific Railway Company, Montreal.

"The Central Heating System of the City of Winnipeg," by G. W. Oliver, Winnipeg Hydro-Electric System, Winnipeg.

In the Library, under the chairmanship of R. O. Wynne-Roberts, M.E.I.C.,

"The Niagara Falls (Ont.) Pumping and Filtration Plant," by H. G. Acres, M.E.I.C., consulting engineer, and S. W. Andrews, H. G. Acres and Company, Niagara Falls, Ont.

Under the chairmanship of G. H. Rogers, A.M.E.I.C.,

"Recent Developments in Long Distance Telegraph and Telephone Communication," by F. B. Coles, carrier and telephone engineer, Canadian Pacific Telegraphs, Montreal.

In the Tudor Room, under the chairmanship of Professor C. R. Young, M.E.I.C.,

"Structural Details of Maple Leaf Gardens, Toronto," by G. Townsend, A.M.E.I.C., structural engineer, and Charles W. Power, Toronto manager, Ross and Macdonald, Inc., Montreal.

In the Club Room a meeting of The Institute's Committee on Engineering Education took place followed by a conference with representatives of the engineering colleges and universities.

Second Technical Session

At the technical sessions held in the afternoon, the papers presented were as follows:

In Hall C, under the chairmanship of Professor L. M. Arkley, M.E.I.C.,

"The New Railroad and Automobile Ferry-Steamer *Charlottetown*," by W. Lambert, M.E.I.C., naval architect, Montreal.

"The Use of Low Rank Fuels," by Professor E. A. Allcut, M.E.I.C., University of Toronto, and H. L. Wittek, consulting engineer, Toronto.

In the Library, under the chairmanship of Brig.-General C. H. Mitchell, C.B., C.M.G., M.E.I.C.,

"Hydro-Electric Developments on the Lièvre River," by H. S. Ferguson, M.E.I.C., consulting engineer, New York.

"A Study of Ice-Thrust in Connection with the Design of Hydro-Electric Plants," by Dean Ernest Brown, M.E.I.C., McGill University, Montreal, and Geo. C. Clarke, M.E.I.C., Fraser-Brace Engineering Company, Ltd., Montreal.

Third Technical Session

On Friday, February 5th, a general professional session took place, which owing to the very large attendance had to be transferred from the Tudor room, where it was originally intended to hold it, to the Banquet Hall. Here Dr. W. W. Colpitts, M.E.I.C., of New York, presided over a discussion on matters pertaining to railway-highway transportation, the subject being introduced in a paper by S. W. Fairweather, Director of Economics, Canadian National Railways, on "The Influence of the Motor Vehicle on Modern Transportation." Mr. Fairweather was followed by R. M. Smith, A.M.E.I.C., Deputy Minister of Highways, Ontario, who outlined the highway viewpoint as far as highway-railway transportation is concerned. A paper by W. A. McLean, M.E.I.C., entitled "The Vehicle and the Road," was presented by L. W. Wynne-Roberts, A.M.E.I.C. Professor W. T. Jackman of the University of Toronto then dealt with some problems in Canadian transportation, and the discussion was continued by Mr. D. Crombie, chief of transportation, Canadian National Railways, Montreal, G. McL. Pitts, A.M.E.I.C., F. I. Ker, M.E.I.C., and a number of other speakers.

After adjourning for luncheon, the discussion proceeded during the afternoon, and was closed by an address from the chairman, who pointed out that the speakers had presented ably but briefly and from various angles the transportation problems whose solution is so pressing in Canada to-day. He drew attention to the essential differences between the situation in Canada and that in the United States as regards railway and highway transportation and emphasized the value of the discussion which had taken place, in enabling the members of The Institute to form a considered opinion on the subject, and gain that comprehensive view of the situation which would be necessary in studying the report to be presented later to the government by the Royal Commission on Railways and Transportation.

Visits to Engineering Works

In the afternoon of Friday, February 5th, arrangements had been made for members to visit a number of new buildings and engineering works in and near the city of Toronto, among which may be mentioned: the Toronto-Leaside transformer station of the Hydro-Electric Power Commission of Ontario, into which power is received from Gatineau at 220,000 volts; the North Toronto sewage disposal plant, opened in 1929; the new hockey arena, the Maple Leaf Gardens, with a seating capacity of 17,000; the toll or long distance equipment of the Bell Telephone Company of Canada, Ltd., which includes that used in connection with the recently opened Trans-Canada line; the central heating plant of the Toronto Terminals Railway Company, which supplies about 500,000,000 pounds of steam per annum to the Union Station, the Royal York hotel and other terminal buildings; the new waterworks tunnels under construction by the city of Toronto which have a total length of nearly ten miles; and the St. Clair high level covered reservoir, which has a capacity of 50,000,000 Imperial gallons.

The Past-Presidents' Prize 1931-1932

The subject prescribed by Council for this competition for the prize year July 1st, 1931, to June 30th, 1932, is **"The Effect of the Development of the Electronic Valve upon Electrical Engineering and Industry."**

The rules governing the award of the prize are as follows:

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved, as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received during the prize year by the General Secretary of The Institute, either direct from the author or through a local Branch.

Students' and Juniors' Prizes

Students and Juniors of The Institute are reminded that five prizes, each of the value of twenty-five dollars, may be awarded to Students and Juniors of The Institute for the prize year 1931-1932 as follows:

The H. N. Ruttan Prize in the four Western Provinces.

The John Galbraith Prize in the Province of Ontario.

The Phelps Johnson Prize for an English Student or Junior in the Province of Quebec.

The Ernest Marceau Prize for a French Student or Junior in the Province of Quebec.

The Martin Murphy Prize in the Maritime Provinces.

Papers in competition for these prizes must be received by Branch secretaries before June 30th, 1932. Furthur information as to the requirements and rules may be obtained from the General Secretary.

Charles Camsell, M.E.I.C.

President of The Engineering Institute of Canada

The wide range of activity of The Institute's members is well illustrated by the career of the new President, Dr. Charles Camsell, B.A., LL.D., F.R.S.C., F.G.S.A. The great area of northern Canada where his early days were spent and in which much of his professional work was done is now accessible by aerial transport, but such an easy method of travel was not available at the time when he carried out his geological work and made his many arduous journeys of exploration. Travel had to be on foot, on horseback, by canoe and by dog train in his journeys and those of the other explorers whose investigations have gradually opened up our western mountains, plains and rivers. His election as President of The Institute is noteworthy because it recognizes the importance of geological knowledge as a foundation for the achievements of the engineer who has to provide a rapidly developing country with fuel, metals, power, transportation and the amenities of life.

CHARLES CAMSELL, M.E.I.C.

From the time when he left the university in 1894, until his appointment as Deputy Minister of Mines in 1920, Dr. Camsell was engaged in the study and exploration needed to ascertain geological data of the kind on which mining and engineering work must be based. Later, his duties at Ottawa have given him a thorough acquaintance with the Canadian mining industry and with Canadian problems connected with fuel and power supply.

The son of Captain Julian S. Camsell, Canadian Rifles, a Chief Factor in the service of the Hudson's Bay Company, he was born at Fort Liard, N.W.T., on February 8th, 1876, and was educated at the University of Manitoba, graduating with the degree of B.A. in 1894. Later he took post-graduate courses in geology at Queen's University in 1901, at Harvard University in 1903, and carried on further advanced studies at the Massachusetts Institute of Technology in 1908 and 1909. From 1894 to 1900 he was engaged in travel and exploration in parts of the Mackenzie river basin and in the region west to the Pacific coast, taking part in geological survey work at Great Slave Lake, Great Bear Lake and the Coppermine river basin. During part of 1901 he was exploring the Moose river basin on James Bay for the Algoma Central Railway; in 1902 he traversed the woods-buffalo country between the Peace river and Great Slave Lake and acted as geologist to the Canadian Northern Railway Company in western Ontario and northern Manitoba in 1903. In the following year he joined the permanent staff of the Geological Survey, travelling from Dawson to the mouth of the Mackenzie river and exploring the Stewart and Peel rivers. The year 1906 saw his activities transferred to British Columbia, where he worked for five years on economic problems. In 1914, in charge of exploratory work for the Geological Survey, he traversed the country between the Athabaska river and Great Slave Lake. From 1918 to 1920 he was in charge of the Vancouver office of the Geological Survey of Canada and was engaged in supervising its survey work in British Columbia and the Yukon Territory. In 1920 he was appointed Deputy Minister of the Federal Department of Mines, Ottawa, and since that time he has served as chairman of the Dominion Fuel Board, as member of Council for the Northwest Territories, as a member of the National Research Council, as a member of the special International Niagara Board, and as Chairman of the Canadian National Committee of the World Power Conference.

Dr. Camsell joined The Institute as a Member on February 16th, 1923, and served on Council in 1929 and 1930. He was vice-president of the Canadian Institute of Mining and Metallurgy in 1921-1922, vice-president of the Royal Society of Canada in 1930, becoming its President in 1931, was President and one of the founders of the Canadian Geographical Society, and holds membership in a number of other scientific and learned organizations.

Among his academic honours may be noted the degrees of LL.D., which he received from Queen's University in 1922 and from the University of Alberta in 1929. His achievements as an explorer were recognized in 1922 by the award to him of the Murchison Grant by the Royal Geographical Society as an appreciation of his services in exploring northern Canada; his long connection with the mining industry was fittingly acknowledged in 1931 when the Institution of Mining and Metallurgy, London, presented him with its gold medal for his work in promoting the development of the natural resources of the Dominion and furthering the general interests of the mineral industry.

Dr Camsell enters upon his Presidency with a wide experience as an administrator and his election to this important office will be particularly appreciated by those of our members who are connected with the government service and with the mining industry.

Address of the Retiring President

S. G. Porter, M.E.I.C.

Delivered before the Forty-Sixth Annual General Meeting of The Engineering Institute of Canada, Toronto, February 3rd, 1932

THE ENGINEERING PROFESSION—YESTERDAY AND TOMORROW

The reports of Council and of the Finance Committee to which you have just listened together with the reports of other committees and of the Branches which will be presented to you today, constitute a full record of the activities of The Engineering Institute and its Branches during the year that is now closing. It is not necessary, therefore, for me to review these activities.

I wish, however, to acknowledge with the deepest appreciation, both on behalf of myself and on behalf of the entire membership which I am happy to represent, the very faithful work of the members of Council, all committees, the officers of the Branches, and the General Secretary and all members of his staff. The loyalty of the staff and their interest in the welfare of The Institute are forcibly evidenced in their voluntary acceptance of a ten percent reduction in their salaries. We trust that the period during which our economic conditions make such a reduction necessary will be of short duration.

When I was elected President of The Institute, I had the ambition to visit all the Branches during my term of office. Undertaking this pleasant and interesting task still further impressed upon me the magnitude of our country, and much to my personal regret I found that the duties and responsibilities of my everyday work would not permit me to realize the ambition. I was, however, able to visit about one half the Branches, and I wish again to express my gratitude for the extremely cordial reception they gave me.

I have been under the handicap of living a long distance from Headquarters, and for that reason have not been able to attend the regular monthly meetings of Council and keep in as intimate contact with its work as I should have liked to do. The vice-presidents have very graciously and efficiently filled the vacancy in the chair, and the General Secretary has kept me advised of the work of Council and the committees, and I wish to thank them for so well performing these additional duties.

In casting around for a topic for use on an occasion such as this, it is natural for one's mind to turn in the direction of a Review and a Forecast. I have therefore chosen as the subject of my address, "The Engineering Profession—Yesterday and Tomorrow."

The engineering profession, in its present day technical and professional sense, is a comparatively young profession. But engineering in its broader practical sense is almost as old as mankind. It had its beginning, no doubt, in the primitive man's adaptation of the elementary forces of nature to his needs, first, probably as weapons in hunting and warfare, or the crude implements devised to meet his simple domestic requirements.

Man has been called "the tool-using animal." He has used tools of a more or less crude form from prehistoric times. At intervals their use resulted in works of great skill, as manifested in the civilizations of Egypt, Mesopotamia, India and China. But they were only the hand tools of the craftsman. Not until near the close of the eighteenth century did the development of machine tools begin, followed in the nineteenth century by the development of power and power driven machinery. Up to that time production had been by artisans working with hand tools. The mechanically inclined workmen whose superior skill set them apart for special duty formed guilds, which played an important part in the early development of trade and industry.

But with the introduction of machinery and steam power, manufacturing underwent such a drastic change that it was termed "the industrial revolution." And finally, as knowledge of the scientific principles of physics and mechanics became more general, their application to the needs of an advancing civilization came to be the function of a group of specially trained men—the engineering profession. Engineering, then, as a technical profession, had its origin largely in the problems created by the industrial revolution. That was, roughly speaking, one hundred and fifty years ago. The development of power driven machinery, with steam as about the sole source of power, together with the development of the processes of production and use of iron and steel, marked the advances of the century from 1780 to 1880. But it is the comparatively brief period since the latter date—that is, the past half century—that marks such amazing progress that it is entitled to be described as "The Romance of Engineering."

It is not my purpose to present an exhaustive review of engineering progress during the past half century, but let me take you in a figurative flight which we will call "From Yesterday to Tomorrow," and point out some of the interesting things along the way. The yesterday of our journey was fifty years ago. Let us recall what it was like. It already boasted of being a machine age. Little mills were dotted along the streams where water power was available or steam plants supplied power, but with no means of transmitting it beyond the range of their maze of shafts, gears and belts. The Corliss engine, using steam at seventy pounds pressure and turning over at the leisurely rate of seventy revolutions per minute, was the embodiment of the greatest and finest development for power generation known at that period. In the boiler room, sweating firemen shovelled coal, scoop by scoop, into the narrow space between the grates and the shells of small horizontal, return tubular boilers. That was the motive power of the day.

On the road was the horse and buggy, on the farm the horse-drawn plough. In our homes kerosene lamps provided the illumination. Some progressive cities boasted of gas lights. The pick and shovel and the hod were standard equipment in building construction. The telephone was still an experiment and a curiosity. There were no electric street cars, no electric lights, no modern house heating plants, no automobiles, no radios, no moving pictures, no aeroplanes. Labourers worked ten to twelve hours per day, with no time nor means for leisure and recreation. It was the age of coal stoves, kerosene lamps, horse cars and mud roads. Yet we often describe it as "the good old days."

With that picture in our minds, let us note some of the outstanding changes which we have seen as we have flown along our brief fifty year course. I am not yet ready to admit that I am an old man, but during my own lifetime, which covers only slightly more than the half century under review, there has been greater and more varied progress in the application of engineering and scientific principles to the needs of civilization than in all the centuries that preceded it. It is in that period that we have seen such amazing development in the use of electric power, steam and water turbines, internal combustion engines, the automobile, aircraft and the radio.

The most prominent feature of our whole journey, and the one which has stood out as a controlling factor all along the way, has been the generation, the transmission, and the application of power.

Steam Power

For nearly a century after its introduction, the steam engine was the undisputed source of mechanical power. It abolished the inflexible water wheel and windmill. and made it possible to locate factories at other points than on the old mill stream. At the mid-point of that century of its reign it was set on wheels and created a system of transportation before unknown, making the half century preceding 1880 notable for improvements made in the steam engine and its application to land and water transportation. It had thus had the field of power production very largely to itself and had reached what was properly considered a high stage of development.

While its monopoly has not continued undisputed, yet it has continued its progress, and today steam turbines and large boiler units employing steam pressures of 1,200 to 1,400 pounds and steam temperatures of 750 degrees F., have displaced the old types of low pressure boilers and reciprocating engines.

Electric Power

While the half century preceding 1880 was notable for the development of the steam engine and its application to transportation, the half century since that date has been even more notable for the development of the use of electricity, the central station, power transmission and the growth of the electrical industry.

Edison invented a commercial incandescent light in October 1879. An efficient generator was invented at about the same time, and when the electric generator was born the key to the distribution of power was found. This started the development of the central station with all it has meant in the distribution and use of power. For electricity and power are the two words around which more than any others the marvellous advance of the last fifty years has centred.

The first real central station in New York was undertaken in 1880 and put into service in September 1882. Since that date the central station industry has doubled in volume on an average of once in seven years, and its statistics read like a fairy tale.

The development of the central station and the electrical transmission of energy were the outstanding features of the first half of this fifty-year period. They still further released the factory from its cumbersome shackles of shafts and belts, and extended the radius of its location to far distant fields. By its ease of transmission, simplicity of control, and flexibility of application, electric power now drives two-thirds of the machinery of the whole country, and the changes it has been responsible for, directly or indirectly, in the life and habits of the people of all civilized nations, have been most far reaching.

Internal Combustion Engines

The next big event in the field of power was the development of the internal combustion engine. It has played a most important part in our economic evolution, making possible the automobile, the tractor and the aeroplane. The first gasoline engine in the United States was built just fifty years ago. At that time gasoline was a worthless by-product in the manufacture of kerosene. The first road vehicle propelled by an internal combustion engine was built by Carl Benz of Mannheim, Germany, in 1885. In July 1894 occurred the first automobile racing competition in the world, at which time there were not half a dozen passenger motor cars on this continent. At the beginning of the century there were only eight thousand motor cars in the United States. Now there are thirty millions, and from the standpoint of installed horsepower, the automobile, in the aggregate, far exceeds all other prime movers.

No industry has had a greater effect on the development of new methods of manufacture, the perfection of mass production, and on the efficiency of shop organization and specialization than the automobile industry. The same chain of influence has extended to the development of new materials, such as light weight alloys, which have made the modern automobile and aeroplane possible.

Power, then, in one form or another, has in the past fifty years brought blessings beyond measure to the human race. It has lessened human toil; it has lifted the drudgery of work from the stooped shoulders of men and women and placed it on the untiring back of the machine. Working hours have been reduced and wages increased, with the result that the working class have been its greatest beneficiaries, and have been able to acquire educational and social advantages undreamed of in earlier times. Nations have increased in wealth in proportion as they have possessed sources of power, and its development and application are proceeding at an ever accelerating rate.

Transportation

Possibly no other phase of a country's development is so true an index of the stage of civilization to which it has advanced as its transportation facilities. Transportation is the great problem underlying the prosperity of a nation. The bringing about of a proper co-ordination of the different types of transport facilities which will best serve the public needs is one of the major problems of transportation today. It requires a thorough scientific analysis to determine how each type can best be used in combination with other types. These are largely engineering problems, but they are also problems of vast public interest, and the engineers who devote their talents to their solution will be rendering a great public service.

Railways

At the beginning of our imaginary journey, fifty years ago, railways were of course already well established. The typical locomotive of that day was the eight-wheel type, weighing less than forty tons, and carrying a steam pressure of 130 to 135 pounds. Freight cars were of wooden construction and had a capacity of 20,000 to 40,000 pounds. Passenger coaches likewise were of wood, seated fifty persons and weighed about 45,000 pounds. In contrast, the latest Canadian Pacific locomotive, No. 8000, is of the multi-pressure type, using steam at pressures of 1,350, 850 and 250 pounds, weighs six times as much as its predecessor of fifty years ago, and has a tractive force eight times as great. Freight cars today are all steel construction and have capacities as high as 270,000 pounds. In passenger coaches the most important development has been the substitution of steel for wood, together with many improvements and refinements for the safety and comfort of the passengers.

The maximum weight of rails fifty years ago was 67 pounds per yard. Now, many railways are using 130- and even 152-pound steel.

The fifty-year period of our flight had already seen four years pass by when the first passenger train crossed Canada to the Pacific. It was only forty-seven years ago that the first train load of wheat moved out of western Canada, and the first thousand bushels was exported from this country. In that brief time shipment for export increased to more than 300,000,000 bushels. Only fifty years ago the Canadian Pacific railway was built, yet Canada today stands third among the nations of the world in total railway mileage.

The railway systems of the United States and Canada are the greatest assets those countries possess, and their high state of efficiency constitutes the engineer's proudest achievement.

Highways

Prior to the advent of the motor car, highway construction was largely a haphazard process in which engineers played little part. Today it is an important branch of engineering, the engineer being responsible both for the design of the motor vehicle and for the road on which it must travel. Some of the most important engineering works of the past decade have been motor highways, an outstanding example being the Mount Vernon super-highway recently completed at a cost of half a million dollars per mile.

In the evolution of transportation during the past century and a half, we began with sailing vessels and horse drawn vehicles. Then the highway yielded to the canal, and the canal to the railway. Now we see the return of the highway as a serious competitor of the railway. The adjustment and co-ordination of the two are problems for the engineer to work out.

Aviation

Such rapid advances are being made in the field of aeronautical engineering that one who is not a specialist dares not discuss them. Less than a quarter of a century elapsed between the first heavier-than-air flight by the Wright Brothers in 1903 and the historic and dramatic flight of Lindbergh in 1927.

The benefits to be derived through the development of aviation are by no means confined to the direct means of transportation it provides for passenger, mail and express service, great as they are. But the development of the aeroplane is making possible a wonderful advance in the possibilities of the investigation, exploration and protection of our natural resources. Much less than half of the Dominion of Canada is served by highway or railway. Much of the part not served is rich in minerals, forests, game and fisheries. The aeroplane and the wonderfully accurate cameras and devices for reducing photographs to engineering maps have opened up a new field for exploring and mapping our more or less inaccessible areas. These methods are found useful not only for general mapping, but for railway and highway reconnaissance, and power and mining development. Canadian aeronautical engineers have established enviable records in this work and Canada today is ranked as the second nation in the world of aviation.

Bridges and Buildings

The development of steel bridge construction has been almost entirely a matter of the past half-century, dating from the introduction of soft steel for structural purposes. The first all-steel truss bridge in America was built over the Missouri river at Glasgow, Mo., just fifty-three years ago. One hundred years ago the longest bridge span in the world was less than 600 feet, and it was considered impossible ever to exceed that figure. Yet, fifty years later the Brooklyn bridge, with a span of nearly 1,600 feet, was opened, the most outstanding engineering work of its kind at that date. Then, in 1931 the George Washington bridge over the Hudson river, with a span of 3,500 feet, was completed at a cost of $60,000,000. It not only has more than double the span of the Brooklyn bridge, but has four times the traffic capacity, with more than eight times the total mass suspended over the river.

Likewise, prior to the advent of rolled steel beams and other structural forms, only slightly more than a half century ago, buildings of more than five storeys were very rare. But with the introduction of structural shapes and of the elevator, together with increased values of land areas, buildings have continued to creep skyward until now forty or even fifty storeys are quite common, while one notable building completed last year, the Empire State building in New York City, has eighty-six floors and reaches the sky piercing height of 1,250 feet. It is today the highest structure in the world, being 266 feet higher than the Eiffel tower, which for many years held that distinction. From the first rolled beam to the all-skeleton skyscraper building was but thirty-seven years.

Material Handling

In no field of engineering and industrial activity has there been a greater revolution and progress than in the equipment and facilities for handling materials. One example will serve to illustrate this statement.

The first cargo of wheat from western Canada was loaded at Port Arthur on the steam barge *Erin* in 1883—less than fifty years ago. It took three days to load the cargo of 10,000 bushels, using wheelbarrows for loading. Last year, Saskatchewan Pool Elevator No. 7 delivered 200,000 bushels to the Steamer *Windoc* in one hour. At that rate, the *Erin* would have been loaded in three minutes, instead of that many days. Modern freighters of more than 500,000 bushels capacity are completely loaded, including the time in trimming and putting on the hatch covers, at an average rate of more than 100,000 bushels per hour.

The foregoing is only a very meagre outline of developments in some of the principal branches of engineering. It would be of interest to note how sanitary engineering, as applied to improved water supplies, sewage disposal, the elimination of sources of contagion and disease, and the heating and ventilating of our homes, has contributed to the comfort, health and longevity of our people; how refrigeration, and the preservation and distribution of perishable foodstuffs have made it possible for the average man today to enjoy articles of diet from distant lands which were denied even to kings a hundred years ago; how petroleum engineering, with all its ramifications, has developed in the wake of the automobile; how mining engineering and metallurgy are playing such an important part in Canada's development; how engineering and science have contributed to the marvellous progress made in the field of communication.

But space does not permit an elaboration of these, nor even the mention of a score of other points of interest that have stood out along the way as we made our flight from the Yesterday of fifty years ago towards our Port of Tomorrow.

Now, as we make a brief stop at the Port of Today, a little time must be devoted to a study of the route that is ahead of us and the nature of the preparation that is necessary to enable us to follow it with continued success.

We cannot help but realize that the outstanding achievements of yesterday are the commonplaces of today, and it requires but little imagination to accept the prediction that the outstanding achievements of today will likewise be considered commonplace tomorrow.

We have gone far since the beginning of the industrial revolution. But the revolution is not over. We are still in the midst of it. Our present difficulties can be properly described as a recurring phase which requires a further readjustment of our industrial and social structure, just as was necessary a century and a half ago, though possibly in a much less marked degree. As the industrial revolution advanced, its problems were not solved by discarding the machines which were responsible for bringing it about. Neither will our present trouble be solved by reverting to the methods and processes of a generation ago. Such is not the spirit of this scientific age. That spirit demands that we build upon the progress we have already made—not tear it down. To build up requires leadership—statesmanship. The problems are not by any means all technical. They are largely economic and social. We know how to meet our technical problems. Even though the answers are unknown, we are versed in the methods of approaching them. But in economic and social problems we are apparently plunging in the dark. Social science has not kept abreast of physical science. As William E. Wickenden says in his chapter on Education and the New Age, in the volume Toward Civilization, "We have the power of super-men over things and their forces, but only a faulty understanding of 'men and their ways'."

Engineering and scientific methods have been wonderfully successful in their application to industry. Is it not possible to make greater application of them to the problems of social economics and politics? Science demands that we "face the facts, and, in the light of them, forge out utterly new solutions," regardless of whether or not they are in keeping with the precedents established by our grandfathers. We have, in our lifetime, witnessed many revolutionary changes in the field of science that have upset our previous conceptions of how the laws and forces of nature act. It is possible that a revolution is due in the field of economics and politics.

Certain it is that, if there are fundamental laws which control our economic and social destiny, as physical laws control the forces of nature, then the events of the past three years have cast a doubt on our ability to interpret and apply them. Broad-minded engineers and men of science owe a patriotic duty to their fellow men to assist economists and legislators in applying scientific methods in seeking a solution of these problems.

In the remarkable advance of engineering during the past century, the scientific method has been the key to progress. So it must be in the future. Whatever the future may hold, it seems certain that only by following the guidance of science can we hope to master the forces of nature that surround us, whether they be the forces of the waterfall or of atomic energy. Research has already accomplished results far surpassing the marvels of Aladdin's lamp. But its work is not finished. The demands on it are extending further and further every day.

The story is told of an official in the Patent Office at Washington, who, a hundred years ago, after recording a large number of impressive inventions, resigned his position because, as he said, there was nothing left to invent, and there was therefore no future to his job. We still meet such people—those who say that any further discoveries are impossible. But it is not such as they who have carried the work of research to success. Scores of the important problems which have been solved during our lifetime have been pronounced to be impossible of solution. Less than ten years before the Wright Brothers' successful flight, even so high a scientific authority as Lord Kelvin declared that man could never fly in a heavier-than-air machine. Right up to the moment of success, thirty years ago, Marconi was assured by other scientists that it was impossible to transmit wireless signals across the ocean.

Science and research have produced so many incredible results that we no longer dare to say that anything is impossible. Every new step forward leads to the border of the unknown, and creates new problems for research. Now, as never before, new problems press for solution.

Industries have in the past, and will in the future, face the tragedy of the exhaustion of a necessary substance. The individual industry so affected may suffer, but science meets the challenge by producing a new process or a new material, and civilization usually finds that it is wealthier instead of poorer, by the change. In 1750, the output of iron in England had dwindled to one-tenth of what it had been eighty years before, and the industry faced ruin because the exhaustion of the forests had made it impossible to obtain an adequate supply of charcoal for smelting. Then Abraham Darby introduced smelting with coke and the industry was saved. The rapid depletion of many of our natural resources creates the problem of discovering other materials or processes for replacing them, or for developing processes for the more economic utilization of the resources which still remain. I have faith that scientific research, whether it be done by engineers, physicists, chemists, biologists, or men in whatever branch of science they belong, will prove equal to its task. In fact, opportunity along these lines is with us now as never before, and fame and fortune await the men who, by their efforts, bring about a solution of these important problems. I do not share the fear of the alarmists who predict that our sources of heat or power, or whatever other necessity they are concerned about, will be exhausted, with fatal results to the human race.

As a result of engineering, we have seen, in a single life-span, wonderful changes wrought in the everyday life of the average man. The uses to which engineering knowledge may be applied are cumulative, and while it would be folly for me even to venture to predict what we may encounter in the tomorrow of our flight, yet, we can face it with the confidence that the engineer and his associate, the scientist, will be able, through the intelligent application of scientific knowledge, to attain ever more and more complete control over our environment and destiny, until we reach the ultimate aim of the Creator, that man shall have dominion over all the earth.

Award of Medals and Prizes

Past-Presidents' Prize

The Past Presidents' Prize of The Institute for the year 1930-1931 has been awarded to A. W. McQueen, A.M.E.I.C., of Niagara Falls, Ont., the subject, "Engineering Education," having been prescribed by Council for this competition.

The committee reported that a considerable number of the fifteen papers submitted attained a very high standard, and that while the award was finally made to Mr. McQueen, several of the other papers were considered of almost equal merit. Among these, honourable mention was awarded to the paper contributed by E. G. Cullwick, Jr.E.I.C., of Vancouver,

A. W. McQueen, A.M.E.I.C.
Winner of the Past-Presidents' Prize, 1930-1931

Mr. McQueen is a graduate of the Faculty of Applied Science and Engineering of the University of Toronto of the year 1923. Following graduation Mr. McQueen entered the service of the Hydro-Electric Power Commission

G. O. Vogan, A.M.E.I.C.

Dr. W. S. Dyer.

Dr. G. S. Hume.

Medallists and Prizewinners for 1931

Eric G. Adams, S.E.I.C.

D. E. Bridge, S.E.I.C.

C. I. Bacon, S.E.I.C.

of Ontario, and subsequently became assistant engineer with H. G. Acres and Company, Ltd., Niagara Falls, Ont.

Professor Cullwick took his degree in engineering at Cambridge University with honours in 1925, and was a Scholar of Downing College. He received his practical training with the British Thomson-Houston Company Ltd., Rugby, and after coming to Canada was with the Canadian General Electric Company at Peterborough, Ont. In 1928 he became assistant professor of electrical engineering at the University of British Columbia.

GZOWSKI MEDAL

This year the Gzowski Medal has been awarded to G. O. Vogan, A.M.E.I.C., for his paper on "The Design of the Chute à Caron Diversion Canal" which was published in the March 1931 issue of The Engineering Journal. Mr. Vogan is a graduate of Queen's University of the year 1917, and was formerly designing engineer with the Alcoa Power Company, Ltd., at Arvida, Que., being now in the service of the Beauharnois Construction Company, Beauharnois, Que.

PLUMMER MEDAL

The Plummer Medal for the year ending June 1931 was awarded to Dr. G. S. Hume for his paper entitled "Structure and Oil Prospects of the Eastern Foothills area, Alberta, between Highwood and Bow Rivers." Dr. Hume is on the staff of the Geological Survey, Department of Mines, Ottawa, and his work has lain largely in the study of geological problems of economic interest in the West. His paper appeared in the January 1931 issue of The Journal.

LEONARD MEDAL

The Leonard Medal Committee awarded the medal for the year 1930-1931 to Dr. W. S. Dyer, M.C.I.M.M., for his paper on "The Lignite Deposit at Onakawana, Moose River Basin." Dr. Dyer is geologist with the Ontario Department of Mines, Toronto, and, like Dr. Hume, has been engaged on work of great importance and interest in connection with engineering problems. It was his geological work which led the Ontario Department of Mines to undertake drilling which disclosed the presence of the important lignite deposit at Onakawana described in the paper selected for the medal award. The paper appeared in the Bulletin of the Canadian Institute of Mining and Metallurgy for July, 1930.

STUDENTS' AND JUNIORS' PRIZES

Three of these prizes were awarded this year as follows:

The John Galbraith Prize (Province of Ontario), to D.E. Bridge, S.E.I.C., of the Canadian Westinghouse Company Ltd., Hamilton, for his paper on "Electric Furnaces as Applied to Industrial Heating."

The Phelps Johnson Prize (Province of Quebec, English), to Eric G. Adams, S.E.I.C., for his paper on "Some Economic Problems Confronting the Wider Application of Railroad Electrification in America."

The Martin Murphy Prize (Maritime Provinces), to C. I. Bacon, S.E.I.C., of North Tryon, P.E.I., for his paper on "Exhausting a Vacuum Tube."

No award of the Sir John Kennedy Medal was made during 1931.

Meeting of Council

The first meeting of the new Council was held at the Chateau Laurier, Ottawa, at two fifteen p.m., on Wednesday, February 10th, 1932, with President Dr. Charles Camsell, M.E.I.C., in the chair, and seven other members of Council present.

The complete membership of Council is now as follows:

President:	*Charles Camsell	Ottawa
Vice-Presidents:	O. O. Lefebvre	Montreal
	H. B. Muckleston	Vancouver
	*A. H. Harkness	Toronto
	*A. B. Normandin	Quebec
	*S. C. Mifflen	Glace Bay
Past-Presidents:	C. H. Mitchell	Toronto
	A. J. Grant	St. Catharines
	S. G. Porter	Calgary
Councillors:	W. P. Copp	Halifax
	*J. R. Morrison	Cape Breton
	A. R. Crookshank	Saint John
	*L. H. Robinson	Moncton
	G. E. LaMothe	Saguenay
	*H. Cimon	Quebec
	J. L. Busfield	Montreal
	C. V. Christie	Montreal
	J. A. McCrory	Montreal
	*F. Newell	Montreal
	*P. L. Pratley	Montreal
	D. C. Tennant	Montreal
	B. Grandmont	St. Maurice
	*J. McLeish	Ottawa
	F. H. Peters	Ottawa
	*R. L. Dobbin	Peterborough
	D. M. Jemmett	Kingston
	T. Taylor	Toronto
	*J. J. Traill	Toronto
	L. W. Wynne-Roberts	Toronto
	*F. W. Paulin	Hamilton
	W. P. Near	London
	*E. G. Cameron	Niagara Peninsula
	A. E. West	Border Cities
	*A. E. Pickering	Sault Ste Marie
	G. H. Burbidge	Lakehead
	*J. W. Porter	Winnipeg
	*C. J. Mackenzie	Saskatchewan
	*J. B. deHart	Lethbridge
	R. W. Ross	Edmonton
	*B. Russell	Calgary
	P. H. Buchan	Vancouver
	*F. C. Green	Victoria

*Newly elected.

At this meeting the formal business required by the By-laws in regard to appointment of committees was taken up.

R. J. Durley, M.E.I.C., was re-appointed as Secretary, and W. C. Adams, M.E.I.C., as Treasurer.

The Finance Committee was appointed with the following members:

J. L. Busfield, M.E.I.C., Chairman
W. C. Adams, M.E.I.C.
A. Duperron, M.E.I.C.
P. L. Pratley, M.E.I.C.
F. P. Shearwood, M.E.I.C.

The chairmen of the remaining standing committees were appointed as follows:

Library and House:	D. C. Tennant, M.E.I.C., Chairman
Papers Committee:	J. J. Trail, M.E.I.C., Chairman
	R. B. Young, M.E.I.C., Vice-Chairman
Publication Committee:	L. W. Wynne-Roberts, A.M.E.I.C., Chairman
Legislation Committee:	Fred Newell, M.E.I.C., Chairman

These gentlemen were asked to submit the names of the other respective members at the next meeting of Council.

In accordance with the rules governing the award of the Students' and Juniors' Prizes, the following were appointed chairmen of the examiners in their respective zones, and the Secretary was directed to ask these vice-presidents to submit the names of the two councillors from their zones whom they desired to act with them in this connection:

Zone A—Vice-President H. B. Muckleston, M.E.I.C.
Zone B—Vice-President A. H. Harkness, M.E.I.C.
Zone C (English)—Vice-President O. O. Lefebvre, M.E.I.C.
Zone C (French)—Vice-President A. B. Normandin, A.M.E.I.C.
Zone D—Vice-President S. C. Mifflen, M.E.I.C.

With regard to the appointment of the Board of Examiners and Education, discussion took place as to its constitution, and the Secretary was directed to request Professor C. R. Young, M.E.I.C., to undertake its chairmanship.

The following committees were continued, their membership being re-appointed as follows:

Committee on Relations with other Technical Societies:
J. A. McCrory, M.E.I.C., Chairman
W. C. Adams, M.E.I.C.
J. L. Busfield, M.E.I.C.

Honour Roll and War Trophies Committee:
Brig.-Gen. C. J. Armstrong, M.E.I.C., Chairman
Col. A. E. Dubuc, M.E.I.C.
Fraser S. Keith, M.E.I.C.
Brig.-Gen. G. E. McCuaig.

Committee on Biographies:
F. H. Peters, M.E.I.C., Chairman
G. J. Desbarats, M.E.I.C.
A. F. Duguid, A.M.E.I.C.

Committee on Engineering Education:
Fraser S. Keith, M.E.I.C., Chairman
E. Brown, M.E.I.C.
R. W. Brock, M.E.I.C.
C. V. Corless, M.E.I.C.
A. R. Decary, M.E.I.C.
F. R. Faulkner, M.E.I.C.
E. P. Fetherstonhaugh, M.E.I.C.
A. Frigon, M.E.I.C.
W. J. Johnston, A.M.E.I.C.
C. J. Mackenzie, M.E.I.C.
C. H. Mitchell, M.E.I.C.
J. Stephens, M.E.I.C.
R. S. L. Wilson, M.E.I.C.

It was decided not to re-appoint the Committee on International Co-operation.

An invitation from the Winnipeg Branch to hold the Annual Meeting for 1933 in Winnipeg was considered, and attention was drawn to the difficulty and expense as regards transportation for members from other branches. The Secretary was directed to ascertain what railway arrangements would be possible, and to inform the Winnipeg Branch that consideration was being given to the question and that it will be brought up at a later meeting of Council.

On the motion of Mr. Harkness, seconded by Mr. Newell, it was unanimously resolved that the thanks of Council be extended to the following for their courtesy and assistance in connection with the recently completed Annual General and General Professional Meeting in Toronto: Dr. W. Hamilton Fyfe, Dr. W. W. Colpitts, M.E.I.C.; Mr. L. W. Wynne-Roberts, A.M.E.I.C., chairman of the Toronto Annual Meeting Committee; Mrs. C. H. Mitchell, chairman of the Ladies Committee, and to the management of the Royal York Hotel.

The Council learned with regret of the death of Past-President W. F. Tye, in Paris, on January 9th, 1932, and of the bereavement of Councillor R. L. Dobbin, and the Secretary was directed to forward letters of condolence to Mrs. Tye and to Mr. Dobbin accordingly.

Attention was drawn to the discussion which had taken place at the Annual General Meeting with regard to the approval by the Council of the Standard Form of Construction Contract prepared by the Canadian Construction Association, this having now received the approval of the Royal Architectural Institute of Canada. After further discussion Vice-President Harkness was appointed chairman of a small committee to examine the document and report as to the advisability of its being approved by Council.

Attention was drawn to the legislation now being sought by the Ontario Association of Professional Engineers, and it was suggested that the support of the Council of The Engineering Institute of Canada in this matter might aid in obtaining the desired result. After discussion, the following resolution was unanimously passed: "That in view of the facts that in seven of the provinces Associations of Professional Engineers have been empowered by provincial legislation to regulate the practice of the engineering profession and that this has resulted in the needed protection of the public, the Council of The Engineering Institute of Canada expresses approval of the legislation now being sought by the Ontario Association of Professional Engineers, which, if enacted, will give to that body privileges similar to those held by the similar associations in the other provinces, and thus provide for the citizens of Ontario the same protection as in the other provinces."

The Secretary was directed to send a copy of this resolution to the Premier of the Province of Ontario, and also to the President of the Association of Professional Engineers of Ontario.

Two requests for Life Membership were considered, and two reinstatements were effected.

A number of applications for admission as Student were considered, and twenty-five Students were admitted.

The Council rose at five o'clock p.m.

Students Admitted

At the meeting of Council held on Wednesday, February 10th, 1932, the following Students were admitted:

Undergraduates at Dalhousie University, Halifax, N.S.:

BLUE, Layton Campbell, Glace Bay, N.S.
CHRISTIE, Robert Louis, 8 Oxford St., Halifax, N.S.
DOUGLAS, Ralph Louis, 139 Morris St., Halifax, N.S.
FERGUSON, James Bell, 207 South Park St., Halifax, N.S.
HARRINGTON, Arthur Russell, 82 Cambridge St., Halifax, N.S.
KITZ, Joseph Russel, 332 South St., Halifax, N.S.
MacRAE, Allister Sutherland, 348 South St., Halifax, N.S.
NORMAN, Ronald Lee, 30 Hollis St., Halifax, N.S.
ROSE, Melville Cumming, Oakfield, N.S.
SARGEANT, Charles Corbet, Jr., 20 Albert St., Dartmouth, N.S.
SHATFORD, Ralph Grant, 20 Thompson St., Dartmouth, N.S.
SMITH, Edward John, King's College, Halifax, N.S.
SQUIRE, Frank Bennett, 207 So. Park St., Halifax, N.S.
SUTHERLAND, Donald Boyd, 57 Atlantic St., Halifax, N.S.
TAYLOR, Lewis James, Victoria, P.E.I.
WICKWIRE, William Alexander Keith, 56 Edward St., Halifax, N.S.

AKERLEY, William Burpee, (Univ. of N.B.), 8 Barker St., Saint John, N.B.
AKIN, Thomas Bernard, Jr., (N.S. Tech. Coll.), Windsor, N.S.
HALLEY, William Charles Howland, B.Sc. (E.E.), (N.S. Tech. Coll.), Officers' Mess, R.C.C.S., Camp Borden, Ont.
HENRY, Thomas, B.A.Sc., (Univ. of Toronto), 50 Ware St., Peterborough, Ont.
HUGHSON, Horace Gifford, (Univ. of N.B.), Petitcodiac, N.B.
LEE, Frederick Sydney, (Univ. of Toronto), 336 Runnymede Rd., Toronto, Ont.
McKIEL, William LeBaron, B.Sc., (Univ. of N.B.), 121 Emerald St. South, Hamilton, Ont.
REIKIE, Matthew Ker Thomson, (Univ. of Alta.), 8211 Rowland Rd., Edmonton, Alta.
SARAULT, Gilles E., (McGill Univ.), 1490 Bernard Ave., Montreal, Que.

OBITUARIES

Ernest China, A.M.E.I.C.

The death is recorded of Ernest China, A.M.E.I.C., at Weyburn, Sask., on January 11th, 1932.

Mr. China was born at Bath, England, on July 16th, 1883, and was educated at public and technical schools.

From 1907 to 1914, Mr. China was engaged as rodman and transitman, picketman, draughtsman etc., with the Saskatchewan Provincial Survey, Dominion Surveys, Grand Trunk Pacific Railway and the Pacific and Great Eastern Railway. From 1915 to 1919 he was on overseas service with the 5th Canadian Overseas Battalion. Returning to Canada in 1919 he joined the staff of the Canadian National Railways as a draughtsman, remaining in the service until 1922, when he became assistant engineer with the Highways Department at Regina, Sask. In 1930 Mr. China was appointed district engineer for the Department at Weyburn, Sask.

Mr. China joined The Institute as an Associate Member on September 23rd, 1924.

William Francis Tye, M.E.I.C.

The membership of The Institute will deplore the death of Past-President William Francis Tye, which occurred in Paris, France, on January 9th, 1932, while Mr. Tye was on his way to Canada from Switzerland, where he had spent the last few years.

He was born at Haysville, Ont., on March 5th, 1861, and was educated at Ottawa College and at the School of Practical Science of the University of Toronto, completing his course at the latter institution in 1881.

On leaving the Engineering School, Mr. Tye took part in a Dominion Land survey in the west, and in 1882 joined the staff of the Canadian Pacific Railway Company as rodman, remaining with the company until 1885 as leveller, transitman and assistant engineer on the main line (Brandon to Griffin Lake, B.C.) and southwestern branches. In 1886-1887 he was assistant engineer and transitman on location of the St. Paul, Minneapolis and Manitoba Railway. Several years were then spent on railway and mining work in Mexico. In 1890 Mr. Tye was locating engineer

WILLIAM FRANCIS TYE, M.E.I.C.

and subsequently division engineer on the Great Falls and Canada Railway, and from 1890 to 1893 he was engaged on preliminary surveys for the Great Western Railway. In 1893-1894 he was engineer in charge of change of gauge on the Alberta Railway, and in 1895 he became chief engineer on construction. In 1896 Mr. Tye was chief engineer of the Columbia and Western Railway from Castlegar to Midway, now part of the Crow's Nest line. In 1897 he joined the Canadian Pacific Railway Company as personal engineering assistant to Lord Shaughnessy and in 1899 became chief engineer of construction. In 1902, Mr. Tye was appointed assistant chief engineer and in 1904 chief engineer, retiring two years later from the railway service to engage in consulting work.

Mr. Tye was at one time president of the Sterling Coal Company, Ltd., and was retained as a consultant by many corporations. His professional opinion was sought in connection with a number of important projects as for instance the radial scheme in Ontario. His paper on "Canada's Railway Problem and its Solution" was a noteworthy contribution to the literature of the subject, and for this he was awarded the Gzowski Medal of The Institute in 1917. His engineering work is best remembered in the west, perhaps, as the high level bridges at Lethbridge and Edmonton were first conceived by him, and he was responsible for the construction of such lines as the Kaslo and Slocan and the Columbia and Western which now form part of the Canadian Pacific Railway Company's system.

A member of the American Society of Civil Engineers and the American Railway Engineering Association, Mr. Tye held high office in both organizations. He joined the Institution of Civil Engineers (Great Britain) as a member in 1910, and was the Canadian member of the Council of that institution during the years 1916-1917 and 1917-1918.

Mr. Tye was connected with The Engineering Institute of Canada for many years, having joined as a Member on December 17th, 1896. He always took a keen interest in The Institute's activities and served on Council during the years 1905, 1906 and 1907, becoming a vice-president in 1908, 1909 and 1910, and president in 1912.

His active engineering career of nearly fifty years saw the rise of the great railway systems in the west, and he took part in much of the arduous preliminary work in Canada and the northwestern States which made it possible for the Canadian Pacific and Great Northern systems to reach their present development. Of outstanding professional ability, it is not too much to say that Mr. Tye was respected and loved by all who worked under his direction, and his death will be deeply regretted by his wide circle of friends and by all members of the profession in Canada who knew him.

Robert Darrow Inness, A.M.E.I.C.

It is with much regret that the death of Robert Darrow Inness, A.M.E.I.C., which occurred on May 31st, 1931, is recorded.

Mr. Inness was born at Liverpool, N.S., on August 20th, 1888, and received his education at the Liverpool Academy.

From 1906 to 1916, Mr. Inness was with the Transcontinental Railway at first as rodman and chainman, as transitman and later as instrumentman on surveys and construction. In 1916 he formed a partnership with Horace Longley, and was engaged on contracting with the St. John and Quebec Railway, as superintendent in charge of his firm's operations. Later Mr. Inness became connected with the Nova Scotia Construction Company, Ltd., of Halifax, acting as their superintendent on the company's construction work on the St. John and Quebec Railway for a time. In 1921 he became a partner in the firm of Aiken and Inness, contractors, and at the time of his death was secretary-treasurer of Aiken, Inness and MacLachlan, Ltd., contractors, St. Catharines, Ont.

Mr. Inness joined The Institute (then the Canadian Society of Civil Engineers) on October 9th, 1909, transferred to the class of Junior on November 17th, 1914, and on June 24th, 1919, became an Associate Member.

George Forrester Richan, M.E.I.C.

Members will learn with regret of the death of George Forrester Richan, M.E.I.C., which occurred at Ottawa, Ont., on December 27th, 1931.

Mr. Richan was born at Barrington, N.S., on November 23rd, 1869, and was educated at public schools and Acadia University. In 1891-1892, he was a rodman with the New York and New England Railway, and in 1892 he was for a time with Frank L. Fuller, C.E., at Boston, Mass. During the years 1893-1895, Mr. Richan was rodman, draughtsman, transitman, locating engineer etc., with the Boston and Albany Railway, when his work included the design and superintendence of work involved in grade separation, yard layouts, docks and terminals. From 1905 to 1907 he was locating engineer with the National Transcontinental Railway and from 1907 to 1913 Mr. Richan was divisional engineer on construction with the same line. In 1913 he became divisional engineer with the Greater Winnipeg Water District which position he retained until 1921 when he joined the service of the Water Power and Reclamation Service, Department of the Interior, Ottawa, as hydraulic engineer. At the time of his death, Mr. Richan was engineer with the National Parks of Canada, Department of the Interior, at Ottawa.

Mr. Richan joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on March 12th, 1908, and became a full Member on March 20th, 1917.

Rolph Murray Todd, S.E.I.C.

Deep regret is expressed in recording the untimely death of Rolph Murray Todd, S.E.I.C., which occurred on November 22nd, 1931.

Mr. Todd was born at Amherst, N.S., on August 1st, 1906, and was educated at the Saint John high school and the University of New Brunswick, graduating from the latter institution in 1928 with the degree of B.Sc. In 1929 Mr. Todd was for a time with the Imperial Oil Refineries Ltd., at Sarnia, Ont., and later in the same year joined the staff of the equipment engineering department of the Bell Telephone Company of Canada, Ltd., Montreal.

Mr. Todd joined The Institute as a Student on December 23rd, 1927.

PERSONALS

T. W. Lazenby, Jr.E.I.C., formerly chief draughtsman with E. Leonard and Sons, Ltd., Kingston, Ont., is now shop superintendent with Messrs. McKelvey and Birch Limited, Kingston.

A. H. Moon, S.E.I.C., who was formerly with the Vocational School at Peterborough, Ont., is now attached to the Department of Education, Vocational Branch, Toronto, Ont.

C. H. Starr, S.E.I.C., is now engaged in the product engineering department of Electric and Musical Industries Ltd., and is located at Hayes, Middlesex, England. Mr. Starr was for a time with the engineering department of the Northern Electric Company at Montreal.

W. H. Spencer, A.M.E.I.C., who has, for several years, been assistant secretary of the Montreal Light Heat and Power Cons., during which time he supervised accident prevention work, will now specialize in safety engineering. Mr. Spencer, who was formerly identified with the electrical engineering division of the company, is a graduate of McGill University in electrical and mechanical engineering, and is particularly fitted by training and avocation to undertake this work.

C. C. Lindsay, A.M.E.I.C., has formed a partnership with Mr. Henri Belanger under the firm name of Lindsay and Belanger, and will practice as a Quebec Land Surveyor, civil and forestry engineer occupying premises in the Architects' building in Montreal. Mr. Lindsay has had extensive experience in all phases of land surveying and general engineering, dating from 1908 in the western provinces as well as in Quebec. Following his graduation from McGill University in 1915, he served overseas for four years with the Canadian and Royal Engineers. For four years he was a mine superintendent and engineer at Thetford Mines, and for the past eight years has been in charge of surveys, and of field administration of the properties of Price Brothers and Company, Ltd., in the Saguenay district. Mr. Belanger, a graduate of Laval University, has been in private practice since 1911.

H. L. SWAN, M.E.I.C.

H. L. Swan, M.E.I.C., has been elected chairman of the Victoria Branch of The Institute for the current year. Mr. Swan, who is district engineer, Vancouver Island, in the service of the Provincial Department of Public Works, has been on the staff of the department for a number of years, during which time he has been resident engineer on construction of a portion of the Cariboo road in the Fraser canyon and also in charge of construction of the Alexandra bridge over the Fraser river, which was built in the year 1927. From 1910 until 1916, Mr. Swan was on the staff of the Kettle Valley Railway, and following his return to civil life after the war, was engaged in private practice until 1924 when he entered the service of the government. Mr. Swan joined The Institute as an Associate Member in 1915, and transferred to the class of Member in 1928. He has always taken an active interest in Institute affairs.

A. M. Narraway, M.E.I.C., controller of surveys, Topographical Surveys Branch, Department of the Interior, Ottawa, has been appointed a member of the Geographic Board of Canada. Mr. Narraway graduated from McGill University in 1910 with the degree of B.Sc. Following graduation he became an articled pupil with Dominion and Ontario Land Surveys, and in 1911-1912 he was an assistant on Dominion Land baseline surveys. In 1913 he became chief of party on Dominion Land Surveys, which position he retained until 1917, when he was appointed controller of surveys.

CORRESPONDENCE

The Editor,
The Engineering Journal,
2050 Mansfield Street,
Montreal, Que.

Sir:

The letter published in the January issue from J. L. Busfield, M.E.I.C., chairman, Committee on Development, is very timely. It covers a great deal of ground in a very small space and should prove "thought provoking" to a great number of our members.

I feel compelled to express the hope that every member will take a personal interest in the work of Mr. Busfield's committee and may be allowed to consider themselves unofficial members of that committee and will by constructive thought in writing, either by letters to The Journal or direct, or through branch action, help to bring some light to bear on the proper policy for our future development.

Mr. Busfield, of course, is right. The primary object of The Institute is the acquirement and interchange of professional knowledge—

but I would like to quote from Dr. Fyfe's* address on the object of a university education. "We need the efficiency which comes through culture, as I have endeavoured to define it, the efficiency that is born of knowledge, wide appreciation, and an interest in human character and it is not only for the experts that we need efficiency. They may guide or instruct and warn us but they will not be the leaders. Leadership lies always with what Aristotle called the φρόνιμοι, well educated and appreciable men who have sufficient understanding to form a sound judgment on any matter of wide interest. These are the proper output of a university and we certainly cannot have too many of them in our country whether they work in collars or in corduroy. I am all for university education—for everyone who is able and willing to profit by it and the rigid exclusion of all who are not."

I feel that the general aims of The Institute should be somewhat analogous to those of a university as defined above by Dr. Fyfe. With the exception that instead of "rigid exclusion" of any, I would make it possible and practicable for any respectable citizen to be associated in some form or another, if his association can in any way benefit The Institute as well as himself.

I have always looked on The Institute as a sort of postgraduate course. A lot of things we can read and do read which are not in our ordinary course of activity but which undoubtedly bring us into closer touch with our countrymen in various lines and broadens our capacity for understanding our own problems as well as those of others.

The late Dean Galbraith, dearly beloved by all of us who had the privilege of sitting under him, said at our graduation dinner, among many other things, "Gentlemen, you must remember we have not made you engineers—we have merely put you in the way of being engineers."

The university is partly endowed and/or assisted by a paternal government. Nevertheless, real fees are exacted. Properly constituted authority sees to it that the business of teaching as well as the financial side are properly and efficiently handled.

If The Institute is to provide facilities for the interchange of professional knowledge (which is teaching) it must also provide adequate business administration. This means adequate finances, of course, and while I have definite views on finances, I do not mean to inject them here. Because of the wide flung nature of its component parts (the branches) and particularly its units (the members) The Institute must provide a quick channel of communication between its executives, its various committees and its members. We have the machinery for such a channel in the E-I-C News and I would like to see discussion on any subject relating to Institute development or letters to the Editor published there at once instead of waiting for space in The Journal. Technical papers, while better printed as soon as possible, are nevertheless still of value if their printing is delayed for a month or two or longer. Delay in disseminating information pertaining to the views of a branch or for that matter the views of a member on any current topic, results in lethargy and loss of interest and disgust and is equivalent to curbing free speech with all the suspicious and antagonisms which such curbing arouses.

This thought arises because I have often been impressed, as no doubt we all have been, with the very worthwhile talks given—sometimes to committees, other times at meetings—which never see the light of day and which are never heard by any beyond the few who are present.

It is, of course, just a parallel to the many very excellent sermons which are preached. Those most in need are not there and there is no way of reaching them.

It seems to me fundamental that, even if unofficial, more reporting, undoubtedly necessitating more thinking and work, must be done, particularly at the present time, and that such effort is useless unless it can be carried on expeditiously, getting anything worthwhile into print at once, striking when the idea is hot and giving the opportunity for reading the discussions of others probably not later than the second issue of E-I-C News after a letter or article appears. I believe the E-I-C News can be used as a most efficient vehicle of communication.

It has also been suggested that Branch news might be published in E-I-C News. Another effort to keep "news" of all kinds current.

Another suggestion is that instead of a branch having to go to the expense of preparing copies of necessary circular letters for its members, the circular letter might be printed on a separate sheet and sent to the branch members with E-I-C News. This will give all branches an opportunity of doing what I feel is very necessary, namely, get matters of policy, etc. over to those who do not attend a chance meeting.

I submit the thought also that we will likely do more to facilitate acquirement and interchange of professional knowledge, if we approach indirectly. Mr. Busfield rightly emphasizes "*It becomes all the more necessary for The Institute to put its house in order and develop itself in the strongest possible manner for the benefit of the profession it serves.*" Most of us will wholeheartedly agree with him.

An easy and effective and very necessary start can be made by clearing the channels of communication—no matter what form Mr. Busfield's Committee on Development, from time to time and ultimately, decide to recommend for The Institute's approval.

These remarks are set down hurriedly—but with the best wishes for a very successful termination of Mr. Busfield's labours, which he rightly refers to as onerous. While doubtless onerous, there is also without doubt the opportunity to do an outstanding service to all of us. Let us all get behind him and help ourselves by helping his committee, not waiting for but making the opportunity.

Yours very truly,
E. P. MUNTZ, M.E.I.C.,
Chairman, Hamilton Branch.

*Principal W. Hamilton Fyfe, Queen's University.

BOOK REVIEW

The High-Speed Internal-Combustion Engine

By Harry R. Ricardo. Blackie & Son, London, 1931, cloth, 6½ x 9¾ in., 430 pp., figs., tables, $9.00.

The development of the high speed internal combustion engine has been phenomenal, and Mr. Ricardo has contributed to this progress in a considerable measure, by his valuable research work on the many phases of design, and on the problems of fuel behaviour, which have been involved. In the volume under review he has added the experience of the period 1923-1931 to that which formed the basis of Vol. 2 of the Internal Combustion Engine, which he published in 1923. Since that time, this book has been regarded as a standard work of reference, and the present volume will prove equally useful, being, as the author states, "a revised and somewhat extended edition" of his previous contribution to published data on this subject.

Progress of design of this nature is mainly cumulative, and as the book deals with basic principles rather than with descriptive detail, except as a means of illustration, it will still provide a jumping off place when its date is no longer a true indication of its adaptability to current practice. Before this point is likely to lead to any serious concern it is hoped that Mr. Ricardo will have removed the cause, by means of another edition.

It is considered that the present volume can be best described by quoting the contents in order of chapters:—Volatile Liquid Fuel; Detonation; Distribution of Heat; Influence of Form of Combustion Chamber; Lubrication and Bearing Wear; Mechanical Design; Mechanical Details; Valves and Valve Gear; Piston Design; Engines for Road Vehicles; Aero Engines; High Speed Heavy-duty Engines for Tanks; High Speed Diesel Engines.

The reviewer feels that further discussion is unnecessary, except for the statement that the chapter on High Speed Diesel Engines outlines the recent development of this type in England.

Mr. Ricardo has a method of attack and expression which should make the book of interest to all thoughtful users of the types of engine which its title describes, as well as providing a mine of information for the student, or for anyone who is more directly concerned with design or operation.

R. J. G.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Junior Institution of Engineers: Journal and Record of Transactions, Vol. 41, 1930-31.

American Society for Testing Materials: Proceedings of the 34th Annual Meeting, Vol. 31: Part 1: Committee Reports; Tentative Standards. Part 2: Technical Papers.

American Institute of Electrical Engineers: Transactions, Vol. 50, No. 4, Dec. 1931.

The Institution of Mechanical Engineers: Proceedings, Vol. 120, Jan.-June, 1931.

Royal Society of Canada: Transactions, Third Series, Vol. 25, Sections 1-3, May, 1931.

National Electric Light Association: Organization Personnel of the Association for the Administrative Year July 1, 1931 to June 30, 1932.

Reports, etc.

Bureau of Statistics, Canada:
- Statistical Survey of Canadian Libraries, 1929-30.
- Statistics of Steam Railways of Canada for the Year ended Dec. 31, 1930.

Dept. of Mines, Geological Survey, Canada:
- Memoir 165: Studies of Geophysical Methods, 1928 and 1929.
- Summary Report, 1930, Parts A, B, and C.

Dept. of Mines, Mines Branch, Canada:
- Memorandum Series No. 52: Status of Hydrogenation of Petroleum, Bitumen, Coal Tar and Coal.
- No. 53: A World Survey of Recent Oil Shale Development.

Dept. of Marine, Radio Branch, Canada:
- Bulletin No. 2: Radio Inductive Interference.

DEPT. OF THE INTERIOR, TOPOGRAPHICAL SURVEY, CANADA:
[Map of] Beaupré, Quebec, 1932.

DEPT. OF THE INTERIOR, WATER POWER AND HYDROMETRIC BUREAU, CANADA:
Water Resources Paper No. 66: Arctic and Western Hudson Bay Drainage.
Hydro-electric Progress in Canada in 1931.
Water Power Resources of Canada [1931].

AIR MINISTRY, AERONAUTICAL RESEARCH COMMITTEE, GREAT BRITAIN:
Reports and Memoranda. No. 1400: Experiments on a Model of the Airship R. 101.
1411: Effect of Lateral Stabilizers on Take-Off of a Flying Boat.
1412: Theoretical Investigation of the Take-Off Time of "Singapore II."
1415: Moments of Inertia of Aeroplanes.
1416: Effect of Centrifugal Force on the Controls in a Spin.
1417: Scale Effect on High Tip Speed Air screws.
1419: Tests on Model of "Wapiti" including Effect of Slipstream.
1420: Wind Tunnel Data on the Balancing of Controls.
1423: Some Features of the Earlier Pterodactyl Design.
1424: Adhesion and Fatigue of Thin Coatings of White Metal Deposited on Mild Steel Surfaces.
1425: Models for the Determination of Critical Flutter Speeds.
1428: Discrepancies in Performances of Aircraft of Same Type.

GEOLOGICAL SURVEY, UNITED STATES:
Bulletin 836-A: Mineral Industry of Alaska in 1930 and Administrative Report.
836-B: Notes on the Geography and Geology of Lituya Bay, Alaska.
Water-Supply Paper 705: Surface Water Supply of the United States, 1930, Part 10: The Great Basin.
Professional Paper 170-A: Glaciation in Alaska.
170-C: A Miocene Flora from Grand Coulee, Wash.

BUREAU OF MINES, UNITED STATES:
Vanadium, Uranium and Radium in 1930.
Asphalt and Related Bitumens in 1930.
Slate in 1930.
Bauxite and Aluminum in 1930.
Tungsten in 1930.
Silver, Copper, Lead and Zinc in the Central States in 1930.
Chromite in 1930.
Secondary Metals in 1930.
Magnesium and its Compounds in 1930.
Technical Paper 506: Microscopic Study of Elkhorn Coal Bed at Jenkins, Letcher County, Ky.
507: Explosions in Washington Coal Mines.
508: Coke-Oven Accidents in the United States, 1930.
509: Production of Explosives in the United States, 1930.
Bulletin 344: Methods and Apparatus Used in Determining the Gas, Coke and By-Product Making Properties of American Coals.

BUREAU OF STANDARDS, UNITED STATES:
Commercial Standard CS34-31: Bag, Case and Strap Leather.
CS35-31: Plywood, (Hardwood and Eastern Red Cedar).
Misc. Pub'n No. 129: Report of the Twenty-fourth National Conference on Weights and Measures, June 2-5, 1931.
No. 132: Properties of Fiber Building Boards.

OHIO STATE UNIVERSITY:
Eng'g Experiment Station Circular No. 24: Smoke and Its Prevention.
26: Economic Altitudes in Industry.
Eng'g Experiment Station Bulletin No. 60: Strength of Concrete Block Pilasters Under Varied Eccentric Loading.
Eng'g Experiment Station Bulletin No. 65: Tests on the Continuous Carbonization of Finely Crushed Coal by Radiant Heat.

PURDUE UNIVERSITY:
Eng'g Experiment Station, Research Series No. 37: An Oscillographic Study of Transformer Characteristics.

NATIONAL ELECTRIC LIGHT ASSOCIATION:
Railway Electrification Committee: Electrification of Steam Railroads.
Hydraulic Power Committee, Eng'g National Section: Bibliography of Hydro-Electric Subjects and Manufacturers' Statements.
Budget Committee, Accounting National Section: Preparation and Administration of Budgets.

[FOREST RESEARCH INSTITUTE], INDIA:
Forest Bulletin No. 75-1931: Preservation of Indian Timbers—The Open Tank Process.

THE SHAWINIGAN WATER AND POWER COMPANY:
Annual Report, 1931.

Technical Books, etc.

PRESENTED BY "CLASS AND INDUSTRIAL MARKETING":
The Market Data Book for 1932—Containing a Directory of Industrial, Trade and Class Publications.

PRESENTED BY E. & F. N. SPON, LTD.:
Elements of Curve Design for Road, Railway and Racing Track . . . by F. G. Royal-Dawson, 1932.
Graphic Solution of Road and Railway Curve Problems . . . by F. G. Royal-Dawson, 1932.

PRESENTED BY NORTHERN ELECTRIC COMPANY, LTD.:
Bell Telephone System, Technical Publications: Monographs B584-B601, B603-B605, B608.

PRESENTED BY PRATT INSTITUTE SCHOOL OF SCIENCE AND TECHNOLOGY:
Michael Faraday, 1791-1867: A Selected List of Books and Periodical Literature . . . Appropriate to the Centenary of Faraday's Discovery of Electromagnetic Induction, Sept. 24, 1831.

PRESENTED BY UNIVERSAL OIL PRODUCTS COMPANY:
Dye Saves Dollars in Treating Gasoline [14 pp.]—Reprinted from Oil and Gas Journal, March 5, 1931.
Effect of Crude Petroleum Price Upon Production of Cracked Gasoline [18 pp.]—Reprinted from Oil and Gas Journal, July 30, 1931.
Cracked Gases to Bring Higher Price [11 pp.].

PRESENTED BY CANADIAN ASBESTOS COMPANY:
Asbestos—"Pierre à Coton" [36 pp.]—Reprinted from Canadian Geographical Journal, October, 1930.
Smooth-On Handbook: A Guide to the Use of Smooth-On Cements [136 pp.].

PRESENTED BY ROBERT W. HUNT COMPANY:
Corrosion- and Heat-Resistant Alloys [3 pp.]—Reprinted from Factory and Industrial Management, July, 1931.
Combating Corrosion with Alloys [14 pp.]—Reprinted from Railway Purchases and Stores, April, May and Aug., 1931.

PURCHASED:
Canadian Almanac and Legal and Court Directory for the Year 1932.
Whitaker's Almanac, 1932.
Who's Who, 1932.
The Electric Light and Power Industry in the United States . . . revised to Jan. 1, 1931, published by the National Electric Light Association.

Catalogues, etc.

SEMET-SOLVAY ENGINEERING CORPORATION:
Bulletin No. 45: The Semet-Solvay Koller Type Gas Producer [12 pp.].

HAMILTON GEAR AND MACHINE COMPANY, LTD.:
Triple Reduction Herringbone Gear-Speed Reducers [4 pp.]
"Roldweld" Electric Welded Steel Spur Gears [15 pp.].

EASTMAN KODAK COMPANY:
Applied Photography—January, 1932 [32 pp.].

DOMINION ENGINEERING WORKS, LIMITED:
Dominion Gearflex Couplings [4 pp.].

CANADIAN INGERSOLL-RAND CO. LTD.:
Portable Air Compressors [32 pp.].

CANADIAN ASBESTOS COMPANY:
Canasco Products [224 pp.].

CANADIAN GENERAL ELECTRIC COMPANY, LTD.:
CR7006-D140D Magnetic Switch [1 page].

COMBUSTION ENGINEERING CORPORATION:
C.-E. V.M. Type Boiler [7 pp.].

DOMINION HOIST AND SHOVEL COMPANY, LTD.:
The Dominion Revolver [4 pp.].
The Dominion Gopher, Shovels, Cranes and Draglines [4 pp.].
The Dominion Gopher Shovel, Gasoline, Diesel, Electric [8 pp.].

C. A. DUNHAM COMPANY, LTD.:
Dunham Type L Concealed Radiators [30 pp.].

DIAMOND IRON WORKS, INC.:
Sand and Gravel Equipment, 1931 [40 pp.].

PARKER APPLIANCE COMPANY:
Bulletin No. 39: Plumbing Fittings [7 pp.].

BRANCH NEWS

Kingston Branch

L. F. Grant, M.E.I.C., Secretary-Treasurer.

Engineering at the End of the Seventeenth Century

A paper on "Engineering at the End of the Seventeenth Century" was presented before the Kingston Branch on February 29th, by D. S. Ellis, A.M.E.I.C., Professor of Hydraulic Engineering, Queen's University.

Professor Ellis said: Early in the eighteenth century when the long reign of Louis XIV was approaching its end, there passed on one of the staunchest of the brilliant circle of men whose efforts contributed to the glory of the 'Grand Monarch.' This was Sebastian Vauban, a Marshal of France, a great engineer and soldier, a builder of fortresses, canals, harbours, towns and anything and everything required by the King his master. It is not unfair to say that before Vauban's time an engineer was a humble person needed in an army to help with the moving of guns, build an odd bridge, do a little mining, and not counting for very much. So great was the influence of Vauban that he lifted engineering to the status of a learned profession. He also founded a school of engineering practice, concerning which Belidor, one of Vauban's men, published a book in 1729 entitled "Engineering Science in Fortification and Architecture."

This book deals with elementary mechanics, earth pressures on walls, arches and domes, materials, masonry, design of military buildings, town planning, costs, specifications and contracts. A résumé of the treatment of these subjects follows.

In mechanics, there is no conception of the idea of a moment as a separate quantity; however the resistance to overturning of a retaining wall is expressed as the equivalent of a certain force applied at the top of the wall, the unit of force being expressed as square feet of masonry. The theory is developed on the assumption that the foundation is rigid and that the wall fails by tilting about the toe. A theory of earth pressure is developed more simply than the modern theories, and apparently giving satisfactory results, the earth being assumed to have an angle of slip of 45 degrees, and the pressure of the resulting wedge being worked out accordingly.

The theory for timber beams assumes zero stress at the upper surface, increasing uniformly to a maximum (tensile) stress at the lower. This agrees with modern views to the extent of making the strength of a beam vary as the thickness and the square of the depth. In a discussion of restrained beams, the author is not so successful, as he arrives at the conclusion that, having three points of bending, the beam will carry three times the load of a simple beam, instead of twice the load. Great stress however is laid upon the importance of experiments, of which a number are described.

The book makes it clear that Vauban and his lieutenants believed that an engineer should have a thorough practical knowledge of the preparation and treatment of materials of construction. Descriptions are given of all the constituents of masonry, mortar, brick, timber, iron and all other substances in common use among engineers. Stone is classified as hard or soft, the former being preferred. It should be left out all winter to see whether it will withstand frost. Freshly quarried stone is not to be used, and the rays of moonlight are supposed to be harmful to certain kinds of stone. The writer laments that bricks are not as good as they used to be, thus anticipating a more modern complaint about many materials. Great stress is laid upon the selection of stone for lime, harder stone being presumed to give better lime. It is noted that Roman masons allow lime to slake for three or four years before using it. There is also evidence that sand was considered perishable.

Oak was pre-eminent as constructional timber. Trees should be cut between October and March and only during the last quarter of the moon, so that the effect of the humid moon-rays may be as little as possible.

Iron was manufactured in the form of bars, none however being larger than two inches square. The iron from Berri in the Loire district was esteemed the best, and that of La Fère second. Spanish iron could be forged cold. A bar with no cross cracks but with black lines, and which was soft under the hammer, was considered a good iron.

The best glass came from Cherbourg, and was made in circular sheets, from thirty to thirty-two inches in diameter. The glass was sold in panniers of twenty-four sheets. There was no allowance for breakage in shipment unless more than seven sheets per pannier were broken. Glass was sold by a measure of ten inches to the foot.

In foundation work, Belidor describes timber grillages and pile foundations. He warns against the practice of driving piles too close together, and suggests that, in springy ground, the driving of piles may stimulate the action of the springs. For dealing with water, he advocates sump pits and pumping.

Heavy fortification walls were built with a facing of ashlar or coursed rubble above the foundation course. The interior was a combination of brick and rubble. For this type of work three different kinds of mortar were recommended, for pointing, bedding and the rubble masonry respectively.

While dealing with masonry, Belidor gives a few remarks on inspection of masonry which make interesting reading. Among other things he says "The contractors do not lose sight of their own interests, and while they fix up the face of a wall to look very nice they throw dirt and rubbish into the core." A mason should not carry a vertical more than a foot-and-a-half without being checked. It must be seen that masons use proper mortar and do not fill the chinks in the wall with mortar instead of spalls. Also it must be made sure that new work is properly bonded to old by wetting down the old and applying to it a coat of mortar.

The author then goes at considerable detail into the question of costs, giving unit costs on the simplest units practicable.

There were in general three methods of carrying out public works: by one general contract, by a number of special contracts, each covering some portion of the work, and by a method which corresponds to day labour. The first was recommended provided that a capable and responsible contractor could be found. Vauban says that great care must be taken to see that the contractor understands just what he is to do as often ignorant men will tender for work in the vague hope that somehow they may make money out of it, but actually having neither the money nor the resources to carry it out. Consequently such men often throw up the work when half-completed, and it costs a great deal to get another man to take it on. The work should not necessarily go to the lowest bidder.

Vauban gives his idea of what a specification should be in words that might well be used today. It should be a memoir explaining all parts of the project, the order and method of constructing the work, the material to be used and generally everything connected with the work which should be known by those building it. It should be clearly written, and well detailed without being confusing, omitting nothing essential and at the same time containing nothing equivocal. Reference should be made to the plans. When it sets forth all conditions it is a guide for the contractor, for the workmen, for the engineer, and enables them to work in harmony.

In general the book gives an impression that the problems of engineering are the same throughout the ages, and that Vauban and his men met them in a manner which should command our respect.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.
G. W. Rowe, Jr.E.I.C., Branch News Editor.

Automatic Equipment

The Lethbridge Branch of The Engineering Institute of Canada held its regular bi-monthly dinner meeting on January 23rd, 1932, in the club dining room of the Marquis hotel.

The speaker was R. S. Trowsdale, A.M.E.I.C., of the Canadian General Electric Company Limited at Calgary, and took for his subject "Automatic Equipment."

The address was illustrated by motion pictures and in this Mr. Trowsdale was assisted by Cyril Watson.

N. Marshall, M.E.I.C., occupied the chair and the speaker was introduced by J. T. Watson, A.M.E.I.C.

The talk was preceded by the usual dinner and social hour during which James Haimes, A.M.E.I.C., led the community singing.

The orchestra under the direction of George Brown was again present and entertained with a lively programme of music.

Mr. N. Fishwick and Mr. Bert Taylor were the guest artists of the evening, the former presenting two delightful cornet solos while Mr. Taylor gave a short comedy sketch which included some splendid tap dancing.

Everyone concerned in the conversion of energy is interested in automatic equipment, said Mr. Trowsdale in opening his address, and almost everyone everywhere is dependent upon it.

Automatic equipment includes gas heating devices, certain parts of the modern automobile, the steam engine and turbine governors, voltage regulators, automatic circuit breakers, and so on.

The term automatic however as used in the electrical industry is generally applied to tasks of greater magnitude than those suggested by the above and usually means the automatic substation and the completely automatic generating station.

Both of these Mr. Trowsdale discussed in some detail outlining the structural features and discussing their method of operation.

Automatic stations in their present form, he said, are only about fifteen years old and the electrical industry itself only about some fifty years old.

However, while the industry may be new, he concluded it is nevertheless one of the most important in the country and one in which 110 millions of dollars were spent in 1931.

Following the address four reels of film were screened showing the manufacture of electrical equipment in a large Canadian plant and also the details of an automatic substation for mining and industrial works.

At the conclusion of the pictures J. A. Carruthers, A.M.E.I.C., moved a hearty vote of thanks to the speaker.

The films shown on this occasion were supplied through the courtesy of the Canadian General Electric Company.

PROPORTIONING CONCRETE FOR DURABILITY

At a special meeting of the Lethbridge Branch of The Engineering Institute of Canada held at the Marquis hotel, Mr. R. S. Phillips, of the Research Laboratory of the Portland Cement Association, Chicago, discussed the importance of proportioning concrete for durability.

N. Marshall, M.E.I.C., Branch chairman, occupied the chair and the speaker was introduced by N. R. Crump, Jr.E.I.C.

The talk was illustrated by lantern slides and the Branch is again indebted to Cyril Watson who so very kindly operated the projector.

Mr. Phillips, in opening his address, pointed out that most of the deterioration which takes place in concrete structures of poor quality is due either to frost action or to alkaline ground waters. Since neither of these destructive agents can attack concrete which is water tight and strong, it is possible to protect against them by taking precautions during the actual making of the concrete. By avoiding the use of excess mixing water and by keeping the concrete from drying out or freezing during the first week after placing, concrete can be made which will successfully withstand the attacks of frost and alkali waters.

The speaker substantiated his remarks by means of lantern slides showing the results of a great many tests made in the Association's research laboratory together with views of both good and inferior concrete structures.

It is interesting to note that many of the structures shown which were as much as forty years old were still in excellent condition while many of those built between 1910 and 1920, in which extremely wet mixtures were used, were in a bad state of repair.

In closing, Mr. Phillips emphasized the responsibility of the engineer in planning and providing for the proper quality of concrete in structures which are to be subject to attack by frost and alkali waters.

At the conclusion of the address James Haimes, A.M.E.I.C., moved a hearty vote of thanks to the speaker, which was carried with applause.

London Branch

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

The Annual General Meeting of the Branch was held at 8.00 p.m. on the 21st of January, but owing to the engagement of a speaker whose topic, "India and the Post-War Orient," was of universal interest, a departure from the usual procedure of a dinner meeting was made.

The speaker was Lieut.-Col. F. Fraser Hunter, D.S.O., Croix-de-Guerre, F.R.G.S., who has had a very distinguished career. He is a Canadian and a graduate of Upper Canada College and the Royal Military College. He has served the Empire continuously since 1898, his appointments having taken him to China, India, Persia, Russia, Belgium, France, Mesopotamia and other countries. He speaks eight different languages and has seen service in the Great War and numerous other campaigns.

The meeting was open to the public and held in the auditorium of the London Life building, about two hundred persons being present.

The chairman, W. R. Smith, A.M.E.I.C., after explaining the objects of the meeting, read the Secretary's report on the year's activities and called upon the members present to remain at the close of the address to transact the annual business. He then introduced the speaker.

INDIA AND THE POST-WAR ORIENT

Colonel Hunter, whose address was illustrated, said that when the Round Table Conference in London terminated, it was found that only a faint glimmer of constructive agreement had been reached by the Indian delegates, but that many vital differences had been fully ventilated, many false bubbles pricked, and reputations made and lost.

Before the Conference the outstanding figure was Gandhi, but since the Conference, in the words of "The Calcutta Statesman," "Mr. Gandhi has failed to impress the people who count; England has found him interesting as an ascetic and on the religious side of his character; it has formed a low estimate of him as a statesman or negotiator." In fact he did not measure up with the statesmen of his own country or any other. His only contribution to the Conference took the form of idle threats, but much of his power still remains and must be reckoned with. The Conference foundered on the rock of communal differences, but Britain is making good her promise of granting a constitutional government.

The concrete result of the Conference, however, are that the present administration is to continue until Federal India is established. Representative working committees have been established in India to study the revision of the franchise and constituencies and to put to budgetary test the recommendations of the Federal Finance Committee and to explore financial problems.

The date for setting the new constitution to work will depend on the pace of the negotiations to be carried on in India, but it is not to be delayed indefinitely by the failure of Indians to agree amongst themselves.

The rope given Gandhi has unleashed a whole series of new movements and emboldened and intensified old antagonisms to British rule. The unrest in India, hitherto of a political, racial and religious character, has recently been developing with increasing rapidity into an upheaval in which non-payment of rent and taxes, murder of landlords, seizure of lands are of frequent and wide-spread occurrence.

The speaker explained that what was intended by Gandhi and his supporters as a peaceful boycott of British trade and a civil disobedience campaign has actually resulted in a wave of terrorist outrages and it is for the suppression of the latter that stern measures are being adopted by the government. He points out that government must prevail when self-government is to be established.

Gandhi and other leaders are thoroughly frightened at the whirlwind of their own sowing. The terrorist movement set up for the assassination of British and loyal Indian officials has reached such a pitch that it has been necessary to confer extraordinary powers upon the government of India to enable them to cope with it. Power has been provided for the setting up of special tribunals and magistrates, presided over by a High Court judge who has power to pass sentence of death for murder or attempted murder. Death sentences may be reviewed by the Lieutenant-Governor in Council but no further appeal is allowed.

India's fight is against herself, not Britain, for as long as she clings to her past she can never attain Dominion status—child marriage, caste, purdah, phallic worship, and other social crimes at which the civilized world stands aghast, must disappear. Legislation, on paper, has been enacted for abolishing some of these, but progress will inevitably be slow.

India has an area about equal to the whole of the United States with Alaska thrown in, and a population of some 352 millions. There are over 2,000 different castes.

In the opinion of Col. Hunter, Manchuria was an absolute necessity to Japan. Politically China had as little moral claim to Manchuria as Japan, for it was the private estate of the Manchu dynasty which conquered China and, in turn, was repudiated by China. In laying claim to Manchuria, China is putting the cart before the horse. Were Manchuria to lay claim to China the situation would be more along the lines of history. By conquest, first of China, then of Russia, Japan obtained rights in Manchuria. Urge of ever increasing population will force Japan to the maintenance of her present policy in Manchuria in spite of the protests of the League of Nations or others.

The speaker gave a vivid description of the present state of affairs in the East, expressing views which may be summarized as follows:—

Politically, there is no China today but only a "state of mind." It is possible that within the next fifty years Canton influence may produce a reasonably independent stable form of government in the south.

There is not the slightest hope of the world emerging fully from its depression without reconstruction of the Russian and Oriental markets,—westerners are too inclined to believe that the West is the world. The fundamentals of our western economic life are meaningless terms to more than half the population of the world. The West exaggerates itself.

The East protests against further exploitation from the West and argues that the War has shown that westerners are unable to manage their own affairs.

This atmosphere is naturally favourable to Communism, whose steady growth in the East seems inevitable.

The key of the Orient today lies in Russia.

Japan means business and it is of interest to note that some of the largest business houses in India have recently shifted their headquarters to Japan.

Whatever the outcome of the next few years, the post-war Orient will be of one mind as regards its determination to resist further domination by the West.

The address was received with hearty applause and a vote of thanks was proposed by Dr. H. A. Stevenson, seconded by D. M. Bright, A.M.E.I.C., and unanimously carried.

About twenty members remained at the close of the address and after the reading of the auditor's report the officers for the ensuing year were elected, the results being as follows:

Chairman	D. M. Bright, A.M.E.I.C.
Vice-Chairman	V. A. McKillop, A.M.E.I.C.
Executive	F. Y. Harcourt, M.E.I.C.
	J. Ferguson, A.M.E.I.C.
	W. C. Miller, M.E.I.C.
	H. A. McKay, A.M.E.I.C.
	H. B. R. Craig, M.E.I.C.
Ex-officio	W. R. Smith, A.M.E.I.C.
	W. P. Near, M.E.I.C.
	F. C. Ball, A.M.E.I.C.
Secretary-Treasurer	W. R. Smith, A.M.E.I.C.
News Editor	John R. Rostron, A.M.E.I.C.

A letter was read from Robt. Angus, M.E.I.C., regretting his inability to attend the meetings and thanking the members for past kindnesses. Mr. Angus, who is the oldest member of the Branch and has reached the age of 86, pointed out the advantages the engineers of the present day enjoyed compared with those of former generations and urged them to make the most of their opportunities.

It was proposed by John R. Rostron, A.M.E.I.C., seconded by H. B. R. Craig, M.E.I.C., and carried unanimously that a letter of appreciation be sent to Mr. Angus.

Ottawa Branch

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

Annual Meeting

The twenty-second annual meeting of the Ottawa Branch of The Engineering Institute of Canada was held in the rooms of the Royal Canadian Air Force, photographic section, Jackson building, on the evening of January 14th. About ninety members were present, the retiring chairman, G.J. Desbarats, C.M.G., M.E.I.C., Deputy Minister of National Defence, presiding.

The meeting commenced with the reading of the notice of meeting by F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer. In the chairman's address the activities of the Branch for the past year were briefly reviewed. The Branch held sixteen luncheon meetings at the Chateau Laurier, three evening meetings and made four trips of inspection to various developments in and around the city of Ottawa. The average attendance at the luncheons was eighty-nine and at the tours of inspection one hundred and twenty.

The Branch was in a very sound position, a matter of particular gratification in view of the conditions prevailing generally. The present total membership for the district taken in by the Branch was four hundred and sixty-eight for the year 1931, and for Ottawa and immediate vicinity was three hundred and ninety.

In his address, the chairman made reference to the formation of an Aeronautical Section of the Branch, which he characterized as an event of outstanding importance. The object of this section was to bring together those engaged or interested in aeronautics and allied subjects and also to provide a close liaison with the Royal Aeronautical Society in Great Britain. The membership roll of this section contained one hundred and eighty-six names, including fifty-six corporate members of The Engineering Institute. During the year ten meetings of the section were held.

Another matter of particular local interest was the presentation of two cases of drawing instruments donated by the Branch as prizes to the third and fourth year classes in draughting at the Ottawa Technical School.

Following the chairman's address, reports were presented by the Secretary-Treasurer and by committees with chairmen as follows: proceedings, by E. W. Stedman, M.E.I.C.; membership, by J. E. St. Laurent, M.E.I.C.; rooms and library, by C. E. White, A.M.E.I.C.; advertising and Branch by-laws, by J. R. Akins, M.E.I.C.; reception, by John McLeish, M.E.I.C., and in addition J. H. Parkin, M.E.I.C., chairman of the Aeronautical Section, reported on its behalf.

The financial statement, according to the Secretary-Treasurer, showed that the assets of the Branch were $1,915.83. The cash balance was $1,750.93.

After the presentation of the reports a number of items came up under the heading of new business. A local question of considerable interest to the engineering profession was the proposed selection by the city of Ottawa of a new site for the city hall which it is looking forward to building. A committee was formed to look into this question and to present its findings to the Branch, which would signify what further action should be taken toward properly presenting the views of the engineers to the public.

A motion was also sponsored to form a new section of the Branch devoted to radio and affiliated with the Institution of Electrical Engineers of Great Britain. This section would function similarly to the Aeronautical Section. It was also decided to extend the policy of granting prizes to the Ottawa Technical School to take in the Hull Technical School, which would in 1932 for the first time receive awards from the local Branch.

The election of officers for 1931 resulted as follows: Chairman, C. M. Pitts, A.M.E.I.C., president and general manager of the Pitts Construction Company, Ltd., and the Peoples Gas Supply Company, of Ottawa; Secretary-Treasurer, F. C. C. Lynch, A.M.E.I.C., director of the National Development Bureau of the Department of the Interior, who continues in office; and Dr. R. W. Boyle, M.E.I.C., of the National Research Council, and W. S. Kidd, A.M.E.I.C., of the E. B. Eddy Company of Hull, as members of the Managing Committee. Other members of this committee who still have a year to serve are R. F. Howard, M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., and C. E. White, A.M.E.I.C.

Toward the end of the meeting Mr. Pitts, the newly elected chairman, took over the chair. He conveyed the thanks of the meeting to the retiring chairman and members of the Managing Committee and to the Secretary-Treasurer for their work of the past year. He also thanked the members for the honour accorded him.

Following the business section, motion pictures were screened and refreshments served.

A National Radio Plan for Canada

At the first noon luncheon of the local Branch after the annual meeting, held at the Chateau Laurier on January 21st, the newly elected chairman, C. McL. Pitts, A.M.E.I.C., occupied the chair, the speaker being C. A. Bowman, A.M.E.I.C., editor of the "Ottawa Citizen." Mr. Bowman in 1929 served with Sir John Aird and Dr. Augustin Frigon on the Royal Commission of Radio Broadcasting. His subject was "A National Radio Plan for Canada." In addition to the speaker and the chairman, head table guests included the Right Honourable Sir Robert L. Borden, Charles A. Magrath, M.E.I.C., Dr. Augustin Frigon, M.E.I.C., Graham Spry, Allan Plaunt, Lieut.-Col. W. A. Steel, A.M.E.I.C., Lieut.-Commander C. P. Edwards, A.M.E.I.C., Dr. Tait MacKenzie, Edward Hawken, G. J. Desbarats, C.M.G., M.E.I.C., John Murphy, M.E.I.C., A. F. Macallum, M.E.I.C., and Noulan Cauchon, A.M.E.I.C.

Mr. Bowman prefaced his address with a number of lantern slides and vividly presented the case of the radio situation in Canada and the possibilities under a proposed national broadcasting plan.

A full report of Mr. Bowman's remarks, to which the audience listened with close attention, appears on page 186 of this issue of The Journal.

Complimentary Luncheon to the President

The Ottawa Branch had as their guest of honour at their luncheon at the Chateau Laurier on Wednesday noon, February 10th, Dr. Charles Camsell, M.E.I.C., the newly elected President of The Engineering Institute of Canada. In addition, members of the Council and other officers of The Institute were present. The head table guests included: R. J. Durley, M.E.I.C., general secretary, Montreal; J. McLeish, M.E.I.C., Ottawa; F. W. Paulin, M.E.I.C., Hamilton; L. W. Wynne-Roberts, A.M.E.I.C., Toronto, late chairman of the Committee on Arrangements for the annual convention recently held at Toronto; J. L. Busfield, M.E.I.C., Montreal; Dr. Charles Camsell, M.E.I.C., Ottawa, President of The Engineering Institute of Canada; C. McL. Pitts, A.M.E.I.C., chairman of the Ottawa Branch; Grote Stirling, M.P., M.E.I.C., Kelowna, B.C.; A. H. Harkness, M.E.I.C., Toronto, vice-president; P. B. Motley, M.E.I.C., Montreal; J. J. Traill, M.E.I.C., Toronto; F. Newell, M.E.I.C., Montreal; G. J. Desbarats, C.M.G., M.E.I.C., late chairman of the Ottawa Branch, and F. H. Peters, M.E.I.C., Ottawa.

Philip B. Motley, M.E.I.C., of Montreal, in a brief address introduced the newly-elected president and spoke of the high position Dr. Camsell held in the public affairs of the country today. As Deputy Minister of Mines he was associated with one of the largest industries of the Dominion. The speaker congratulated the Ottawa Branch upon the selection of a President from its membership and extended to him the felicitations of The Institute upon his election.

Dr. Camsell, in replying to this address, briefly outlined the course of The Institute up to the present from its birth some forty-six years ago as the Canadian Society of Civil Engineers. At the time of its formation the membership was largely confined to those engaged in the civil branch of the engineering profession. However, some years ago, in keeping with widened qualifications for membership the name was changed to The Engineering Institute of Canada. The qualifications and aims of The Institute are still in the process of further development and more would be heard on this question later.

The list of the past-presidents of The Institute included very few who had been even remotely connected with mining activities. Dr. Camsell considered his election as President as an expression of the general expansion of the views of The Institute in regard to the activities to be embraced by it. He even considered that, great as has been that expansion, there might still be room for something further in that regard. As for the honour itself accorded him, he prized it highly and appreciated the assurances of loyalty and support that had been accorded him from all sides.

J. L. Busfield, M.E.I.C., of Montreal, member of Council and chairman of the Committee on Development, was the next speaker. He outlined the work of the committee which had its origin in the plenary meeting of the Council last fall. This committee, composed of nine past-presidents of The Institute together with a number of others, was developing proposals which it was hoped would make The Institute of greater service, and consequently more attractive, to engineers in all classes.

The relation between The Institute and the various Associations of Professional Engineers in the different provinces was also being reviewed by the committee. The associations, while still in their infancy, were working for a closer co-ordination among themselves in order to have more uniform requirements for admission. Their function is, of course, the regulation of the right to practise under provincial legislation and membership in them is practically compulsory for those wishing to engage in certain branches of engineering work. In The Engineering Institute, on the other hand, membership is purely voluntary.

Mr. Busfield at this point outlined the amended qualifications for membership which it was proposed to submit to Council. There would be the following classes of membership: members, fellows, honorary members, juniors and associates, thus reducing the present six classes to five. It was also being suggested that every applicant for membership should be directly sponsored by a member and his application should have behind it a positive recommendation from the executive of the branch to which the applicant would belong. For those residing outside of Canada it was suggested that qualification would be membership in some organization comparable to The Engineering Institute.

The task of the committee, stated Mr. Busfield at this point, had only just begun. Its further work was being actively carried on. All proposals agreed upon by the committee, after being accepted by Council, would have to be submitted at an Annual General Meeting, and then would be voted on by the whole membership. In concluding his address, Mr. Busfield stated that his committee would gladly welcome any suggestions from the membership at large.

In the afternoon, immediately following the luncheon, a meeting of the Council of The Institute was held at the Chateau Laurier.

Quebec Branch

M. Boyer, S.E.I.C., Secretary-Treasurer.

A Trip to Alaska and Western Canada

Philippe Méthé, A.M.E.I.C., Director of the Quebec Technical School, was the speaker at the regular monthly meeting held on December the 14th, 1931, at the Quebec Technical School.

Many members availed themselves of the opportunity of visiting the school, before the lecture, and of seeing the evening classes at work. The automobile assembly-room, the large machine shops, and a special class in mechanical draughting and designing attracted considerable attention.

Mr. Méthé, well known to our members for his activities as former Secretary of the Branch, was introduced by Hector Cimon, M.E.I.C., local chairman.

The subject of Mr. Méthé's address, "L'Alaska et l'Ouest Canadien Vus par un Ingénieur," had been chosen at the request of many members, following the speaker's journey to the Pacific coast last summer with the University of Montreal excursion.

The speaker sketched in a most interesting way the successive phases of the journey, noting the many outstanding feats of engineering construction, quite undreamt of in the days which preceded the development of that marvellous stretch of natural beauty and riches.

After touching on the characteristics of the cities of Winnipeg, Edmonton, Calgary, Vancouver and Victoria, Mr. Méthé recalled the feverish days of the Yukon gold stampede, and presented interesting details and figures on the three principal Alaskan industries: fishing, lumbering and mining.

Mr. Méthé concluded his lecture by showing a film taken during the trip, after which a vote of thanks to the speaker was proposed by Gustave Piché, A.M.E.I.C., seconded by T. J. F. King, A.M.E.I.C., and a most enjoyable meeting was brought to a close.

Nation Planning

A luncheon-meeting was held at the Chateau Frontenac on January the 11th, with an attendance of over thirty members.

The speaker, Mr. A. G. Penny, President of the Quebec Board of Trade, was introduced by H. Cimon, M.E.I.C., Branch chairman, and addressed the meeting on "Nation Planning," a "logical and necessary extension of town-planning," the object of which would be to promote a more even distribution of population and industrial establishments.

Scientific mapping out of the whole country, in order that development might be as wide-spread and general as possible instead of being confined to any particular cities or district was the basis of the proposals which Mr. Penny laid before his audience, illustrating his idea by taking as an example what could be done in the province of Quebec.

"Quebec presents a nearly ideal nation-planning pattern," Mr. Penny said. "You have the hinterland of forest-covered and mineralized territory bordering a large cleared area given over to agriculture and dotted with urban centres. The unit pattern is roughly that of a village serving as a distributing centre for so many farms, of a town serving as the distributing centre for so many villages, and of a city serving as a distributing centre for so many towns; this unit being repeated and varied according to conditions. But there must be no congestion within or between units; circulation of wealth must pulse evenly and freely backward and forward between the factory and the farm." The speaker then visualized nation-planning in the province, with the St. Maurice Valley as dividing line between the two main sections, of which Montreal and Quebec would be the respective centres.

As an example of evils which nation-planning would avoid, Mr. Penny remarked on the disparity between central Canada and the Maritimes, and held that if anything could be done to improve the situation it should be done before development had gone too far along present lines.

"Nation-planning consists of bringing all forms of communications to their highest possible pitch of perfection, so that trade may be assisted and wealth circulate freely." The agencies are railroads, highroads, power lines and telegraph and telephone wires. Waterways being natural arterie of trade do not lend themselves readily to human control.

With regard to the important part utility services played in industrial development, Mr. Penny referred to Quebec's water power resources, which the province was fortunate in having so widely distributed.

He thought that railroads appeared to be the principal obstacle to a healthy nation plan in Canada, largely because of the chaotic structure of freight rates they have built up.

The history of the National Transcontinental Railway instanced the conflict that could develop between the nation-planning efforts of public men and the revenue-getting efforts of railroaders, Mr. Penny said, showing the reluctance which had met Quebec's attempts over fifteen years to bring grain to this city over that railroad.

Every community saw the importance of attracting new industries, Mr. Penny said in conclusion, and he was glad to see real estate and labour conditions leading industries to seek out small communities and effecting a more general distribution. It did seem, however, that the government might set up some neutral commission which could render expert assistance and advice to every community, regardless of their local means.

W. G. Mitchell, M.E.I.C., of Price Bros. and Company, Ltd., and Alex. Lariviere, A.M.E.I.C., a member of the Quebec Public Service Commission, were called upon to move a vote of thanks to the speaker for his thoughtful address, and the vote was accorded with acclamation.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
G. C. Clark, S.E.I.C., Branch News Editor.

A meeting of the Saint John Branch of The Engineering Institute of Canada was held at 8.00 p.m. on January 11, 1932, in the Admiral Beatty hotel.

The meeting was called for the purpose of interesting members of the Branch in civic and public affairs as a diversion from the usual procedure of having a speaker to address the members upon some particular subject. The meeting in this case discussed the report of the Saint John City Assessment Revision Commission. Graphs showing various aspects of the taxation situation in the city such as assessment, valuation, taxation rate, ratepayers, population, etc. over a period of years had been prepared and were useful for reference purposes during the discussion.

Considerable discussion centred upon the proposed method of taxing income. Special commendation was voiced upon the recommendation of the Assessment Revision Commission, that the city adopt a town planning scheme as it was considered that a direct relation existed between taxation and town planning.

The meeting commended the Assessment Revision Commission for its exhaustive report and sincerely trusted that with some modifications the recommendations of the commission would be implemented in the near future.

It was not thought that the proposal of the Assessment Revision Commission to make the employer responsible for the collection of taxes from his employees was desirable or workable in connection with engineering or construction work.

The chairman was given authority to appoint a small committee to present our views on the tax recommendations at the Civic Taxation Committee meeting to be held in the future.

Saskatchewan Branch

Stewart Young, A.M.E.I.C., Acting Secretary.

The Durability of Concrete

A special meeting of the Saskatchewan Branch of The Engineering Institute of Canada was held in the auditorium of the Balfour Technical School on January 20th, 1932, when the speaker of the evening was Mr. Phillips of the Portland Cement Association, his subject being "The Durability of Concrete."

The meeting was attended by some sixty persons, including members of the Architects' Association and the Builders' Exchange of Regina.

After detailing the results of experimental and research work in the matter of durability the speaker showed a number of slides, some of which contained graphs indicating proper mixes to obtain maximum of strength and durability.

The address was productive of considerable discussion, after which a hearty vote of thanks was tendered to Mr. Phillips.

Fertilizers

The regular meeting of the Saskatchewan Branch of The Engineering Institute of Canada was held in the Hotel Champlain on Friday evening, January 22nd, 1932, being preceded by a dinner at which thirty guests were present.

Following the dinner a short interval of time was alloted to the introduction of guests and matters of general business, when D. A. R. McCannell, M.E.I.C., chairman, introduced the speaker of the evening, John Cameron, the Saskatchewan representative of the Consolidated Mining and Smelting Company, his subject being "Fertilizers."

In the course of his address Mr. Cameron stated that heretofore experimenters had concluded that commercial fertilizers by broadcast methods were of little value in agricultural development in Saskatchewan, the main question being one of adequate precipitation.

The Consolidated Mining and Smelting Company, a number of years ago, decided to institute a research programme and after collecting data on the subject, commenced a series of tests, using special drills, until in 1930 more than fourteen hundred co-operative tests were being made in the prairie provinces. The supervision of these tests was under the three provincial departments of agriculture.

Distinctive types of soil in various areas were selected and fertilized plots so laid out as to be alongside non-fertilized plots. The results of three years' work showed that commercial fertilizers had a definite place in western agriculture. Briefly the following conclusions were arrived at:

(1) "Stand-still" periods of growth are overcome by the use of commercial fertilizers, the gain in growth being from four to six inches.

(2) The maturity of grain was advanced, making a difference normally of about seven days (in dry areas about four to five days and in the northern area about ten to twelve days).

(3) The class of cereal is advanced two to three grades and from five to ten bushels per acre.

(4) The economic balance is reached at approximately three bushels per acre of an increase, any yield beyond this being profit.

(5) Rust resistance is increased.

(6) Due to non-setback, weed control is facilitated, the grain choking the weeds out.

(7) Attacks of wire worm are repelled and may be reduced almost to the vanishing point by the use of phosphatic fertilizers.

(8) Uniformity of stand and ripening is increased. (Combine users west of Saskatoon are most enthusiastic about the use of phosphatic fertilizers.)

Mr. Cameron then proceeded to describe the plant at Trail, British Columbia, this being of particular interest to the engineers. The plant is constructed wholly of steel and brick, covering an area of sixty acres. Approximately four hundred men are employed at the plant throughout the year. Sulphur dioxide was given off as a waste product, causing considerable damage to vegetation in the area surrounding the plant, and the company was therefore studying the question of making use of this waste product.

In concluding his remarks Mr. Cameron stated that wherever test work in the province had been carried out the farmers are increasingly interested.

The address was productive of considerable discussion, a hearty vote of thanks being voted to the speaker by the meeting.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

Some Problems of Canadian Transportation

The regular monthly meeting of the Sault Ste. Marie Branch was held in the Windsor hotel on January 29, 1932.

The paper entitled "Some Problems of Canadian Transportation," by Professor W. T. Jackman, of the University of Toronto, which was presented before the Hamilton Branch and by that Branch printed and supplied to the Sault Branch, was read and formed the basis of a very interesting discussion.

R. S. McCormick, M.E.I.C., general superintendent of the A.C.R., led the discussion regarding the competition existing between motor trucks and the railroads. He felt that this problem was being solved and would be effectively met by co-operation and evolution. The public demanded the best possible transportation at least cost, and he believed that co-operation between trucks and railways would result in the cheapest and best transportation, something each alone could not effect. One example of the co-operation existing between railway and automobile transportation was cited, that of an American railway that kept trucks in operation. The trucks had removable bodies which could be swung onto another chassis for terminal delivery.

J. W. LeB. Ross, M.E.I.C., on the St. Lawrence Waterway, thought Professor Jackman's figures on costs much higher than any investigation had justified for continuous transportation of wheat to Europe. He saw no reason why ocean boats would not ultimately come through the great lakes, provided a 27-foot deep channel was available. Mr. Ross pointed out that many small ocean boats do come up the great lakes each year. Ocean transportation via the great lakes would be possible, he maintained, if the channels were deepened to 27 feet, and a broader boat evolved than at present plies the lakes.

District engineer H. F. Bennett, A.M.E.I.C., thought that ocean-going vessels would undoubtedly come up through the great lakes if the navigation channels were deepened. The centre of population of the United States, he stated, is now somewhere in Wisconsin, and boats would undoubtedly get cargoes both ways and hence would not be dependent entirely on wheat cargoes.

Mr. James Kelleher cited the *Baltic* as an instance where ocean vessels navigated channels as narrow as any part of the St. Lawrence waterway and open for the same length of time each year.

Mr. R. Burns said that during 1931 an average of one boat a day had called at Albany, situated 160 miles up the Hudson river, a small river compared with others. He felt that experience had shown that water transportation reduced freight charges and so the deep waterways through the great lakes would open a market in the southern states for Sault newsprint.

The consensus of opinion of the assembled engineers was that traffic flows when channels are available.

A vote of thanks was tendered the Hamilton Branch for their kindness in supplying copies of the paper.

H. F. Bennett, A.M.E.I.C., chairman of the Papers committee of the Branch, reported that the next meeting, on February 26, would be addressed by Mr. J. H. McDonald, of the Algoma Steel Corporation, on the subject "A Treatise on Steel." Moving pictures will be shown.

The meeting on March, 18 is to be addressed by Mr. Horton, of the Bell Telephone Co., who will show pictures illustrating New Developments in Telephony. These meetings will be held in the Windsor hotel, dinner at 6.45 and the meeting at 8 p.m.

Victoria Branch

I. C. Barltrop, A.M.E.I.C., Secretary-Treasurer.

The Victoria Branch opened the 1932 season by holding an enjoyable and interesting meeting at the home of F. C. Green, M.E.I.C., Surveyor General of the province. H. L. Swan, M.E.I.C., was in the chair, and the speaker of the evening was P. Philip, M.E.I.C., chief engineer of the Provincial Public Works Department. Twenty-seven members were present as well as several ladies.

The Strength of Human Materials

Mr. Philip had chosen for his subject "The Strength of Human Materials." He pointed out that, in the design of all structures the strength of the materials available was of prime importance and, after defining the various terms such as "stress," "strain," and "elastic limit" he proceeded to illustrate the manner in which human materials behave when subjected to various stresses producing strain, and outlined the resistance to stress of which the human material is capable.

The importance of careful selection of human material, in order to minimize the number of misfits and failures, was emphasised: the axiom that, to every action there is an equal and opposite reaction, is fully demonstrated in actual life, Mr. Philip stated, and the engineer must constantly keep the importance of this in mind in his relations with those with whom he comes in contact. Just as in a building, certain materials have a definite place, so in the human structure there are proper places for the various component parts which go to make up the whole mass into one efficient unit: a sudden reversal of stress, however, may cause failure in a member.

Mr. Philip pointed out that, unlike structural materials, the human material is capable of return to normal long after the apparent elastic limit has been reached, and this consideration led to determination of safe human working stresses. As with structural materials, this may be determined partly on the results of special tests and partly on the behaviour of similar material in other human structures. Mr. Philip stated that executives need to consider the strength and weakness of human materials and to gauge the human factor of safety: the human element, comprising the brain and, through it, the body has, unlike the ordinary inert material, the capacity of withstanding an almost infinite stress provided that the stress is applied in such a way as to permit of the gradual building up of increased resistance, thus translating the human material from one class to another with a higher working stress.

The speaker expressed it as his opinion that, of the many valuable qualities to be found in the human material, "Loyalty" is the most desirable and he placed this factor ahead of great tact, diplomacy or efficiency. In instancing the high qualities to be found in selected human materials, Mr. Philip referred to the expedition of the explorer, M. Andree, who attempted to reach the North Pole by balloon with two chosen companions and also the companions who accompanied Captain Scott on his Antarctic expedition. Each leader selected his companions because of strength of character as well as because of great enduring powers: each leader required his material to have a high factor of safety.

In closing the speaker emphasized the propriety of giving credit to those to whom credit is due, quoting from Kipling's "McAndrew's Hymn" to explain the unfairness of forgetting that every member of the "structure" is entitled to a share of the credit which, however, is often only given to the main member.

As was the intention, Mr. Philip's paper evoked a very interesting discussion. Four members were prepared to give short addresses on points arising out of the paper following which the chairman called on every individual member present to express his views. Points brought out included the opinion that an organization, like steel, is an alloy and, like steel, the alloy may be many times stronger than any of its individual constituents, the selection and proportioning of the ingredients being of the utmost importance. Criticism of our educational system was expressed as failing to fit each individual to a calling suited to his own particular make-up: the example of the seemingly square peg in the round hole who, by perseverance aided by tactful guidance, is able to fill his position successfully was referred to. Loyalty rather than extreme ability, moral rectitude and the advice and helping hand to juniors from senior members were among the points advanced by others.

A hearty vote of thanks was tendered to Mr. Philip and a similar vote to Mr. and Mrs. Green for their hospitality was unanimously passed, following which the meeting adjourned. Refreshments were kindly served by Mrs. Green assisted by the ladies present.

A National Broadcasting Plan for Canada

C. A. Bowman, A.M.E.I.C.,
Editor, The Citizen, Ottawa, Ont.

Address given before the Ottawa Branch of The Engineering Institute of Canada, January 21st, 1932.

At the present time in Canada there are sixty-six radio broadcasting stations. The combined power of the Canadian stations is given as 51,670 watts.

United States broadcasting stations reaching Canada have a total power of 750,000 watts. At least thirteen United States stations each have broadcasting power about equal to all the stations in Canada combined. The whole of the settled area of Canada is blanketed by United States broadcasting.

The Canadian stations lack the range to cover Canada. They cluster in regions where they have the better prospect of selling radio advertising, so that in some districts there is duplication and overlapping of stations while elsewhere there is no adequate service. In some remote communities where broadcasting from Canadian stations would be appreciated, none is received.

The Dominion government in November 1928 appointed a royal commission on radio broadcasting with Sir John Aird as chairman "to examine into the broadcasting situation in the Dominion of Canada and to make recommendations to the government as to the future administration, management, control and financing thereof."

The report of the royal commission submitted to the government in September 1929, recommended, in effect, that one national broadcasting company in Canada should be established by government authority. It could be called the Canadian Radio Broadcasting Company. My own preference would be the Royal Canadian Broadcasting Company, or some other distinctive national name.

The national company would have a board of twelve directors: nine more particularly representing Canadian provincial interests, three representing the interests of the Dominion at large. In my opinion, there should be no salary attached to the position of director. The directors should be appointed by the governor-general-in-council to serve without remuneration. I am confident that there would be no difficulty in finding twelve representative Canadian citizens of public spirit to serve Canada in this honorary capacity.

The commission recommended that this proposed national broadcasting company of Canada should purchase existing stations, using as much of the present equipment as possible to distribute Canadian broadcasting more evenly over the country. At the same time, the report proposed that plans to build a network of larger stations should be proceeded with. The commission had the benefit of the advice of technical officers of the government that complete daylight coverage could be given across Canada by seven 50,000-watt stations with four supplementary stations for service in local areas out of touch with the network.

This plan called for an initial capital expenditure of $3,225,000 to be advanced from the Dominion treasury, as well as the amount required to purchase existing properties. The commission had in mind, however, the possibility of launching the national broadcasting service without necessarily proceeding to build the seven large stations forthwith. With a better distribution of existing facilities, eliminating needless duplication, a national service could be started with a much smaller initial capital expenditure.

Revenue for the operation of the Canadian broadcast service would be derived mainly from license fees. An annual fee of three dollars, to be paid by receiving set owners, would yield, according to present estimates of the number of sets in Canada, about $1,800,000. At the time when the commission reported, there were only about 300,000 sets owned in Canada, consequently it seemed desirable that an annual subvention of possibly $1,000,000 should be paid from the Dominion treasury "in the interests of Canadian listeners and in the national interests of Canada." But with 600,000 as the estimated number of set owners in 1931, paying three dollars annually, or less than one cent a day, the national service could be started without any annual subvention.

As an additional source of revenue, the commission recommended that radio advertising in the form of sponsored programmes should be accepted. No direct advertising would be permitted, but programmes of entertainment could be accompanied by an announcement of the name of the sponsor as a form of goodwill advertising. As well as providing additional revenue, the sponsored programmes would introduce the element of competition into the broadcasting entertainment. Critics of the Aird Commission's recommendations habitually overlook this important factor. They confuse the proposed Canadian system with the rigid exclusion of advertising as it is under public ownership in Great Britain. The essence of the Canadian plan is to give the most efficient technical service with the least cost by avoiding wasteful duplication in the building of broadcasting stations. Radio transmission would be treated as a natural monopoly like the telephone service, or the water service in municipalities, but there would be no monopoly of programme building. Transmitting facilities would be available for broadcasting by the Canadian National Railways, Canadian Pacific Railway Company, or any other Canadian advertiser at less cost than under competitive private stations with the duplication of equipment. There could be just as much diversity of entertainment as though the stations were privately owned, but the national system would be far better equipped with revenue available from license fees than private enterprise could afford to build. It is obvious that the radio advertising alone would be insufficient to provide the necessary revenue for an adequate national broadcasting service in Canada. In private hands, the lack of revenue from Canadian advertising sources would mean an increasing reliance on United States broadcasting. Nowhere in the national plan for Canada is there any proposal to interfere with the freedom of Canadian listeners to hear broadcasting from the United States, but Canada would be assured of a Canadian radio service owned, controlled and operated by the Canadian people.

It is unnecessary to dwell on the present condition of broadcasting in Canada. It could be compared with the position of Canadian motion picture enterprise about twenty-five years ago. Without a national plan to safeguard Canada's interests in the radio realm, radio broadcasting must inevitably tend to become merged with the larger broadcasting interests of the United States, just as the motion picture interests have been so merged. A national policy is needed to establish Canada's place in the radio realm. At the present time, private interests in the United States have appropriated an unwarranted share of the available radio frequencies for radio broadcasting. Under international agreement the broadcasting band is 950 kilocycles wide: ranging from 550 to 1,500 kilocycles. As it is necessary to space the channels for broadcasting at 10 kilocycles apart, there are thus only ninety-six channels available to avoid interference between stations in North America.

United States broadcasting stations have appropriated seventy-nine of the ninety-six channels for exclusive use. By the gentleman's agreement, so called, they have left six channels to Canada for exclusive use. The remaining eleven channels are shared by Canada and United States stations of low power. Canada has, however, departed from this limitation by allotting frequencies to several stations between the frequency spaces ordinarily used in the United States. Actually twenty-five channels are being used in Canada but only six are exclusively Canadian. It has never been conceded by Canada that the United States is entitled to any such disproportionate share of the ninety-six available frequencies. Conferences have been held between Ottawa and Washington authorities where the argument has been advanced on behalf of the United States that radio frequencies should be divided between the countries in proportion to population. Canada has wisely declined to consider any such proposed division. The Canadian view is that national area and cultural needs should govern as well as population. Up to the present, the United States has perhaps felt justified in ignoring this basis of claim because of the inadequate use made of the existing broadcasting facilities in Canada. They could properly point out that at least two of Canada's exclusive radio frequencies are used mainly for the purpose of importing United States broadcasting into Canada. So long as Canadian stations are little more than relay stations for United States broadcasting, there is no very strong reason for conceding more exclusive frequencies to Canadian private interests.

It would seem particularly desirable that Canada's national radio policy should be determined during the coming session of Parliament. The international radio conference is to be held at Madrid in September of this year. Big strides have been made since the last international conference in Washington in 1927. Even greater development may be immediately ahead. It is vital that Canada should establish the right to an adequate share of radio frequencies in the broadcasting band. Mexico will certainly demand consideration at the international conference. Canada should be prepared with a national plan to claim at least twenty exclusive frequencies. The interests of the nine provinces have to be safeguarded. One possible design of broadcasting station suitable for Canada would include twin transmitting equipment. The Quebec station, for example, with twin transmitters, could be broadcasting one programme in French simultaneously with one in English. But there should be the same facilities for every province, so that the communities served could be given the choice of a national programme or a local programme simultaneously. This plan to protect provincial interests in broadcasting would require at least eighteen exclusive frequencies. With only two spare frequencies for experimental and other national purposes, Canada's claim to twenty exclusive channels, of the ninety-six available, would be moderate and reasonable.

So long as Canada has no national plan, however, it may be difficult to convince the international conference at Madrid or to convince the United States that Canadian broadcasting claims should be regarded seriously. No one can tell what the possibilities are of broadcasting progress in the years ahead. The necessity of safeguarding Canada's place must, however, commend itself to every Canadian of vision.

The report of the royal commission associated with the name of Sir John Aird would surely merit consideration by a special committee of Parliament during the forthcoming session.

The Third International Conference on Bituminous Coal—1931.

B. F. Haanel, M.E.I.C., Chief, Division of Fuels and Fuel Testing, Mines Branch, Department of Mines, Ottawa.

The Third International Conference on Bituminous Coal was held in the Carnegie Institute of Technology, Pittsburgh, November 16-21, 1931. At this, as well as the two previous conferences, Canada was well represented, the representatives including John McLeish, M.E.I.C., Director of Mines; B. F. Haanel, M.E.I.C., Chief of Division of Fuels and Fuel Testing, Mines Branch; Dr. Robert McKay, Geologist in charge of coal, Geological Survey; R. E. Gilmore, M.E.I.C., and R. A. Strong, A.M.E.I.C., of the Fuel Research Laboratories, Department of Mines; Dr. H. M. Tory, President of the National Research Council; Professor Edgar Stansfield, M.E.I.C., of the Alberta Research Council, and Mr. C. Tasker of the Ontario Research Foundation. No papers were presented by the Canadian delegation, but Mr. McLeish acted as chairman of the section on coal cleaning, and Professor Edgar Stansfield contributed to the discussion on the papers devoted to the origin and classification of coal. England, Germany, France, Japan and other European countries were also well represented.

This conference, unlike the other two, was devoted mainly to the economics of the coal situation in the United States—the technical papers assuming a secondary position. The address of welcome was delivered by Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, and at the general session addresses were delivered by the following: Myron C. Taylor, chairman, Finance Committee, United States Steel Corporation; Honourable Albert C. Ritchie, Governor of Maryland, and Sir Harry E. Brittain, Member of the Council of the Associated Chambers of Commerce, Sheffield, England.

The most important of these addresses was that delivered by Myron C. Taylor, who outlined the coal situation in the United States, and the troubles arising from it. He made an attempt to combat the idea which is gaining a considerable number of supporters, that the mechanization of the coal industry, as well as that of other industries, has been the largest contributing cause towards unemployment and the deplorable condition in which the coal mining industry finds itself today. Mr. Taylor was able to present many powerful factors to support his arguments, but he failed to offer any constructive ideas regarding the rehabilitation of the coal mining industry, and the unemployment problem.

Governor Ritchie dealt with the coal mining situation in some detail but his address was largely devoted to the part which governments should or should not play in any attempts to rectify mistakes made in the past and to place the coal industry on a sounder basis. He was absolutely opposed to government legislation which would in any way lean towards the nationalization of the coal mining industry, or any other industries in the United States.

Sir Harry E. Brittain outlined the coal mining industry in Great Britain.

Ninety-six papers were presented, most of which were read by their authors. Of these, four were devoted to economics; four to competition between fuels; eight to pulverized fuel; eleven to gasification; eleven to the economics of low temperature carbonization; four to power plant fuel; eight to origin and classification; two to steam purification; four to high temperature carbonization; three to smoke and dust abatement; four to preparation; four to railway fuel; three to domestic utilization of coal; five to hydrogenation and liquefaction; three to steamship fuel; five to by-products; three to the economic problems of coal; five to coal cleaning; and five to coal carbonization problems.

A subscription dinner was held at the Hotel Schenly on Wednesday evening, November 18th. This dinner practically concluded the conference and most of the Canadian delegates left the following night. The chairman, Dr. Baker, appointed a committee composed of representative American citizens to review the various suggestions made for assisting the coal mining industry and to frame recommendations for its betterment. This committee did not report their findings before the writer left.

The Third International Conference on Bituminous Coal left the writer with the impression that the coal mining industry in the United States is in a very bad, if not hopeless, position, and that those in charge of not only this important key industry but other great industries dependent on it to a large extent, were unable to make any constructive criticisms or suggestions for its improvement. Many of the papers presented were of a high order and technically were of great value, but like many papers presented at such conferences, they treated of research in the laboratory stage or of process work in the course of development, while other papers describing processes which have been developed to the point where they might be applied on a commercial scale, led one to believe that certain processes could be applied profitably at the present time; whereas a knowledge of the facts would lead to an opposite opinion. Such papers, especially when presented by men of authority, are apt to do considerable harm. However, the vital question before the conference did not concern the introduction of new methods for processing coal, but was one concerning the increased use of coal or the closing down of a number of mines, so that the many papers concerning processes for the utilization of coal were treated as being more of an academic than of a practical nature, and did not in any sense contribute to the solution of the main problem, viz. that of unemployment in the coal mining industry, due to the falling off in the demand for coals of all kinds. The situation as regards the production of coal in Canada was not touched upon at the conference, nor was that in England, otherwise than in the address by Sir Harry E. Brittain and the few papers presented by English technicians.

New Developments in Nickel

Abstract of Address by Robert C. Stanley, President, The International Nickel Company of Canada, Ltd., appearing in the "Financial Times."

Although the nickel industry has shared with industry the world over the disappointments caused by the delay in business recovery, developments during the past year indicate a continuing growth of diversity in uses, which will be more generally appreciated as industry steadily works its way back to normal volume. Twenty-four nations include pure nickel tokens in their official currency, some 3,000,000,000 coins having been struck from this metal since the Swiss government first adopted pure nickel coinage in 1881.

Its principal use is in tanks of heavy construction, in which are handled materials corrosive to iron and not corrosive to nickel.

One of the most important developments of the year in nickel plating has been the beginning under the auspices of the Research Committee of the American Electroplaters Society, of a programme of exposure tests and the development of standardized specifications for plated products and for raw materials.

Nickel plating in solution of low Ph. is being used successfully by one of the large automobile producers in many of its plants. This bath is more acid than that commonly used.

During the past year development work has been going on for the purpose of developing a nickel steel for ship hull plates and deck plates. The results have been satisfactory. This means that a substantial saving in weight can be effected by use of high strength nickel steel. Some ships have already been designed to use these plates, but no commercial ship has as yet been laid down. Nickel steel has been used for special structures in naval ships for more than forty years.

The use of nickel steels for chisels and battering tools is little known, although a number of firms have employed it for years in punches, chisels, rivet sets, etc. Now, by the development in England of a special heat treatment, the successful application of this material has been extended.

During the year the company has compiled and distributed to the railroads a group of specifications on nickel steels and nickel irons for cars and locomotives. These recommendations were prepared in collaboration with authorities in this field of construction.

The success of SAE-4615 steel containing 1.75% nickel and 0.25% molybdenum has led to the development of a new steel with higher properties containing 3.5% nickel and 0.25% molybdenum. This material looks promising for use in heavy duty gears.

Nickel Iron Alloys

Ni-Resist, the corrosion-resisting cast iron, containing 14% nickel, 6% copper and 2% chromium, has expanded considerably in its use both for corrosion-resistance and as a mild heat resisting material. It is used in the chemical, oil refining and other industries as a heat resisting material for temperatures up to approximately 1,500 degrees F., and has shown wide expansion during the past year for many new uses.

During the past year it has developed that a cast iron containing from 20% to 30% nickel and about 2% chromium, shows very high resistance to caustic corrosion and is readily machinable. It has been adopted for many fittings, pump parts and other apparatus connected with the handling and manufacture of caustic.

The use of nickel heat treated cast iron dies showed a marked expansion during the year. Use of these dies is for forming automobile bodies and radiator shells.

The use of nickel cast iron for brake drums has also shown wide expansion.

The use of nickel-chromium cast iron has been pretty well established for several years. The success of this material has led to investigation of the effect of other alloys in combination with cast iron. A promising mixture has been found, containing 2% nickel and 1% molybdenum which shows unusual tensile strength and toughness; but this is an expensive mixture and lower alloys containing 1% nickel and from 0.35 to 0.50% molybdenum are finding applications in cylinder blocks, brake drums and other wearing parts.

During the past year increasing use has been made of chromium-nickel iron alloys by sulphite paper mills in overcoming the serious corrosion problems encountered in the handling of solutions of calcium bisulphate and sulphurous acid. Used properly, equipment made from these alloys seems to have indefinitely long life in applications where bronzes last only from eight to twelve months.

During the year 1931 a great deal of interest was shown by electrical engineers in the recent development of nickel-iron alloys for magnetic purposes.

Alloys for high initial permeability of particular interest in communications work have been emphasized by the Bell Telephone Laboratories, and the more standard alloys of the 50-50 nickel-iron type have become available to designing engineers for various classes of instruments for magnetic shielding and for small transformers for radio, airplane and marine use where saving in weight is important.

A new product known as Inco Chrome Nickel has been developed especially for the dairy industry. This is completely resistant to corrosion and tarnish by milk and milk products. At the same time it can be fabricated readily by any of the methods commonly in use.

As a result of tests made during last year the suitability of monel Metal for bolts, screws, and miscellaneous fittings on outdoor electrical equipment, such as railroad electrification systems, railway signal equipment and transmission lines, appears in a different and improved perspective.

Preliminary Notice

of Applications for Admission and for Transfer

February 19th, 1932

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, 1932.

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

BRANT—THEODORE JACK, of 521 Huron St., Toronto, Ont., Born at Ottawa, Ont., Nov. 9th, 1905; Educ., B.A.Sc., Univ. of Toronto, 1929; June 1929 to Nov. 1930, power plant design, telephone systems engrg. dept., Northern Electric Co. Ltd., Montreal; at present, demonstrator in hydraulics, dept. of mech'l. engrg., University of Toronto, Toronto, Ont.

References: J. H. Ings, R. W. Angus, E. A. Allcut, F. C. Dyer, R. E. Smythe.

HAIRSINE—SYDNEY, of St. Catharines, Ont., Born at Leamington, Ont., Dec. 16th, 1899; Educ., 1919-21, Detroit Technical Institute, elect'l. diploma, 1921; 1922-25, elect'l. ap'ticeship, 1925-26, test office, working up performance of electrical apparatus, and from 1926-28 in switchboard engrg. at Canadian Westinghouse Company, designing power switchboards, substation layouts, wiring diagrams for power circuits, control circuits, including automatic substations and magnetically controlled movable bridges; 1928 to date, factory testing of elect'l. equipment, elect'l. inspection, checking elect'l. control diagrams, supervising elect'l. installn. of bridges and gate-lifter at Welland Ship Canal, also supervising elect'l. mtce. of bridges.

References: A. L. Mudge, M. B. Atkinson, W. E. Ross, E. G. Cameron, A. G. Murphy.

MILNE—JAMES RAMSAY BURT, of Kenogami, Que., Born at Edinburgh, Scotland. Jan. 10th, 1905; Educ., 1920-25, indentured ap'tice, marine engrg., H.M. Dockyard, Rosyth, including completion of four year course at H.M. Dockyard School, 1920-24. Worked on all kinds of naval machinery, 1½ years in drawing office, ship trials, etc.; 1925 to date. engr. and dtsman., Price Bros. & Co. Ltd., Kenogami, Que. Gen. mtce. and repairs, pulp and paper mchy., pipelines, etc., pulp bleaching plant, Jonquieres Pulp Co., wet end board machine for same company, also pulp laboratory and fire protection system; misc. reinforced concrete work and estimating for all of foregoing work.

References: N. D. Paine, G. F. Layne, A. Cunningham, F. W. Bradshaw, W. L. Yack.

PARADIS—LEO, of 2 Ste Julie St., Quebec, Que., Born at Riviere du Loup, Que., Jan. 10th. 1900; Educ., B.Sc., (Mech.), Tri-State College, Angola, Indiana, 1931; 1918-21, machinist in different shops; 1921-23, machine shop instructor, Grand Mere Industrial School; 1923-25, die maker at Briggs Body Plant, Detroit, Mich.; 1925-27, tool maker at Dodge Brothers, Detroit, Mich.; 1927-29, machinist, Anglo-Canadian Paper Mills, Quebec, Que.; not employed at present.

References: H. Cimon, J. Joyal, P. Méthé, A. V. Dumas, A. G. Sabourin.

ROBSON—RICHARD CHRISTOPHER, of South Slocan, B.C., Born at Bromley, Kent, England, July 13th, 1904; Educ., 1922-25, applied science, Univ. of B.C.; 1928, course in advanced elect'l. engrg., Prov. Govt. Schools, Vancouver; 1925-26, highway constrn., Vancouver, B.C.; 1926-27, dftsman., American Can Co.; 1927-29, dftsman., Canadian Fishing Co., Vancouver. Marine, mech'l., wood structures, wharfs, boiler installn., refrigeration; 1929-31, designing dftsman., Cons. Mining & Smelting Co., Trail, B.C. Mech'l., elect'l. and struct'l. power layout and distribution, lighting; 1931 to date, designing dftsman., West Kootenay Power & Light Co., South Slocan, B.C. Power house, dams, river work.

References: W. G. Swan, B. R. Warden, S. C. Montgomery, A. E. Wright, G. P. Stirrett, A. S. Mansbridge.

RICE—WALTER LESLIE, of Toronto, Ont., Born at Leicester, England, March 6th, 1904; Educ., 1923-32, evening classes, Toronto Technical Schools. 4 year course, machine drawing and design; 4 year course, maths.; 2 year course, applied mechanics and strength of materials; 1926-28, rodman, etc., and 1928 to date, dftsman and instr'man, sewer section and water supply section, dept. of works, City of Toronto. (1931, acting res. engr., central section of water works tunnel.)

References: A. U. Sanderson, J. Milne, T. Taylor, G. Phelps, F. J. Hancox, G. G. Powell, S. G. Talman.

SAND—THORLEIF BAGGE, of Toronto, Ont., Born at Arendal, Norway, Oct. 10th, 1904; Educ., 1925-27, Technical College at Horten, Norway, graduated in 1927; Private and Commercial Air Pilot Certs., Breslau, Germany, 1923-1924; 1924-25, engaged in civil flying and studying airplane constrn., Royal Australian Exp. Air Force, Sydney, Australia; Aug. 1927 to June 1928, inspr., boiler and bridge works, Larvik, Norway; June 1928 to March 1929, asst. engr., Norwegian Hydro's Chem.-Tech. Test Laboratory at Oslo, Norway; 1929 (Mar.-Nov.), inspecting field-repair work for Norwegian Govt., telegraph dept.; winter and spring 1929-30, running own flying school in Norway; Sept. 1930 to date, dftsman. Abitibi Canyon Dam, Dominion Construction Corporation, Ltd., Fraserdale, Ont.

References: H. E. Barnett, T. V. McCarthy, G. Mitchell, W. J. Bishop, R. L. Hearn.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

JAMIESON—ROBERT EDWARDS, 234 Metcalfe Avenue, Westmount, Que., Born at Ottawa, Ont., Nov. 5th, 1891; Educ., B.Sc., 1914, M.Sc., 1920, McGill Univ.; 1908-10, bookkeeper, N.T.C. Rly. constrn.; Summers, 1911, bookkeeper, Can. Nor. Rly. constrn.; 1912, transitman, Quebec & Saguenay Rly. location and constrn.; 1913, transitman in charge of party, C.P.R. mtce.; 1914, transitman, Magnetometric Survey, Dept. of Mines, Dom. Govt.; 1916, designer, Halifax Ocean Terminals Rly.; 1916-19, overseas Can. Siege Artillery, Lieut.; 1914-15, demonstrator, 1919-23, lecturer, 1923-29, asst. professor, 1929-31, associate professor, and 1931 to date, professor of civil engrg., McGill University, Montreal. In addition to regular work at university engaged on various engrg. works since 1920, design, consultation, tests and reports. (*A.M. 1921.*)

References: E. Brown, A. F. Byers, H. G. Hunter, W. S. Lea, D. Stairs, W. C. Thomson.

ROSS—KENNETH GEORGE, of Sault Ste. Marie, Ont., Born at Toronto, Ont., August 2nd, 1884; Educ., Grad. S.P.S., Univ. of Toronto, 1906; O.L.S.; 1907-08, instr'man., for Ontario Land Surveyor; 1909-14, Ontario Land Surveyor; 1915-18, overseas, England and France, Major; 1918, Ontario Land Surveyor; 1909-1932, partner, and at present vice-president, Lang & Ross Ltd., Engineers, Sault Ste Marie, Ont., General Engrg. and Contracting, specializing in hydro-electric developments and transmission lines. (*A.M. 1919.*)

References: J. D. Jones, J. L. Lang, R. S. McCormick, A. E. Pickering, E. V. Caton, G. G. Gale.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

CLARK—JAMES ERNEST, of 119 Bagot St., Kingston, Ont., Born at Pulborough, Sussex, England, July 30th, 1904; Educ., B.Sc. (Elec.), Queen's Univ., 1928; 1926 (4 mos.), gen. machinist, Canadian Locomotive Co., Kingston; 1927-29, factory and test, Canadian General Electric Co., Peterborough; 1929 to date, field engr., designing and estimating on exchange outside plant, Kingston District, Bell Telephone Company of Canada. (*S. 1928.*)

References: J. A. Loy, R. M. Richardson, W. M. Cruthers, H. S. Dick, D. M. Jemmett, T. A. McGinnis, L. T. Rutledge.

SMALLHORN—EDWARD ROBERT, of 2033 Harvard Ave., Montreal, Que., Born at Levis, Que., June 18th, 1903; Educ., B.Sc. (Civil), McGill Univ., 1923; Summers, 1920, track work, C.N.R.; 1922, street and sidewalk survey work, City of Montreal; 1923-25, design and constrn. of filter plants for Acton Vale, Levis and Metis Beach, Que. Also design and constrn. of sewage pumping station, etc., for Ste Anne de Bellevue, Que. all as asst. to H. G. Hunter, M.E.I.C., June 1925 to Jan. 1926, asst. engr., Dept. Rlys. and Canals; 1926-27, principal asst. to Willis Chipman, M.E.I.C., Toronto, on design and later in charge of constrn. for filtration plant, reservoir and pumping station for City of Welland, Ont.; 1927-28, principal asst. to R. S. & W. S. Lea, Montreal, design and constrn. of pumping station, City of Windsor, Ont., design and constrn. of hydro-electric development for Town of Coaticook, Que., and other work; Nov. 1928 to Apr. 1929, sales engr., Aerocrete Montreal Limited, for pre-cast roofs; 1929 (Apr.-Aug.), constrn. supt., A. F. Byers & Co., Montreal; August 1929 to date, managing partner, Aerocrete Construction Co., Montreal. (*S. 1923.*)

References: A. F. Byers, W. S. Lea, R. S. Lea, H. G. Hunter, E. A. Ryan.

Molybdenum

Greeks said "molybdenum" when they meant the stuff we call lead. They also applied this name to other substances that looked like lead. By the ancients the metal we now distinguish as molybdenum was considered to be some derivative of lead, from which it differs greatly. This error is easily understood when one realizes that the rarer metal is most commonly found in nature in the form of molybdenum sulphid, a compound of molybdenum and sulphur, for which the chemist's symbol is MoS_2, a soft, flakey, black substance resembling graphite.

Sargent secured this information from Dr. O. Kochi, Faculty of Technology, Imperial University of Tokyo. Years ago a German steel expert analyzed a part of a sword blade made by a famous Japanese artist, Masamune (1330 A.D.) and discovered in it the rare element molybdenum, doubtless as an impurity. This led the discoverer to ascertain the source of Masamune's alloy iron. Thereupon he purchased this iron in large lots, much to the surprise of the Japanese. Later, when they analyzed captured German cannon, they decided where a part at least of the molybdenum ore was obtained.

Discovered by Scheele in 1778 in the form of an oxid, molybdenum was first separated as a metal by Hjelm in 1782. It is now produced commercially by hydrogen reduction of the oxid, pure oxid being obtained from ammonium molybdate. The resulting metallic powder is sintered, forged and rolled into desired shapes. When pure, molybdenum is soft, white and ductile.

During the last thirty-five years, a great deal of research was done in Europe, Japan and the United States. Many characteristics were developed. Not until the World War did it come into prominence; it was extensively used as an alloying element in light armor plate, helmets and Liberty engines because of great increase in strength and toughness imparted to steel.

Even in war time its application was limited, due to uncertainty of the supply and high cost. In the last few years, large deposits of ore have been discovered in the United States. There are deposits, of varying richness, in many parts of the world, but the largest and richest known are in this country. Commercial deposits are found ranging in richness from ½ of 1 per cent up to 8 per cent or 10 per cent MoS_2. After grinding and flotation, the ore is concentrated to about 80 per cent MoS_2. From these concentrates commercial products are made. Rapid lowering of cost by increased production has resulted in a large portion of the world's requirements being supplied from American mines. This important element could not be shut off from this country in times of stress as could some alloying elements used in steel.

It has been said that, excepting carbon, molybdenum is the most potent alloying element added to steel. Molybdenum can be substituted for tungsten in the ratio of 1 for 2. In quantities generally used in steel, molybdenum for the most part goes into solution with the iron, though when present in percentages of over 1 per cent, or when considerable quantities of chrome or manganese are present, it forms a double carbide. It is also probable that a definite compound of molybdenum and iron is formed when cooled through the critical range. Used in percentages as low as one-tenth of one percent, or two pounds to the ton, it has shown marked tendencies in resisting corrosion. In percentages up to 10 per cent it offers a possible substitute for the tungsten high-speed tool steels.

Thin-walled, high-strength, chromium-molybdenum steel tubing has made modern high-speed airplanes possible. No substitute has been found for highly stressed members in the fuselage. It combines the unusual advantages of high strength without complex heat treatment, easy weldability, and no appreciable loss of desirable properties in welded joints. It enables designers to increase strength with no increase in weight.

The pure metal is extensively used in the incandescent and radio bulb industry. In the forms of salts and oxides it is used in the chemical and dye industries. According to a booklet, "Rare Metals": "To say that the air or ether carries the radio broadcast wave is true, but it's a certain metal sealed tight in tubes which puts the wave on the air, and then in different tubes, recaptures it, to be turned back into music or words. This metal is molybdenum—the metal that talks." Literally thousands of miles of molybdenum wire, drawn through diamond dies, have been used in the radio industry.

Thus do we find modern industry, engineering and research making a place for a material known for a century and a half, but little used until within the last few years.—W. H. Phillips in *Research Narratives of The Engineering Foundation.*

Liquefaction of Coal

It is now nearly twenty years since Bergius discovered that by treating suitable coals with hydrogen under pressure he could convert a considerable part of their substance into liquid products. It was found desirable to work at a temperature of about 450 degrees C. and a pressure of some 200 atmospheres, and the technical difficulties of the process, including notably those arising from pressure, were not overcome for large-scale working until about ten years ago. Previously, however, experiments had been made on the hydrogenation of oil, and, with the improvement in high-pressure practice, work was continued by Bergius and many others on the action of hydrogen on coal. The Bergius process consisted in mixing powdered coal with a suitable oily vehicle and a small amount of ferric oxide into a thick paste, which, under hydraulic pressure, was forced into reaction vessels, where it was subjected to the action of hydrogen at the temperature and pressure mentioned. About seven years ago, experiments on the subject were also begun by the Fuel Research Board of the Department of Scientific and Industrial Research, originally on a laboratory scale, but afterwards in a continuous plant with a capacity of 1 ton of coal a day. The object with which most of these experiments were started was to convert coal completely into liquid products. This also was one of the purposes of the Fuel Research Station's investigations, which are still in progress, but in the course of them it was observed that, before the stage of liquefaction was reached, fundamental changes occurred in the properties of the coal under treatment, and it was discovered that, before liquefying the coal, the hydrogenation process could convert non-coking into coking coal. It has now been decided to publish details of the various investigations into hydrogenation that have been made at the station, and a beginning has been made with a report principally concerned with the results of incomplete hydrogenation and its effect on various types of coal.

One reason for using a vehicle with the powdered coal, as used by Bergius, was to facilitate the reaction between the coal and the hydrogen and lessen the tendency towards coking. When, therefore, in the course of the station's experiments, evidence appeared of reactions between the coal and the hydrogen before the coking temperature had been reached, it was decided, in order to study the nature of the intermediate hydrogenation products that were thus being formed, to work without a vehicle, the presence of which was thought likely to mask the effect. As a result, it was found that, when the solid products of hydrogenation of a particular bituminous coal (Arley) obtained after a temperature of 370 degrees C. had been reached were carbonized, a profound change occurred in the type of coke produced. Originally this had been hard, and only slightly swollen, but the product was found to yield a highly swollen coke, and, tested by the Campredon method, to give a coking index of 39 as against 24 for the original coal.

A series of experiments was undertaken to ascertain what variations, if any, could be produced by hydrogenation to various extents of an originally non-coking coal. The results showed, on the coal chosen, a sharp increase of coking power in the carbonized product according to the temperature of hydrogenation. Working in all experiments at an initial pressure of 100 atmospheres, and with periods of treatment which varied only from 90 minutes to 105 minutes, the maximum temperature of hydrogenation was increased by steps of 10 degrees C. from 340 degrees to 380 degrees. At the two lowest temperatures, the solid product had been slightly fused in parts, and at each subsequent ascending temperature a larger part had been fused, until, for the first time in the series, the whole had been fused at 380 degrees. These products gave corresponding results when carbonized at 600 degrees C. in the Gray-King assay apparatus. While the original coal so treated gave a non-coherent powder, the carbonized product of hydrogenation at 340 degrees was coherent, though very soft, and at 350 degrees was black, hard and dense. The products of treatment at each higher temperature were successively more and more swollen, till that at 380 degrees yielded a frothy and swollen coke even after having been mixed before carbonization with a third of its weight of powdered electrode carbon.

In conclusion, it appears to have been made out that the products obtained at the lower stages of hydrogenation are due to the action not merely of temperature and pressure, but also of hydrogen, and may be regarded as partially hydrogenated. The existence of these intermediate products does not seem to have been recognized previously, and their discovery may be an event with important consequences.—*Engineering.*

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2050 Mansfield Street, Montreal

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Situations Vacant

CHIEF ENGINEER, for 12,000 h.p. steam-electric plant in West. Experience in pulverized coal essential. Must qualify for Alberta certificate. Technically trained man preferred. Apply with full particulars and photograph to Box No. 798-V.

SALES ENGINEER, to travel Eastern Canada. Mining engineer, Canadian citizen, not over 40 years of age; experienced cyanidation and flotation operations, ore testing and selling to mining industry. Give full details of previous experience, names of former employers and salary desired. Apply to Box No. 803-V.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

DRAUGHTSMAN, experienced in design steam and ventilating plants, boiler layouts, hoisting and other machinery, and structural engineering. Good references. Present location Montreal. For interview apply Box No. 329-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing or sales organization. Apply to Box No. 334-W.

CIVIL ENGINEER, A.M.E.I.C., over thirty years experience in municipal and construction work, specializing in roadway work of all classes, wishes position; or will enter into a contract with a reputable firm of roadway contractors to act as superintendent and engineer. Capable of supervising large contracts with the most up-to-date construction methods. Available forthwith. Apply to Box No. 336-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available February 1st. Qualified Captain in military engineering. Apply to Box No. 377-W.

Situations Wanted

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and moveable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.G., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

Situations Wanted

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

MECHANICAL ENGINEER, Jr.E.I.C., five years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in mining, pulp and paper industries, seeks association with manufacturer as designer and sales engineer. Holds some patents on machinery for trade. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes one year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door substation construction, as assistant engineer. Also geological survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931, N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator

Situations Wanted

manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; student's test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsiblity or taking charge of technical work for small concern. Apply to Box No. 669-W.

CIVIL ENGINEER, graduate University of New Brunswick '31, in C.E. Experience consists of three seasons on a survey party. Available October 1st. Desires permanent position. Willing to go anywhere. Apply to Box No. 672-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

CIVIL ENGINEER, graduate, Jr,E.I.C., age 25, single. Experience includes mill construction, design and supervision. Also design of hydraulic structures, bridge foundation, rigid frames and caissons. Will go anywhere. Apply to Box No. 677-W.

RADIO ENGINEER. Graduate McGill Applied Science '30. Experience includes the cesign, development and production of broadcast receivers, as well as general radio laboratory practice. Apply to Box No. 680-W.

ELECTRICAL ENGINEER, graduated 1914, desires position with engineering firm or electric utility. Experience in design and layout of power houses and sub-stations, including automatic and supervisory control equipment; design of switchboards and switching equipment; manufacturing, testing, erection and operating of electrical apparatus of all kinds. Anywhere in Canada. Permanent position preferred. Apply to Box No. 681-W.

OPERATING ENGINEER, A.M.E.I.C. Operating superintendent or assistant. Age 44, married. Twenty years experience in industrial manufacturing, steel mills, power plants and quarrying operations, both large and small. Very successful with labour problems, cost accounting, etc. Will take any position with view to betterment. Available immediately in any location. Apply to Box No. 682-W.

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The Influence of the Motor Vehicle on Modern Transportation

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 4th and 5th, 1932.

SUMMARY.—In this paper the author traces the fundamental changes which have taken place in modern transportation due to the development of the motor vehicle, and discusses the economic scope of the motor as a commercial competitor of the railway. He outlines the problems which have been created by the adjustment of the motor vehicle and pre-existing forms of transportation to the new conditions. The paper discusses such features as the decrease in passenger revenues of steam railways in Canada, the increase in freight traffic carried on the highways in competition with the railways, and the contacts between highway and rail transportation in regard to matters other than traffic or service.

The author points out the vast field of potential usefulness for the motor vehicle and the ease with which the economic forces now called into play can be directed to uneconomic ends. The paper includes a series of statistical tables relating to its subject matter.

In presenting this paper, the author wishes to state that it represents only his personal views, and is in no way an argument put forward by the railway interests with which he is associated.

Perhaps no more interesting subject could be selected for discussion than the influence of the motor vehicle on modern transportation. It is interesting not only in an academic sense, but also in a practical sense, because the forces brought into play through the application of the motor vehicle to modern transportation, are so great and so far reaching in their effect, that they have a profound bearing upon our modern industrial economy. Measured in its true perspective, the development of the motor vehicle will probably rank, in the history of transportation, on an equal footing with the development of the art of steam propulsion and of electric traction.

Before dealing specifically with some of the more detailed aspects of the motor vehicle, in its relation to modern transportation, it might be well to review briefly some historical parallels of the growth of a new economic force comparable to the motor vehicle. Such a review will go a long way towards explaining the apparent confusion which at present exists regarding this controversial subject, and will in fact reconcile views, which on the one hand see the motor vehicle as a new and vitalizing force of boundless potentialities, and which on the other hand see it as an uneconomical development.

First, it must be understood that the motor vehicle is a latter day achievement of the industrial revolution. This has a very great bearing upon one of the most important aspects of the problem of economic adjustment following its adoption. The past hundred and thirty years have seen a complete revolution in the world's attitude toward inventiveness and progress. The modern world looks steadily forward to increasing production, increasing wealth and an accelerated tempo of living. It seizes with enthusiasm upon every new idea developed by inventive ingenuity, it exploits all avenues by which the new principle may be applied, and the same is true of the merchandizing and commercialization thereof. This is a great contrast to the slow and painful process by which new ideas had to be pushed forward upon a reluctant world at the beginning of the industrial revolution.

This psychological attitude of a whole people creates a very specialized problem in dealing with any new principle, which has more than a minor effect upon the whole economy. If the adjustment is left to the policy *laissez faire*, the resources and boundless enthusiasm of a whole nation may produce very serious results; because, while the record of the industrial revolution has been one of progress on the whole, that progress has been purchased at the expense of innumerable mistakes, involving the loss of capital on a truly colossal scale. Nowhere is this principle better illustrated than in the first great development in modern transportation—the steam railway. The student of economics, and particularly the student of transportation economics, will readily perceive in the history of the development of steam railways various phases which present a striking parallel to the development of the motor vehicle, but spread over a much greater period of time—a period so great, in fact, that the railway as a transportation agency has not as yet exhausted its potentialities.

There was first the period of scepticism and disbelief, followed by a tendency, of brief duration, to treat the new agency as a novelty. Then, as its industrial potentialities came to be realized, there burst upon the world a period of over-enthusiasm, a period during which railways were built everywhere for every conceivable purpose, and sometimes for no purpose at all. England, as the centre of the art, witnessed the earliest expansion, and English engineers, English capital and English factories supplied much of the railway mileage and equipment of the world, just as the United States has done in the case of the motor vehicle. Next followed the inevitable results of over-expansion, and the period from 1840 to 1880 witnessed, in the older countries, a profound re-adjustment of the railway to realities. In the process vast amounts of capital were lost and many dreams were shattered. Since that time the railway, as a transportation agency, has settled down to a useful existence, limiting its activities reasonably within its proper economic sphere, not attempting the impossible, but directing its efforts to increasing efficiency and mechanical perfection.

When electric traction became technically feasible, the world had become accustomed to miracles and was ready and willing to believe in the boundless application of this principle, an attitude of mind which is current even today. Steam traction was thought to be a thing of the past. The same phases were passed through as those indicated in the case of the steam railway, with the exception that, owing to the inherent disabilities of the electric railway, over-expansion was checked at a fairly early date. The electric railway in turn settled down to a useful, if somewhat specialized, existence.

Now we are in the throes of an adjustment of a new economic force—the motor vehicle. So far as can be seen at the present time, its potentialities are great enough to make it rank as an equal of the steam railway. Already, in Canada and the United States, investment in the motor vehicle, its allied instruments of production and the highways equals, or exceeds, the investment in railways. The accelerated tempo of living, previously mentioned, has brought about this result in a period of less than three decades, and this is an achievement without parallel in the industrial history of the world.

Is it surprising that this new instrument, entering into a field already covered by the electric railway and the steam railway, should have brought about a condition of stress, or that the development has been marred by minor mistakes? Need we be surprised if it is found that something akin to the tremendous over-expansion, which took place in steam railways, and which took place in electric railways, has in point of fact taken place in regard to the application of the motor vehicle? May it not be a reasonable conclusion that, after the fog of obscurity has cleared away, the motor vehicle will be found fulfilling a sane and sensible function, co-ordinated to our general productive and distributive economy so as to produce the largest measure of benefit to society?

If anything like an intelligent discussion of the subject is to be undertaken, the fundamental economic and engineering principles underlying the development of the motor vehicle must be considered. Without delving too deeply into the intricacies of economics, there appear to be, broadly speaking, two classes of human activity; the one, a productive economy, directed toward the control of natural forces and the wresting from the earth of our subsistence, at whatever standard of living we elect or to which we have educated ourselves; the other, a distributive economy by means of which our group productivity is expressed in a better standard of living. In detail, the two, so far as they represent material things, are found to be inextricably mixed; but, if the sound productive economy does not exist, then the ramifications of the distributive economy cannot function; and, on the other hand, if the incentive and opportunity for an increased standard of living is not present, the productive economy becomes useless. To make a somewhat crude metaphor, the relationship between the distributive and the productive economy might be likened to dangling a carrot in front of a donkey's nose to induce him to draw a plough, thereby increasing the productive economy which would produce more and juicier carrots. The carrot fulfils a perfectly normal and needful function, and, in a similar fashion, the great expansion in production of consumers' goods represents the machinery by which the distributive economy works.

On theoretical grounds, there does not appear to be any limit to the extension of this principle, although practically, at any given time, it is in point of fact limited on the one hand by the capacity of the real productive economy to stand the burden, and on the other hand by the education of the people at large to a given standard of living. A beautiful illustration of the over-zealous application of it is to be found in the so-called "new era philosophy," which preceded the great depression.

Under which category is the motor vehicle to be classed? Is it a stimulant and incentive to increased production, to the end that a higher standard of living may be enjoyed, or is it a modern implement in the productive economy of the world? In whatever class the motor vehicle may finally be placed, there is no doubt that in its inception it belonged to the first. It was distinctly a luxury with a great popular appeal, but initially limited to a narrow market on account of its cost. The broadening of that market and the satisfying of it by mass production has been the greatest single factor in our industrial development and increase in standard of living in the past two decades. The motor vehicle has entered to a degree into our productive economy, but even today the luxury appeal of the automobile is still the major factor in the motor vehicle industry and the major portion of the use to which the motor vehicle is put. The motivation behind the construction of good roads is also in a large measure, in this country at least, still one of pleasure driving, and no more poignant fact in support of this view can be cited than the tourist traffic, which the motor vehicle and the provision of improved highways has developed. According to a bulletin issued by the Bureau of Statistics, the expenditures by United States automobile tourists in Canada during 1930 were slightly in excess of $200,000,000. Canadian automobile tourists in the United States expended approximately $63,000,000, leaving a favourable balance to Canada of nearly $139,000,000. This clearly indicates the part which pleasure use plays in highway construction.

Lagging somewhat behind the development of the motor vehicle as a luxury, there has been its development as a commercial vehicle, both for the carriage of persons and of goods, and it is interesting to note the degree to which that commercialization has been aided by developments primarily directed towards pleasure. In the first place, had there not been a wide market for the motor vehicle created by its luxury demand, the economies of mass production for the manufacture of the commercial vehicle would never have been possible; and again, had not good roads been developed in response to popular demand for pleasure purposes, the commercialization of the motor vehicle would have been limited to urban centres and to specialized activities. It will be seen that the commercial vehicle, in impinging upon the pre-existing transportation systems, was powerfully aided by what were in effect substantial bonuses or subsidies, and in particular this is true of the field of its active competition with them. It is a pure accident that good highways when constructed were built on the principle of trunk lines connecting important centres, rather than as radials serving those centres. This accident was the insistent popular demand for an opportunity to travel far and wide in pleasure automobiles. A rationally planned system of highways, if directed towards commercial ends, would have been laid out on a radial basis, the highway supplementing instead of competing with trunk line railway connections. The present situation is that practically every mile of important railway line in Canada and the United States is paralleled by improved highways, and these highways are being used to an increasing extent for commercial, as distinct from pleasure, use.

It is the purpose of this paper to develop the economic scope of the motor vehicle as a commercial competitor of the railway, and to deal with some of the problems which have been, and are likely to be, created by the adjustment of the motor vehicle and pre-existing forms of transportation to the new conditions. This is a very complicated problem and one which has been handled and mishandled by propagandists, representing the special interests on each side. It would be a fair statement to make, however, that whatever specific damage the motor vehicle has caused to pre-existing forms of transport, that damage has been more than compensated by the growth in the standard of living and the consequent increase in industrial activity. In other words, if the railways, as a major transportation agency, had to choose between the present and prospective motor vehicle competition, or the complete elimination of the motor vehicle, there could be but one answer. Another point will perhaps serve to further clarify the situation. There is no such thing as vested interest in public service; eventually the public will obtain that form of transportation which, all things considered, is cheapest and most acceptable. Nevertheless, in the process of re-adjustment there is apt to be a great wastage of effort, and of capital, and therefore, some scientific treatment of the principles underlying competitive services is warranted. To a certain extent, governments are possibly justified in limiting the free play of economic forces until the proper economic sphere of each form of transportation can be fairly well defined.

Before dealing with the more detailed aspects of the transportation problem created by the commercial motor vehicle, it might be well to deal briefly with its economic possibility in providing transportation needs, both passenger and freight. There are quite obviously two limits defining the price at which transportation can be sold. On the one hand, the price cannot be below the cost of providing the service, and on the other hand, the price cannot be above the value of the service to the shipper. Relative costs of service might at first glance be considered the controlling factor in determining which of competitive transportation facilities would be used, but quite frequently the value rather than the cost of service will be found to be the controlling factor in competition, especially if any difference in expedition or other collateral advantage exists. A proper understanding of the growth of motor vehicle competition, to the extent that it competes with, rather than complements, existing transportation agencies, can only be had by a thorough understanding of the application of these two principles.

As a passenger conveyance, the motor vehicle assumes two forms, either the private automobile or the motor bus. The motor vehicle in these two forms comes into active competition with railways, both steam and electric, and the competitive situation has developed to a point where certain sound generalizations can be made. It is, of course, difficult to differentiate between the pleasure and commercial use of the highways, not only as regards private passenger travel, but also as regards bus travel. In the main, however, it may be said that the motor vehicle performs by far the greater part of the country's passenger business. The best estimate which can be made indicates that seventeen per cent of urban and rural passenger travel is by steam railways, fourteen per cent by electric railways, sixty-eight per cent by private automobiles and one per cent by motor bus.

In reaching this stage of development, the motor vehicle has dealt rather severely with its competitors, although it must be confessed that it created the major part of its own traffic. The most vulnerable of the pre-existing forms of service were the radial electric lines and the branch lines service of the steam railways. The radial electric railways serving territory more densely populated were the first to suffer. Except in special locations, radial electric railways are now obsolete. As good highways became extended, the private automobile, later supplemented by the autobus, made such serious inroads into the steam railways' passenger traffic as to lead to the severe curtailment of service upon branch lines, and a future may be fairly confidently looked to where, climatic conditions permitting, services of this kind will be completely usurped by the motor vehicle.

In the field of long distance travel, the motor bus and private automobile have been much less successful, and the steam railways of Canada have shown a steady increase in the volume of long distance travel, in spite of serious declines in the total volume of passenger traffic.

The street railways in small cities were severely hit by the motor vehicle. First the jitney, and later the private automobile and bus, rendered the street car obsolete in cities with a population of less than one hundred thousand. In very large cities the motor vehicle has utterly failed to meet the transportation problem, and some form of railway, either street railway or subway, will continue to be dominant.

Here we have an illustration of the principle that governments are possibly justified in limiting the free play of economic forces. The jitney had the power to destroy, but not to supplant, the regular means of mass transport in large cities, and after a brief period of promiscuous competition the jitney was abolished as a competitive factor in the interests of the general public.

The expression of these various forms of competition in terms of our two principles indicates, in the case of passenger traffic, that value of service is a much more important factor than cost. The public cheerfully pay a huge annual bill for passenger travel on the highway, expending in Canada in an average year $570,000,000—more in point of fact than the total cost of steam railway transport for all services, both freight and passenger. The private automobile is actually an expensive form of transport, even when the driver's time is not debited against the movement. The motor bus, when charged for the use of the highway on an equitable basis, is capable of producing passenger transportation more cheaply than the railway, the average all inclusive cost per bus seat mile being approximately one cent, as compared with a cost per passenger seat mile by the railways of one and a third cents. Nevertheless, the railway can effectively compete in long distance traffic. These figures are in each case inclusive of overhead and an apportionment of interest charges. The out-of-pocket cost in any particular movement would be considerably different.

It might be interesting to develop at this point an estimate of the direct effect upon steam railways of the competition of the passenger motor vehicle.

Despite an annual population increase of two per cent, Canadian steam railways carried approximately five and three-quarter million (thirteen per cent) less passengers in 1929 than they did in 1923, and in that period steam railway passenger revenues have declined $5,000,000 per annum. This decrease in passenger revenues might be attributable to two causes:—

(*a*) A restricted travel habit of the general public.
(*b*) The use of some means of transport other than rail.

The tremendous increase in motor vehicle registration and gasoline consumption completely repudiates the former, and consequently the only conclusion that can be reached is that the public is using another means of transportation. If the travel habit of the public has not decreased, there is no reason to suppose that steam railway passenger revenues in 1929 would not have been $97,000,000, or $17,000,000 more than they actually were. Bus revenues in 1929 were estimated at $4,000,000. The remaining loss, therefore, must be charged to the activities of the private automobile.

An examination of steam railway statistics reveals that commuter traffic has, if anything, increased since 1923; the length of the average distance a railway passenger travels has also increased, and consequently it would appear that the traveller wishing to travel a greater distance than the commuter, but not more than seventy-five or eighty miles, is the one who is using the motor vehicle as a means of transport.

When the motor vehicle is considered as an agency of freight transport, the element of pleasure vanishes, and, as a consequence it might well be expected that cost of service, as distinct from value of service, would be more nearly the governing principle involved. The motor vehicle in this field finds itself in competition with the horse-drawn vehicle and the steam railway, and a little consideration will show that it is incapable of completely supplanting either.

The higher capital cost and higher operating expense, as compared with the horse-drawn vehicle, shuts the motor vehicle out of a field where the percentage of the time utilized in actual transportation is limited. This is generally the case for hauls below three miles. Below this limit the horse-drawn vehicle is dominant, and will remain so. Under the pressure of economic retrenchment the horse is quite liable to recover a considerable portion of traffic now uneconomically carried by the truck.

In competition with the steam railways, the motor vehicle as a freight facility, from a cost of service point of view, has a fairly defined but limited scope. The cost per ton mile via the motor truck for transportation only is on the average much higher than by the railway, but collateral features, such as elimination of handling costs or of packing restrictions, make the truck an economic facility for distances up to fifty or seventy-five miles. Beyond that limit, movement via the truck, if justified at all, must be justified on the value of the service and not on the cost of service. The expedited movement of selected commodities between selected shippers and consignees is possible on a value basis up to distances of possibly five hundred miles; but such traffic could, by nature of the definition, never attain large proportions. The bulk of the nation's land transport must of necessity remain with the steam railways. There is too great a disparity in cost to permit of anything like a complete substitution of the motor vehicle for railway service in this country where the average haul of railway freight traffic exceeds three hundred and fifty miles. This thought is perhaps worthy of a little explanation.

For purposes of illustration, if it be assumed that enough trucks and enough highways existed to permit of the movement of all Canadian freight by truck, a short calculation indicates that to perform this service every able-bodied man in Canada would need to be a truck driver—obviously a ridiculous impasse.

On basic and fundamental principles, the steam railway possesses inherently two elements leading to a lower cost for freight transport than can possibly be attained by the truck. All transportation consists, in effect, of overcoming friction, and, if there were no friction in the world, transportation would present no problem worthy of note. In fact, the difficulty would be to stop anything once in motion. The combination of a truly cylindrical wheel, with a surface of extreme hardness, rolling upon a steel plane, constitutes a reduction of friction to the ultimate known degree. In a broad sense, the railway transmits its freight on roller bearings, the rails constitute the race and the wheels the rollers. The principle has not been carried to the ultimate limit by the general installation of roller bearings on the axles; but, even without this refinement, the frictional resistance per ton of a loaded freight car, once it is in motion, does not exceed three pounds. The case is far different for a motor vehicle. True, a great improvement has been made by the development of hard surfaced roads, but this is partly offset by the necessary development of a soft and constantly deforming rubber tire, the result being that under the most favourable circumstances the frictional resistance per ton of a motor truck is in the vicinity of seventy pounds, and under relatively unfavourable circumstances, such as operation over a gravel road, that resistance may rise to one hundred and ten pounds. This factor is of extreme importance, since it indicates that, other things being equal, the power consumption per ton mile via the motor vehicle is upwards of twenty-two hundred per cent greater than by railway.

Again, the railway train, running upon tracks specially assigned to it, and to which it is confined, permits of the extension of the mass principle of transportation to a much greater degree than the truck. The result is that from the point of view of man-hours consumed per unit of transportation produced, the steam railway is immeasurably superior to the truck. The average train load in Canada is approximately 523 pay tons, and custom has decreed that five men shall constitute a train crew. That means an output per man-hour of 1,674 revenue ton-miles. Under favourable conditions this figure can rise to 10,000 revenue ton-miles per man-hour. A single truck, under favourable circumstances, would produce a figure not much beyond 80 revenue ton-miles per man-hour. Inventive ingenuity has attempted to solve this problem by types of semi-trailers and trailers; but, so long as the motor truck uses the highway in common with other vehicles, the development of the idea of a train is impracticable, and, therefore, the ton-mile output per man-hour must of necessity remain low, as compared with the steam railway.

Some might argue that with the development of the art, the disparity on these two points between the motor vehicle and the steam railway will tend to diminish. Such an argument overlooks the fact that the field for improvement is just as wide in the case of the steam railway as in the motor vehicle, and therefore, the relative disparity will always exist. No other conclusion can be reached but that the steam railway, for mass transportation, will never be displaced in this country by the motor vehicle using the highway.

Nevertheless, within the economic sphere which has been tentatively defined as lying between three and seventy-five miles, there is a vast potential field of usefulness for the motor truck. The railway is in effect an efficient wholesaler, but rather an expensive retailer, of freight transportation. The truck, while hopelessly deficient as a wholesaler of freight transportation is reasonably efficient as a retailer, and there is adequate scope for both. In the days before the development of the motor vehicle, when the only railway competitor was the horse-drawn vehicle, the economic range of retail transportation did not exceed ten miles, and this is the reason why, in the development of the country, railway stations were spaced at approximately seven-mile intervals. It may be confidently asserted that had motor vehicles developed concurrently with the railways, stations would be found much further apart, possibly at distances of twenty-five or thirty miles. The present fact is, however, that stations have been established at seven-mile intervals, and the public considers it is entitled to rail transportation in that detail, with the result that there is an over-lapping of services. The situation is further complicated by climatic conditions, winter operation by motor vehicles being impracticable in a large part of Canada. This country must, therefore, continue to face a condition of over-lapping competitive services, unless one or the other is abolished.

Reverting to the two governing principles previously enunciated (cost of service and value of service respectively), it will be found that in general in this competitive field the freight rates charged by railways are upon the basis of value of service rather than cost of service. This is an interesting contrast to passenger traffic. Custom has decreed a flat rate per passenger mile, irrespective of distance; but, for one reason or another, standardization of freight rates to a flat rate per ton-mile has never been attempted. Short haul and high valued traffic has moved at high rates, while long haul and low grade traffic has moved at low rates. The railway, in point of fact, has served in a dual capacity—on the one hand as a transportation agency, and on the other hand as a creator and equalizer of opportunity. It has, so to speak, assumed part of the functions of government and has used its freight charges as an economic tariff. This was a natural consequence of a complete monopoly of land transport; but the situation has changed with the development of commercial highway transport. No longer is it possible for the railways to charge the value of service on short haul traffic and use the surplus above cost of service to cheapen long haul traffic. They must, if they are to retain this short haul traffic, compete on a cost of service basis, and in many cases be willing to concede a premium to the motor vehicle for expedited delivery.

Should the encroachment on the short haul traffic reach considerable proportions, the effect upon the whole transportation scheme of the nation would be very serious, since the retention of Canada's foreign markets, for most of her exportable goods, depends upon the maintenance of as low freight rates as possible.

The true volume of freight traffic carried on the highways in competition with the railways is very difficult to obtain, and a false impression frequently results from a consideration of truck registration figures. Most trucks are either of special type or restrict their activities to cities. A country-wide survey indicates that of all trucks registered in Canada not more than three per cent can be classed as "for hire" trucks. These, it is estimated, carry 1,500,000 tons of freight, manufacturing 71,000,000 revenue ton-miles, and damaging the freight revenue of Canadian railways to the extent of $12,000,000 per year. This was the situation in 1930.

The indicated trend of increase in this traffic is twenty-five per cent per annum, so that if continued for any length of time, the inroads would reach serious proportions. At the present time, it amounts to less than four per cent of all freight revenue, but the effect on the net income of the railways probably amounts to not less than $7,000,000.

In addition to the freight carried "for hire" on the highways, there is an ever-growing volume of freight transported in owners' vehicles. It has proved utterly impossible to make a rational estimate of this traffic, but it is in all probability at least equal in volume to the movement for hire, so that the probable total direct competition in freight traffic amounts to not less than $24,000,000 per year, constituting seven per cent of the gross revenue, and probably a reduction of $14,000,000 in the net—with the inroads showing a tendency to increase at a rate of twenty-five per cent per annum.

This competition is by no means confined to the economic sphere of the truck, and as a consequence the country at large is paying a higher transport bill than would otherwise be the case.

As an off-set to these specific inroads into the railways' traffic, the presence of motor transport as a whole has created a large volume of railway traffic, estimated in a normal year to amount to ten per cent of tonnage handled by Canadian railways. Nevertheless, it is quite apparent that a condition is being brought about, which will require a considerable modification of our transportation economy. No longer will it be possible, to the same degree, for the railways to use monopolistic powers to create and equalize opportunity. In the competitive zone it must of necessity fight for its right to exist, and in that fight others may be damaged. Such damage may possibly justify the state in intervening in a fashion similar to the intervention of the state when it put an end to jitney competition with tramways in cities. A complete prohibition of over-the-road trucking would be a drastic and complete cure, but one unlikely to be adopted. Broadly speaking, there appear to be three other possible schemes:—

(1) The creation of a monopoly in over-the-road trucking.

(2) The zoning of over-the-road trucking, thereby limiting its use to an efficient distance of say seventy-five miles, or

(3) The establishment of a true *laissez faire*.

Many people might argue that the last condition exists today, but this is far from being true. *Laissez faire* implies an equality of opportunity and a fairness in the application of public regulations, the condition of service and tariffs. Equality of opportunity is not now present. Commercial motor trucks do not pay adequately for the use of the highway—in fact, they receive a substantial subsidy. The railways are handicapped in competing with the truck because they are subject to public regulation, and, as a condition of service, must not discriminate in tariffs as between different shippers. All things considered, the sensible course to pursue would appear to be the establishment of a real *laissez faire*. On the one hand, the truck should be assessed reasonable charges for the use of the highway and should obey reasonable restrictions for public safety. On the other hand, onerous regulatory restrictions should be removed from the railways within the competitive zone. This would permit them to vary their charges in accordance with local conditions, to discriminate between shippers and to be relieved of the obligation of providing a regular service or any service at all, except where they saw a profit. If this policy of *laissez faire* should prove too disturbing to business in general, as has sometimes been advanced, then the only other effective remedy is some physically restrictive and easily policed legislation against promiscuous trucking. Regulation of rates and services to a basis comparable with that of the railway will inevitably fail of its objective. It has been tried in numerous instances on an elaborate scale, but has never succeeded. The multiplicity of units and the direct personal contact between shipper and trucker render the enforcement of tariff and service regulation totally impracticable. Regulation for public safety there can and certainly should be; but effective regulation of rates and service, as applied to trucks, there never can be without monopoly.

No matter in what form the adjustment may be made, short of complete abolition of over-the-road trucking, there must be an increase in the rates of those commodities where the railway still enjoys a monopoly, to compensate for the traffic either lost or reduced in profitableness, by reason of highway competition. That is one of the effects of highway competition and one which cannot be ignored. It is to be hoped that the necessary adjustment of long haul tariffs will not be so substantial as to handicap Canada's export trade.

Having dealt at large with the problem, it is now proposed to deal somewhat in detail with the form of contacts between highway and rail transportation insofar as they relate to matters other than traffic and service. These contacts may be listed as:—

(*a*) The grade crossing problem.

(*b*) Indirect subsidies to highways by low freight rates on highway materials.

(*c*) Possible use of the highway by the railway.

(*d*) General economic welfare of the country.

The development of motor transport has accentuated the grade crossing problem far beyond its economic importance. Due to their spectacular nature, accidents at level crossings have achieved great publicity, which has resulted in turning public opinion towards a demand for an energetic programme of level crossing elimination. A careful analysis of grade crossing and other accidents reveals that only seven per cent of all motor vehicle fatalities occur at level crossings. A further analysis of the five major causes of violent deaths in Canada reveals that twenty-five per cent are due to motor vehicle fatalities, and consequently the so-called level crossing menace is only responsible for two per cent of the violent deaths in Canada in any one year. Looked at in its true perspective, the elimination of the level crossing is not as necessary in avoiding loss of life as other highway improvements, and yet the steam railways have been involved in expenditures in excess of three million dollars annually to remedy the carelessness of motor vehicle drivers, who do not directly make any financial contribution for the alleviation of these conditions.

Few people appreciate the extent to which the railways have indirectly subsidized highway competition by hauling road materials at lower than ordinary rates. At the period when railway rate increases were granted to meet increasing costs, roadway materials were specifically exempted, and it is estimated that had these rates been increased in proportion with other rates, the gross revenues of the railways would have been $20,000,000 greater than they have been. It may be noted that this amount closely approximates Federal aid to highway construction. This is an interesting sidelight upon a confused problem and another example of the fashion in which railways have been used as a subsidizing agency instead of giving direct government aid. The principle was quite sound so long as a monopoly existed; but, with the monopoly gone, the case is quite different, and it is rather amusing that the highways so subsidized should be the very agency to remove the monopoly.

Occasion may arise where the railway may find it desirable, convenient or economical to use the highway for the transport of goods or of persons. Legally, this could be readily accomplished by means of a subsidiary company, but at this point a sharp division in principle becomes apparent.

Either the railway may use the highway for purposes of economy, or it may use the highway for purposes of profit. The first, which implies either a substituted facility or a co-ordinated facility, requires no further justification. As a substitute, the motor vehicle could be utilized to:—

(*a*) Speed up existing train services by the elimination of stops, but the development of Canada has not given rise to such traffic density on its railways that the elimination of stops would be a sufficient reason for engaging in motor vehicle operation.

(*b*) Replace local trains where highways permit. This appears to be a field in which, by substituting motor vehicles for local trains, the steam railways might effect a saving in expenditure. Unquestionably, this is a field of usefulness to the railway, but each proposed substitution must be studied separately, giving due consideration to increased taxation, all-weather roads, steam train reserve and unionization of employees, with increasing operating costs, before definite decision can be made—and in Canada the field appears very limited.

Unless the railway enters the general field of motor vehicle transportation, true co-ordination cannot be brought about. As far as the cartage of freight and passengers to and from railway stations is concerned, the motor vehicle would not be antagonistic to the railways, but would represent truly co-ordinated rail and highway service, but to produce such service the railways would have to enter the general field.

The venturing of the railway into general highway trucking for purposes of profit cannot be predicated on a desire to regain lost traffic. In entering the trucking field, the railways would be competing with themselves and would also be in competition with all independents, and any probable profits would have to be so generously discounted, that it is exceedingly doubtful if any inducement, short of complete monopoly, could be offered to the railways to enter this field.

A paper of this kind would not be complete without some reference to the "container" as an instrument of co-ordination. There is nothing mysterious about a container. It is only a portable steel box, capable of being loaded to and from railway cars, and having general dimensions of 6 by 7 by 9 feet—a cubic content of 578 cubic feet. The container does not possess any motive power of its own, and is dependent on known transportation media for movement. The use of containers reduces loss and damage claims, and undoubtedly freight can be shipped thereby with less expense for packing and crating than if moved by the regular rail method. The success of the container depends on the amount of traffic moving from point to point, and this means between shipper and consignee, in quantities from four to ten thousand pounds. Only one hundred and fifty shippers out of a total of eighteen thousand in New York availed themselves of container service, although container rates are considerably lower than rail rates. Consequently it might be inferred that the field for container operation in Canada is limited.

The final contact between the railways and highway transport is reflected in the general economic welfare of the country. The railways undoubtedly belong in their entirety to the productive economy of the nation. The motor vehicle and the highways are mixed in character, and belong largely to the class of non-essential, but very desirable, facilities and services, the burden of which must be borne by the productive economy of the nation, aided by the net value of such tourist traffic as may have been stimulated by them.

It will be interesting to develop briefly the situation which has arisen in Canada as the result of the development to date of the highway and motor vehicle. In the first place, the investment in highways exceeds $900,000,000, and the investment in motor vehicles $1,250,000,000, so that the investment of the people in Canada in highway and motor vehicle transport comes within a measurable distance of the total investment in railway facilities. A distinction must be made at this point between investment and debt. The figures cited above relate to investment; the source of the money is largely unknown. It is invested in 196,000 miles of improved roads, 237,000 miles of roads classified as passable earth and in 1,258,000 motor vehicles.

Already the play of these forces has led to a realization that taxes for highway purposes must be substantially increased and the expediency of having sufficient funds to meet increase in expenses, without raising general taxation, necessitated the placing of special taxes on the owners of motor vehicles. For record, identification, safety and regulation, it is very necessary that all motor vehicles be registered, but in the beginning it was not intended that the registration fees should be a source of any considerable revenues. With the phenomenal increase in motor vehicle registration, the fees yielded more and more revenue, until in Canada in 1929 over twenty-two and a half million dollars were received from this source (an average per vehicle of $18.82).

Increasing revenues from registration fees did not yield revenues sufficiently large to meet the rapidly rising highway expenditures, and the fact that motor vehicles used gasoline for propulsion was capitalized. The simplicity of the tax on gasoline and its ease of collection appealed to the various governments, and, as their needs for funds became greater, the tax on gasoline was increased. For some time a tax of five cents appeared to be the upper limit for such a tax, but, recently, three states in the United States raised this tax to six cents, and still more recently one state imposed a tax of seven cents on gasoline for highway purposes. (It must be borne in mind that this tax of seven cents per gallon is based on a United States gallon, and on a volume basis would amount to 8.4 cents per imperial gallon, the Canadian unit of measure.) During 1930, $22,655,225 was collected in Canada through the medium of the gasoline tax—an average of $18.27 per registered motor vehicle.

Registration fees and gasoline taxes are not assessed on any apparently equitable basis. The registration fee, for instance, is, in North America, assessed on a variety of bases, such as horsepower, piston displacement, value, tire equipment, gross weight, net weight, chassis weight, etc. and the gasoline tax varies between two cents and seven cents per United States gallon. Fundamentally, equity in the distribution of a tax demands a causal connection between use, potential or actual, and the tax levy. There does not appear to be any rational measure of potential use, and therefore taxation based on potential use, if assessed at all, must be on an arbitrary basis. Taxation for actual use involves consideration of weight, distance, speed and commercialization. It is quite apparent, therefore, that the equitable division of motor taxation is a complicated matter involving to a considerable degree arbitrary apportionments, and the most that can be said of it at this time is that the combination of a graduated registration or license fee, together with a gasoline tax, furnishes a method sufficiently flexible to permit of a reasonably equitable assessment. The total amount to be raised by taxation is readily determinable; the difficulty in equitable assessment lies in the apportionment between the gasoline tax and the registration fee and the graduation of the latter as between different types of vehicles.

The true cost of our highways is $146,000,000 per annum, if we do not carry out any further improvements. The difference between direct motor vehicle taxation and true highway costs was in excess of $100,000,000 in 1930, and this difference is rapidly becoming larger. If highway vehicles are to bear the total cost of the highways, which have been improved for their use, motor vehicle taxes would have to be increased two hundred and forty per cent. In other words, the average registration fee per registered vehicle in Canada would be increased from $18.82 to $64.00, while the tax on gasoline would be 15 cents per gallon. In an economic sense the failure to assess these taxes against the motor vehicle simply means that the burden has been transferred to the general tax levy either past or future.

The annual economic burden laid upon the country by reason of the investment in and use of these facilities amounts to the amazing total of $946,000,000 per year—almost twice the total economic cost of our railway service. Not all of this $946,000,000 represents cash outlay; some of it represents foregone interest upon roads built out of surplus; some of it represents accruals of maintenance and depreciation laid up against the future; but it is none the less true that the economic burden approximates that figure. This may be regarded, not as a terrible thing, but as an evidence of the abounding wealth of Canada, and her ability to maintain a high standard of living among her people. However, it does serve to throw into proper perspective the magnitude of the economic forces called into play by the motor vehicle, and the ease with which these forces may be subverted and directed to uneconomic ends, with possible serious national results.

In conclusion, this can be said. In the past we have committed many economic blunders, the cost of which was not brought home to us on account of the ever-growing wealth of Canada, arising from the exploitation of her natural resources at an unprecedented rate. Perhaps we have been over prodigal. The present depression has served to bring forcibly to attention our national burdens. The motor vehicle has a vast potential field of economic usefulness, to which it should be confined, in the general interests, as the continuance of economic waste of such a vital force as transportation can but lead to increasing transportation costs of our basic commodities, with possibly disastrous results.

Appended hereto is a series of statistical tables relating to the subject matter of the paper.

TABLE I

Investment in Transportation Services in Canada

	Road	Equipment	Total
A. Highways and Motor Vehicles:			
Motor Trucks...	——	$ 400,000,000	——
Motor Busses...	——	20,000,000	——
Private Autos, etc..........	——	830,000,000	——
Total.......	$ 900,000,000	$1,250,000,000	$2,150,000,000
B. Steam Railways..	2,525,000,000	628,000,000	3,153,000,000
C. Electric Railways.	——	——	240,000,000
Grand Total....			$5,543,000,000

TABLE II

Cost of Operating an Average Automobile on Various Types of Road (University of Iowa)

	Cost in Cents per Mile	Relative Cost
High Type Roads........................ (Pavements of all kinds in average condition)	5.44	1.00
Intermediate Types..................... (Gravel, macadam and bituminous treated surfaces)	6.43	1.18
Low Types.............................. (Natural soil roads and light gravel or sandclay surfaces)	7.50	1.38

TABLE III

Annual Cost of Highway and Motor Vehicle Transportation in Canada—1930

	Highways	Autos	Trucks	Busses	Others	Total
Financial Charges:—						
Interest at 5 per cent.........	$45,000,000	$41,500,000	$20,000,000	$ 800,000	$ 600,000	$107,900,000
Depreciation................	21,300,000	114,900,000	28,900,000	1,600,000	2,200,000	168,900,000
Totals..................	66,300,000	156,400,000	48,900,000	2,400,000	2,800,000	276,800,000
Cost of Repairs:—						
*Maintenance................	*36,900,000	——	——	——	——	36,900,000
Engine and body repairs.....	——	114,900,000	40,500,000	1,900,000	1,140,000	158,440,000
Totals....................	36,900,000	114,900,000	40,500,000	1,900,000	1,140,000	195,340,000
Cost of Operation:						
Gasoline (Tax incl.) 25 cents..	——	90,000,000	29,000,000	1,400,000	2,000,000	122,400,000
Lubricants ($1.00)...........	——	11,500,000	3,800,000	200,000	160,000	15,660,000
Tires ¾ cent................	——	57,600,000	17,400,000	400,000	1,000,000	76,400,000
Garage......................	——	30,000,000	10,000,000	450,000	500,000	40,950,000
Drivers.....................	——	60,000,000	120,000,000	4,100,000	10,000,000	194,100,000
Incidentals.................	——	3,000,000	500,000	100,000	100,000	3,700,000
Taxes—Reg. Fees...........	——	14,600,000	5,000,000	450,000	30,000	20,080,000
Special..............	——	——	50,000	180,000	50,000	280,000
Totals....................	——	266,700,000	185,750,000	7,280,000	13,840,000	473,570,000
Grand Totals..............	$103,200,000	$538,000,000	$275,150,000	$11,580,000	$17,780,000	$945,710,000

*Direct Motor Vehicle Taxes deducted from this amount.

TABLE IV

Comparative Pertinent Statistics of the Three Land Transportation Agencies—Steam Railways, Electric Railways and Highways and Motor Vehicles

	1929			1930
	Steam Railways	Electric Railways	Total Railways	Highways and Motor Vehicles
Investment in Road (millions)....................	$2,525	——	——	$900*
Investment in Equipt. (millions)	$628	——	——	$1,258*
Total (millions).........................	$3,153	$240	$3,393	$2,158*
Investment per capita....................	$315	$24	$339	$216
Road mileage (miles)............................	41,409	2,202	43,611	196,000 (imp. highways)
Persons per mile.................................	246	4,677	236	53
Employees (No.).................................	187,846	18,801	206,647	230,000*
Salaries and wages (millions).......................	$291	$27	$318	$240
Locomotives (number)...........................	5,531	75	5,606	——
Passenger equipt. (cars)...........................	7,250	4,667	11,917	1,066,575
Freight equipt. (cars)...........................	217,756	572	218,328	165,464 (trucks)
Capacity of freight equipt. (tons).................	8,309,991	14,872	8,324,863	413,660*
Passengers carried (millions)......................	39	833	872	——
Passenger miles (millions).........................	2,897	2,385*	5,282*	11,632*
Av. length pass. journey (miles)	74.2	2.8*	——	——
Av. rev. per pass................................	$2.06	6.1c	——	——
Av. rev. per pass. mile (cents).....................	2.77	2.13	——	——
Pass. service (pass. miles) per capita...............	290	238*	——	1,130*
Tons handled (millions)..........................	115	4	119	——
Rev. ton-miles (millions).........................	35,025	26*	35,051*	2,900*
Av. haul per ton (miles).........................	304	7	——	——
Av. rev. per ton................................	$3.34	——	——	——
Av. rev. per ton-mile (cents)......................	1.099	——	——	——
Freight service (rev. ton-miles) per capita..........	3,400	——	——	282
Annual economic cost (millions)....................	$541	$46	$587	$946

*Estimated.

Note:—1929 Railway Statistics are used as representing more nearly normal conditions than 1930.

TABLE V

Registration of Motor Vehicles, Canada—1920-1930

Year	Passenger Cars	Commercial Vehicles	Busses	Others	Total	Per cent Increase
1920......	—	—	—	—	407,064	—
1921......	422,872	32,889	—	9,617	465,378	14
1922......	462,275	37,610	—	13,936	513,821	11
1923......	515,178	56,219	—	15,453	586,850	11
1924......	573,975	65,327	—	12,819	652,121	11
1925......	639,695	76,267	—	12,043	728,005	11
1926......	728,067	87,437	843	20,457	836,794	12
1927......	821,367	101,475	1,017	21,813	945,672	11
1928......	921,395	130,733	2,190	22,501	1,076,819	11
1929......	1,013,663	155,748	2,255	23,928	1,195,594	11
1930.... .	1,047,494	165,582	2,100	24,712	1,239,888	3.5

Commercial vehicles 1922—37,610.

Commercial vehicles 1930—165,582.

Average annual increase—19 per cent.

If this rate of increase is sustained for eleven years more, there will be as many commercial vehicles on the highways as there are passenger autos today.

TABLE VI

Expenditures on Highways in Canada

Year	Construction	Maintenance	Total	Revenue from Motor Vehicles
1927.........	$29,729,667	$16,024,217	$45,754,284	$24,533,992
1928.........	38,912,029	18,963,381	57,875,410	31,375,826
1929.........	55,173,160	21,109,686	76,282,846	41,272,277
1930.........	69,998,233	23,102,817	93,101,050	42,819,070

TABLE VII

Relative Importance of Railways and Motor Vehicles as Transportation Media

	Passenger miles	Per cent of total
In Passenger Service—1929		
Passenger miles by:—		
Steam railways..........	2,897,215,000	17
Electric railways*..........	2,384,680,000	14
	5,281,895,000	31
Busses*	132,000,000	1
Private automobiles*..........	11,500,000,000	68
Grand Total..........	16,913,895,000	
In Freight Service—1929	Revenue ton miles	
Revenue ton miles by:—		
Steam railways..........	35,025,895,000	92.1
Electric railways*..........	27,500,000	0.1
	35,053,395,000	92.2
"For Hire" trucks*..........	71,000,000	0.2
Other trucks*..........	2,900,000,000	7.6
Grand Total..........	38,021,395,000	

*Estimated.

TABLE VIII

Investments in Highways—Canada

1926..........................	$578,700,000
1927..........................	617,270,000
1928..........................	664,104,000
1929..........................	729,100,000
1930..........................	800,000,000
1931..........................	880,000,000 (*estimated*)

TABLE IX

Estimated Expenditures by Auto, Train and Boat Tourists

	Auto	Train	Boat	Total
United States Tourists in Canada:				
1920.........	—	—	—	$83,734,000
1921.........	—	—	—	86,394,000
1922.........	—	—	—	91,686,000
1923.........	—	—	—	130,977,000
1924.........	—	—	—	158,876,000
1925.........	—	—	—	177,882,000
1926.........	—	—	—	186,791,000
1927.........	134,426,000	—	—	215,763,000
1928.........	167,384,000	72,521,000	10,596,000	250,501,000
1929.........	215,577,000	79,759,000	10,685,000	306,021,000
1930.........	202,409,000	63,874,000	12,955,000	279,238,000
Canadian Tourists abroad:				
1924.........	—	—	—	73,873,000
1925.........	—	—	—	77,163,000
1926.........	—	—	—	90,693,000
1927.........	57,032,000	—	—	103,782,000
1928.........	59,785,000	24,633,000	18,827,000	103,245,000
1929.........	65,055,000	26,163,000	20,083,000	111,301,000
1930.........	63,489,000	24,266,000	25,537,000	113,292,000
Balance in favour of Canada:				
1924.........	—	—	—	85,003,000
1925.........	—	—	—	100,719,000
1926.........	—	—	—	96,098,000
1927.........	77,394,000	—	—	111,981,000
1928.........	107,599,000	55,126,000	*9,145,000*	147,256,000
1929.........	150,522,000	53,596,000	*9,398,000*	194,720,000
1930.........	138,920,000	39,608,000	*12,582,000*	165,946,000

Figures in italics are unfavourable.

TABLE X

Revenues from Motor Vehicles Taxation—Canada (Excl. Yukon)

Year	Registration fees	Gas Tax	Total
1922...............	$ 9,221,146	$ 185,118	$ 9,406,264
1923...............	11,146,229	280,404	11,426,633
1924...............	11,262,885	1,417,705	12,680,590
1925...............	13,439,055	4,068,157	17,507,212
1926...............	15,432,974	6,360,690	21,793,664
1927...............	16,570,647	7,963,348	24,533,992
1928...............	19,002,427	12,373,429	31,375,826
1929...............	22,511,734	18,760,543	41,272,277
1930...............	20,163,845	22,655,225	42,819,070

TABLE XI

Railway Traffic Statistics—Canada

Year	Passengers Carried			Freight Carried		
	Steam Railways	Avg. Journey (miles)	Electric Railways	Steam Railways (tons)	Avg. haul (miles)	Electric Railways (tons)
1924	42,921,800	66.9	726,497,729	91,599,639	333	2,546,928
1925	41,458,084	70.2	725,491,107	94,624,599	338	2,706,312
1926	42,686,166	70.3	748,710,836	105,221,906	325	3,493,457
1927	41,840,550	72.9	781,398,194	106,011,355	329	3,269,028
1928	40,592,792	77.4	808,023,615	118,652,969	351	3,892,114
1929	39,070,893	74.2	836,729,851	115,187,028	304	3,662,765

Highway-Railway Transportation

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Presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 5th, 1932

SUMMARY.—The author's principal topic is the extent to which provincial governments in their expenditure on highways are responsible for the competition now offered to the railways by the operation of busses and trucks running on the public highways. It is pointed out that a very large proportion of these vehicles circulate in cities and over secondary highways, and that their economic haul is comparatively short. He doubts whether this kind of traffic can ever be carried out by railways. The most serious competitor of the railways is the privately owned passenger car, which in Ontario furnishes nearly 90 per cent of the traffic on the public highways. The author is of opinion that highway construction by the Canadian provincial governments has not been on an extravagant scale and has been adequately financed. He believes that highway authorities can give but little assistance to the railways in their present difficulties, and the real problem in connection with freight traffic is due to the development of truck haulage.

In a paper outlining the highway viewpoint, so far as highway-railway transportation is concerned, it is desirable to present the situation as seen by the highway engineer.

The problems confronting engineers and those interested in transportation today are:

1. Are the bus and truck offering serious competition to railways in Canada?
2. If so, are the provinces who have jurisdiction over our highways unwittingly aiding subsidization of this operation to the disadvantage of the railways?
3. Is the present transportation problem confronting the railway with its parallel shrinkage in revenue directly chargeable to the provinces, or should the railway corporations share part of the blame?
4. What is the solution?

Our answer to the first question is generally "No." Traffic census taken in the province of Ontario for the last ten years indicate that the truck accounts for considerably under 10 per cent of our traffic and the bus not more than .66 per cent. Taken together until last year the combined transportation systems did not equal 10 per cent.

So far as the bus was concerned, investigations determined that the bus primarily served communities and areas that could not be reached by the railways in any case. It was a new form of transportation developed to a very considerable extent with a view to serving the citizen who would ordinarily have used his own car, but who found the bus gave him all the comforts of his own conveyance at considerably less cost. In Ontario 626 busses are registered as operating over our highways.

As to the truck, it is a competitor to railway transportation, but by no means to the extent the railways would ask us to believe. Ontario has 70,673 registered truck owners. Of this number, 3,900 are what are known as p.c.v. (public carrier vehicle) operators; that is, 95 per cent are privately owned or operated as part of the business of some concern, and 5 per cent p.c.v. operators.

Observation made recently over a period of six weeks, during which time every truck passing a given point on our highway was weighed, determined the fact that 69.22 per cent of the tonnage carried on the road was by p.c.v. trucks and 30.78 per cent by private owner. As approximately 95 per cent of the trucks registered were privately owned, it was concluded that of the 70,673 trucks noted above, by far the greater proportion of them were either remaining in the urban centres or operating over secondary highways.

Among the statement of Mr. Ferguson of the Canadian National Railways Bureau of Economics that a rough estimate placed the tonnage carried by what are known as the p.c.v. operator at 1,500,000, and knowing from investigations on the highways that the ratio between p.c.v. and privately owned trucks is approximately 70 to 30, this would mean that 650,000 tons would be carried by the private owner. While it is appreciated that a greater tonnage than this total is carried by the truck operators, the vast percentage of their business is within urban centres. It is estimated by railway men studying the freight movement in Canada that 0.3 per cent of the tonnage moved is handled by p.c.v. operators and 6.7. per cent is moved by all other trucks, including operation within urban centres. Referring again to our investigations, however, where it was found that the ratio in tonnage moved is as 70 to 30; that is, 70 tons to public vehicle carrier as compared to 30 tons to private owner, it was determined that of the 6.7 per cent, only .13 per cent passes over the highways. In other words, only .43 per cent of the freight moved in Canada is moved by truck—almost a negligible amount.

Another rather interesting fact determined from the traffic census was that the haul generally was short. This naturally applies more particularly to the private operator. This is forced home when it is remembered that in the operation of moving a commodity even a short distance it has to be handled at least ten times, if taken by rail, but only four times if moved by truck. No one could conceive of a merchant in the north part of the city of Toronto who had an order to deliver merchandise at Aurora, 22 miles north of the city limits, transporting his goods 7½ miles south to the railway freight sheds, attended with the necessary packing and crating as required, when he could load his packages on his own truck without any special boxing or wrapping and have them delivered to his customer at Aurora by the time he would have received his receipt for his goods at the railway freight sheds.

And so it follows, What is the economic limit of this class of haul? The truck transportation companies contend up to 100 or 150 miles, and even further with special types of vehicle. The author's opinion would be to place this limit on a single truck from 60 to 75 miles.

This "less than car load" business has been discussed with the railways at various times with a view to determining how seriously they were affected. Two opinions, both from the railwayman's point of view, will answer this question:

First: If the cost of highways assessable to commercial motor vehicles seems high, it should be remembered (on the other hand) that if these vehicles are permitted to move goods. at less than cost, taking from the railways their most remunerative traffic, the present low rail rates on long haul basic commodities will have to be increased.

And another view,—Whether certain short haul L.C.L. traffic is remunerative to the railways is a very debatable subject, only definitely determinable after careful study of all the contributing cost factors.

If the railways were to enter the truck field as it now applies, it is an open question as to the amount of business they would regain. In any case, one is forced to conclude that truck competition applies only where the distance is greater than 60 miles. For anything under this it is not clear how railways can assume that they are a competitor. Even were the provinces to increase rates several times what they are at present, the private truck would probably continue to function, the unfortunate consumer eventually paying the difference in cost.

With regard to the second question, "Are the provinces who have jurisdiction over our highways unwittingly aiding subsidization of this operation to the disadvantage of the railways," it should be noted that in the province of Ontario at the commencement of highway construction, local experience had to be taken as a guide. Few countries have our great variation in climatic conditions. From 85 degrees and possibly 100 degrees summer heat, to 30 degrees below zero in the winter is a common range in Canada. In addition, variation in subsoil conditions applies every few hundred feet—from heavy gumbo clay to the lightest of blow sands,—with the surface of the road subjected to freezing and thawing, drainage frequently inadequate and many other difficulties often facing the highway engineer.

Particularly where the highway is taking winter traffic, nothing but the heaviest type of pavement will stand. While it is contended that a 2-inch bituminous re-tread is sufficient to carry a very large percentage of our traffic, and while it will carry a fairly extensive traffic during the summer time, with the coming of wet weather in the fall and other varying conditions that apply throughout the winter, this type of surface would not last without the heaviest of maintenance. As a matter of fact, the author's experience has been that it is not economical, nor should it be constructed when the road is under traffic throughout the year.

The question has been raised as to what thickness of surface should be laid to give good riding qualities, to take care of the heaviest type of traffic, to resist climatic changes, and at the same time be economical in construction. Ontario experience has indicated that either a concrete or heavy type of asphalt road meets these requirements.

In the United States common practice has been to build concrete pavement 6 inches in thickness in the centre and 9 inches at the sides. Varying combinations of aggregates have been used, from 1:1½:3 mix to 1:2:4 mix, the pavement being designed to carry 9,000 pounds wheel load, or a maximum of 18,000 pounds to one axle. In the province of Ontario the thickness of this type of surface has been increased and pavement is now built which has 7 inches thickness at centre and 10 inches at the sides, our mix being 1:2:3.

The reason for this increase in thickness is largely due to experience with the Toronto-Hamilton highway, built as it was on the basis of the old design, 8 inches in the centre and 6 inches at the sides.

There should be hesitation in criticising the design of the Toronto-Hamilton highway, because of the fact that the road was built when traffic was extremely light and it was anticipated much of the load would follow along the centre instead of dividing into two distinct lines, as later occurred. With the increase in traffic and the development of the two-way road, the design was changed as mentioned above, with the consequence that excellent results have been secured.

Another feature that added to the improvement of the new type over the Toronto-Hamilton highway was that the changed design requires an expansion joint longitudinally in the pavement, forcing any crack to occur along the centre line. Heaving has rarely applied in this new design and it is believed that any thinner section than is being built at the present time would deteriorate eventually, owing to climatic conditions, if for no other reason.

An example of the destruction of a thin slab of concrete pavement was a pavement laid from Welland to Port Colborne. Built in 1915, with a thickness of 5 inches, under the careful supervision of Dominion government engineers, this pavement only lasted five years. Certainly no bus traffic ever passed over the road, and it is a question if the truck traffic is worthy of mention. The Toronto-Hamilton highway, built in 1916, has taken an annual traffic estimate at over 5,000 vehicles a day since it was opened, for many years taking over 50 per cent of the truck traffic passing over our rural roads, and until four years ago the maintenance cost on this particular road had averaged only $190 per mile. As a matter of fact, the major portion of the surface is as good today as it was the year it was completed.

If the Toronto-Hamilton highway can be accepted as an example of highway durability, the balance of the concrete surface recently laid, built to a much higher standard, should be expected to last for all time, if motor traffic might be accepted as the only destroying agent. Unfortunately, however, the main factor, climatic conditions, must be taken into consideration and eventually this most destructive agent will decide the life of our pavements.

Two examples of the effect of bad subgrade plus climatic conditions can be cited: first, a pavement laid in 1930 east of Brampton on Highway No. 7, showed last year definite signs of failure. A second example is an asphalt surface laid on Highway No. 3 east of the town of Blenheim. Within a year after this pavement was built many breaks had developed in the surface. In both these cases a two-course 6-inch asphaltic top had been laid on an old prepared gravel surface. The underlying subgrade, however, was a heavy non-porous clay. In both instances, bad subgrade, combined with climatic conditions, caused the road to fail.

The author believes that motorists should contribute approximately 66 per cent of the cost of the highways, but this should only apply in areas where they are a factor. It is hardly fair or reasonable to expect that large contributions should be made by motorists to the development of colonization roads over which little or no traffic passes and seldom a motor car. In Ontario alone on this class of road in the last ten years $20,000,000 has been expended.

Similar data as regards other provinces are not at hand, but it seems fair to assume that they are spending in proportion to Ontario. On this basis the total expenditure in Canada in the last ten years would be approximately $45,000,000. Money used in the construction of this type of road has generally been obtained by borrowing. This is the practice in the province of Ontario at least. A sinking fund sufficient to retire the bond issue so far as highways are concerned has been provided, duration forty years. While generally this period exceeds the life of the ordinary pavement, most of our indebtedness covers permanent works, such as grading, culverts and bridges, drainage, right-of-way, and many other expenditures of a like nature, made in the early days of our development.

Ontario and its municipalities (outside of separated towns and cities) have expended since 1903 the sum of $286,000,000. In revenue the sum of $145,042,843.86 has been received leaving a balance of $140,957,156.14. When one remembers that not until 1926 did the motor car become a factor as a revenue producer, it would appear so far as Ontario is concerned that they are approaching a position where they are meeting any fair demand that can be made upon them.

Last year (1931) in the organized part of the province of Ontario, $22,854,132.26 was expended. Toward this amount the province contributed $14,262,751.20 or 64.1 per cent, the balance being paid by municipalities. The total revenue during 1931 from motor car registration license fees and gasoline tax amounted to $16,745,952. In other words, the amount returnable because of the motor car exceeded expenditure so far as the province is concerned by $2,483,200.80. True, these figures take no consideration of the provincial debt on highways, now amounting to $113,000,000, but should the motorist eventually return this money? Certainly his payment of $2,483,200.80 during 1931 is going a long way toward paying the interest at least.

A common complaint of the railway is to the effect that they are obliged to subsidize highway construction by maintaining low rates on road building materials. It is only fair that the policy applied in Ontario be explained. Generally, the greater part of our highway mileage could be built without moving more than 5 per cent of the aggregate so far as asphalt roads are concerned, and not more than 25 per cent on concrete surfaces. In effect, we can produce in practically every case, at considerable saving, everything but the asphalt and cement at the job. The question may be asked, why ship aggregates in any case? The answer is this. Ontario has a number of commercial quarries engaged in the production of stone and in addition there are many gravel and sand deposits all efficiently equipped to produce road materials in large quantities. Large sums have been expended in machinery and equipment, the continual operation of which is vital to the community. These stone or gravel producers are given business whenever possible. In the first place, it helps the community, and in the second, the railway gets the freight. As long as costs are not entirely out of proportion, this practice is followed.

There is also another contentious point between railway and highway authorities, and that is grade crossing elimination. In Ontario since 1921 this class of work has received fairly serious consideration. Altogether fifty-five crossings have been removed, the cost of which has been divided as follows:

Contributed by cities and towns	$ 24,044.86
" by railroads	421,303.15
" through grade crossing fund	564,339.67
" by Department of Highways	2,014,810.68
	$3,024,498.36

The above expenditures apply only to main highways in rural Ontario.

In the above figures no account has been taken of the development in the unorganized sections of the provinces, although the Department's activities in northern Ontario have been considerable. The railways, however, have included these unorganized sections in their presentation. During the winter of 1931-32, between $10,000,000 and $12,000,000 will be expended in this section, almost entirely for the purpose of relieving the unemployment situation. Other provinces are spending along the same lines in like proportion. Can these expenditures be fairly charged to the motorist? The building of the trans-Canada highway is a national undertaking. True, it is being subsidized to the extent of 50 per cent by the Federal government, but this assistance is of very little significance as compared with the tremendous sums voted by the Dominion government toward the building of three parallel railway lines across this continent. Certainly the motorist has only a minor interest in a trans-Canada highway and from the truck or bus operator's viewpoint, it is a question if they have any interest whatever.

Ontario does not feel that it is subsidizing the bus or truck. Gradually as the control of this latter class of transportation improves, rates will be adjusted to permit of an adequate distribution of cost, when the conveniences and advantages enjoyed by transportation companies must be considered to permit of an equitable distribution of fees.

It will possibly be of interest here to note the suggested schedule of fees prepared by the railways:

Gross weight		
2 tons	$ 2.00	Private passenger automobiles
3 "	20.00	1-1½ ton trucks and heavier automobiles
4 "	51.00	2 ton trucks
5 "	95.00	2½ " "
6 "	151.00	3 " "
7 "	220.00	3½ " "
8 "	301.00	4 " "
9 "	395.00	4½ " "
10 "	502.00	5 " "

Were these rates put into effect in Ontario, on our present registration, the revenue would drop to $4,491,012, a loss of about $250,000 when compared with the present revenue.

It would seem that the above schedule was prepared especially to catch the eye of the passenger car owner,—a matter of turning the other cheek, as it were—because the ordinary passenger car must be conceded to be the greatest competitor of the railway and the most definite contributing factor to their decreased revenue.

The Railway Committee asked to study highway competition estimated as follows, for the year 1929:

Passenger automobiles	11,500,000,000 pass. miles	= 78.5%
Steam railways	2,900,000,000 " "	= 19.8%
Busses	250,000,000 " "	= 1.7%

While there is no doubt that the motor car has stimulated travel from one state or province to another, there is also the positive fact that this type of traffic was a monopoly in the hands of the railways in the not too distant past.

The ordinary passenger car, it is safe to assume, travels in the neighbourhood of 5,000 miles per year. At $2.00 per year an average of .04 cents per mile for registration fee would apply. In addition, the gasoline tax, based on an average of 15 miles to the gallon at 6 cents would mean .04 cents per mile, or a total government tax of .44 cents per mile—a figure considerably lower than ever could be expected to apply and entirely out of all proportion to the advantages received.

Ontario has a registration in passenger cars of 491,918, estimated to affect about 1,500,000 people. Their field of operation is very much broader than the truck or bus, touching almost every mile of highway. Lowering the fees on passenger cars would therefore encourage greater demands from this class of operator. So that, by paying little or nothing toward the highway development, they would have everything to gain by increased expenditure.

Keeping in mind that our traffic census shows that more than 90 per cent of the cars on our roads are passenger cars, it might be argued by the truck and bus operator that they should pay in proportion to their density, or according to the space actually occupied on the road surface. Accepting this argument and allowing that the passenger car occupies an average area of 78 square feet and a truck 175 square feet, based on the traffic census, passenger cars should pay 75.08 per cent of the cost of our roads, 24.92 per cent being charged to trucks. On our present schedule of fees, passenger cars in Ontario, it is estimated, will provide 59.00 per cent of the revenue we receive, 16.08 per cent less than they should pay, accepting space on the highway as a factor.

The committee appointed to investigate highway and railway transportation states, "It will thus be seen that the bus is almost negligible in the passenger transportation field in Canada, and that the increased use of private automobiles must be the major factor influencing declining railroad passenger revenue."

Every Canadian citizen desires to know the truth. It may not be very palatable, but at least he is in a position where he cannot say "He did not know." If the highway development in this country has placed a financial burden upon him, he should be relieved. From the railway viewpoint, that is the case. The Bureau of Economics of the Canadian National Railways estimates the value of our highways at $900,000,000. The estimate of the Ontario Department of Highways would place the value at not over $750,000,000, based on the expenditure of Ontario in the organized area, as mentioned before, of $286,000,000, Ontario being the worst offender and spending nearly as much, it is understood, as the other provinces combined.

The total length of road in Canada is placed at approximately 350,000 miles. Of this, 154,000 miles are unimproved and have no value. We therefore have 196,000 miles of improved road. It is fair to assume that an average of at least $3,000 per mile would have been expended by the provinces in the regular course of their development, regardless of motor traffic, or a total of $588,000,000 would have been spent. We should go a step further, and assume that the building of this early mileage was almost exclusively for the purpose of permitting the shipper to transport his commodity to the railway sidings. The building of this early mileage, now so bitterly criticized, was essential to the very existence of the railways. The development of communities, whether village, town or city, all came as a matter of course. Is it not fair to take the stand that this expenditure was nothing more than an additional government subsidy to the many others the railways had already received?

If Canada's road mileage has cost $900,000,000, as stated by the Bureau of Economics, Canadian National Railways, $312,000,000 might then be accepted as the cost of additional development attributable to the motor car.

During 1930, the provinces expended about $23,000,000 on highway maintenance, and $70,000,000 on construction. Here again we are confronted with the fact that of this $70,000,000 at least $5,000,000 was expended on colonization roads, over which few motorists will pass for many years.

A summary of the situation above gives the following:

$312,000,000 at 5 per cent	$15,600,000
Maintenance, 1930	23,000,000
Depreciation, 3 per cent	9,360,000
	$47,960,000

During 1930, as stated before, $70,000,000 was spent as a capital expenditure. It is common practice to allow that 8 per cent would retire this expenditure in twenty years, or a further levy of $5,600,000 would apply in 1931. During 1930, by way of revenue, the provinces collected approximately $43,000,000.

Allusion has been made by various railway officials to our hectic highway programmes, to our extravagant development, our unsound financing systems, to our subsidization of the motor car to the disadvantage of the railway, and many others of a like nature. It is difficult to comment on utterances of this kind. but they are being made publicly, even in an engineering meeting some reply may be permitted. A suggestion has been made by prominent railway officials to the effect that "The education of the public can be directed through the newspapers and addresses to public spirited bodies. To date the railways have only furnished speakers to such bodies on request. They should now not only supply speakers, but also solicit opportunities for laying the highway situation before the public." In almost the same breath these same officials recommend that the closest possible contact be maintained with government departments, so that the railways may be in a position to co-operate in their endeavours to solve highway problems. It is regretted that the author's official position does not permit him to discuss such an attitude, but it is difficult to see how the co-operation so very much desired can be attained with such a spirit predominating.

Engineers with a knowledge of highway building will, it is believed, accept the statement that the construction of highways in Canada has not proceeded on an extravagant scale, and further that the work has been done at a minimum of cost. Certainly prices have been lower the last few years than have applied for many years. If for no other reason, unemployment relief, plus these extremely low prices, justified going ahead.

As to the subsidization of the railway competitor, anything the provinces have expended is of little or no significance when we remember the vast sums of money, lands and guarantees turned over to the railways by the municipalities, the provinces and the Dominion government.

Much has been said as to the investment of the motoring public, the cost of their cars, cost of repairs, garage rentals, etc. Surely expenditure of this kind has no definite bearing on this discussion from the public point of view. It is a man's own concern whether he owns a motor car or not. One might criticize quite as positively the man who owns a radio, for over $110,000,000 has been expended on radio equipment by Canadians in the last four years.

Provincial development, so far as highways are concerned, is fairly recent. While many miles of gravel and earth roads had been built prior to the war, the type of traffic with which the engineer had to contend did not encourage the development of hard surfaced roads. As a matter of interest, it is estimated that up to 1924, 1,000 miles would have covered all the surface laid in Canada. Provincial governments have to deal with many features in our highway activities, bus regulations, truck regulations, legislation governing motor vehicles generally, highway construction, highway financing, policing and many other problems of a like nature. Gradually, no doubt, solutions will be found, but one must creep before one walks, and so changes will apply in performance of our work as conditions arise. It is unfortunate that regulations within the various provinces differ so far as motor vehicles are concerned and it is sincerely hoped that the time is not far distant when far greater uniformity can be expected. Canada should have less difficulty than applies in the United States because of fewer provinces to deal with the matter. Bus regulations are improving and even now it is conceded that little more can be expected from them.

The truck is the real problem. Since it became a factor, amended legislation has been presented to the various governments each year, looking to improvement. Gradually regulations, fees, etc. will be applied which will make this class of vehicle return a revenue commensurable to the advantages it enjoys.

What is the solution? Highway expenditures will be curtailed, no doubt, but will this bring added revenue to the railways? Will the 4,000,000 or more United States motorists leave their motor cars at home and come to Canada by train? It is estimated that this motor tourist business brought to Canada in 1930 over $215,000,000, a very substantial sum, and each year this third most important development in Canada has shown an increase, with the possible exception of 1931, on which figures have not yet been returned. The tourist business is of vital importance and should be encouraged to the limit of our resources.

Can we assist the railways? Very little, it is to be feared. Possibly increased rates on public carrier vehicles operating beyond the 60 mile limit might return to the railways a small revenue. Apart from this, it seems doubtful whether we can be of much assistance. Increased rates on private truck owners would simply increase the price of the commodity to the customer. Legislation tending to affect the bus will only raise the price of the passenger's ticket. The people of this country are satisfied with this new form of transportation. It is meeting wholehearted support and any legislation tending to deprive them of this convenience of operating on rubber will not be received very kindly.

In closing, it is perhaps permissible to suggest to the railways one more survey of possible truck and bus cooperation. After all, highways are as vital to the national development of Canada as the railways, and it would be extremely unfortunate if officials on both sides could not find some common ground for co-ordination. Practical men, willing to take a broad view, are plentiful enough. It just requires that they put their shoulders to the wheel and start it going.

Statistics of Bus and Truck Registration and Operation in Relation to their Use of Highways in the Province of Ontario

The presentation of the following charts is intended to convey facts which have been taken from departmental records, and have a bearing on the subject of the use of the highways made by the motor bus and truck.

Fig. 1 is a percentage distribution of King's Highway, county and other roads over which there is bus service

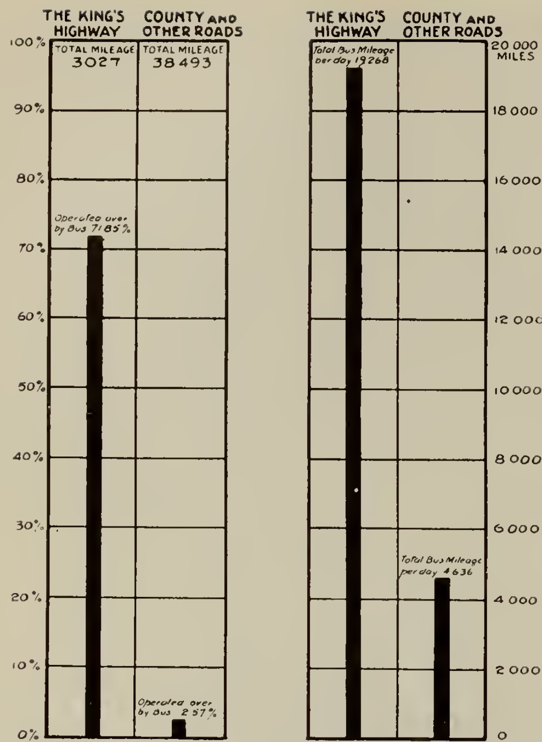

Fig. 1—Percentage Distribution of Bus Routes on the Highways and Total Daily Mileage Operated.

established and also shows the total daily travel by these vehicles. It will be noticed that the percentage of King's Highway over which there is no bus operation is 28.15 per
highway over which there is no bus operation is 28.15 per
cent while over county and other roads the percentage of highway used by these vehicles is only 2.57 per cent of the total mileage.

The department has, for some years, conducted a traffic survey at strategic points on the highways in order

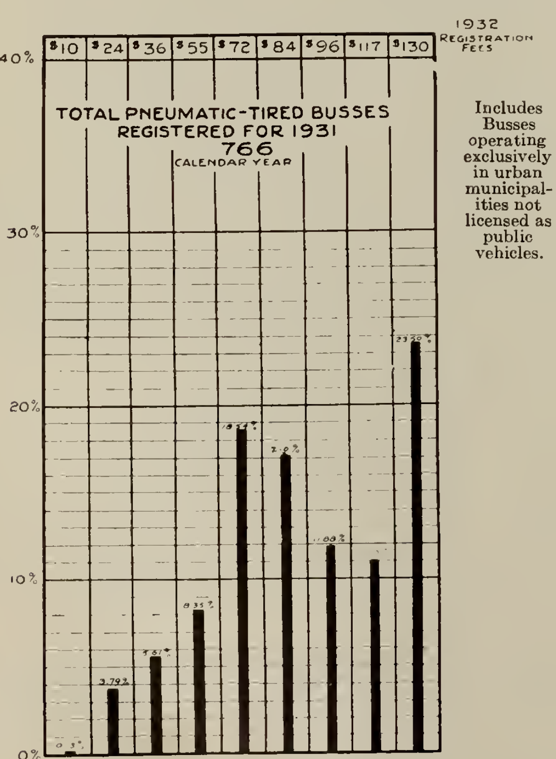

Fig. 2—Percentage Distribution of Pneumatic-Tired Busses by Gross Weight.

to obtain definite details of the class of vehicles using our highways and the density of traffic at these points. This survey discloses that bus traffic is only .66 per cent of the total motor vehicle traffic moving over our highways.

There are 489,713 private cars registered in this province as against 766 buses. One hundred and thirty-nine of the latter are operated exclusively in urban municipalities, which leaves only a total of 629 buses operating

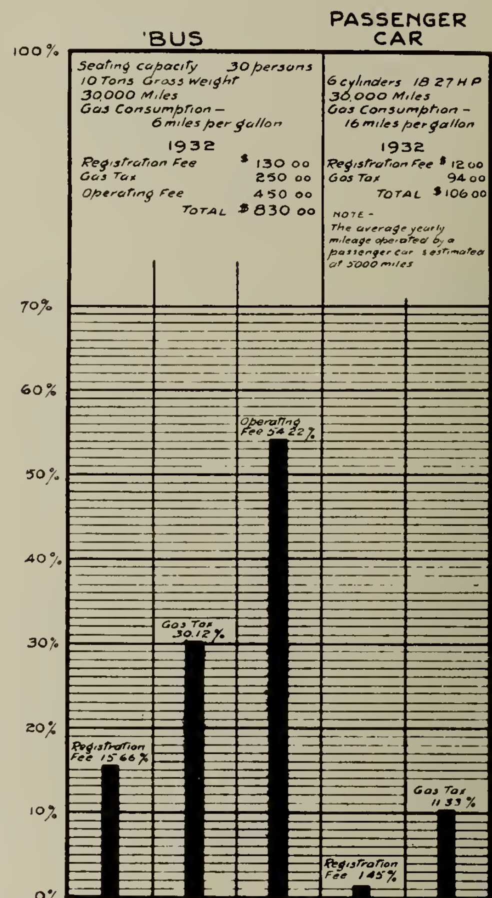

Fig. 3—Percentage Distribution of Fees and Taxes Paid on a Bus Operating on the King's Highways as compared with a Private Passenger Car.

between fixed termini over our highways, or a percentage of .13 of all passenger vehicles. Of this small percentage there is only one point where there is any inter-provincial travel, and this at the height of the summer season does not exceed six trips per day.

The Highway Traffic Act of this province does not permit a four-wheel vehicle with a greater gross weight than ten tons. Fig. 2 shows the various weights of buses registered and operated together with the registration fee for each class of vehicle.

Fig. 3 indicates the total fees and approximate taxes which are paid annually to the province for a thirty-passenger capacity bus weighing ten tons gross, and operating 30,000 miles, with a gas consumption averaging six miles to the gallon. The cost of this tax at 5 cents per gallon is $250.00 or 30.12 per cent of the total cost, while the operating fee prescribed under the Regulations of the Public Vehicle Act of one-twentieth of a cent per potential passenger mile of travel, is $450.00 or 54.22 per cent of the total cost of $830.00.

The relative fees and tax paid for the operation of the 6-cylinder car covering 30,000 miles is given for the purpose of comparison, and discloses that the bus pays upon the basis of mileage travelled, nearly eight times as much as the privately owned car. The basis on which the fee is com-

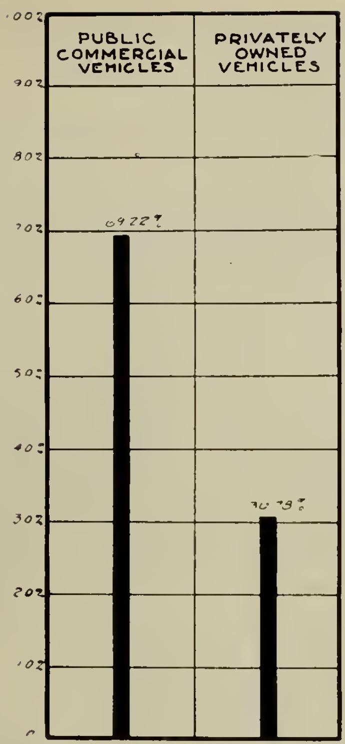

Fig. 4—Percentage Distribution of Tonnage Conveyed over the King's Highway on Owners Vehicles compared with those Licensed as Public Commercial Vehicles.

puted for bus operation is provided in Paragraphs 7 and 8 of the Regulations passed pursuant to the Public Vehicle Act, the mileage operated by each licensed bus being declared on the schedule filed by the licensee and approved by the Department. As before stated this fee is based on the potential passengers carried. For instance, a thirty-passenger bus operating a scheduled trip with one passenger or none is required to pay the same fee as if it carried its full complement of passengers.

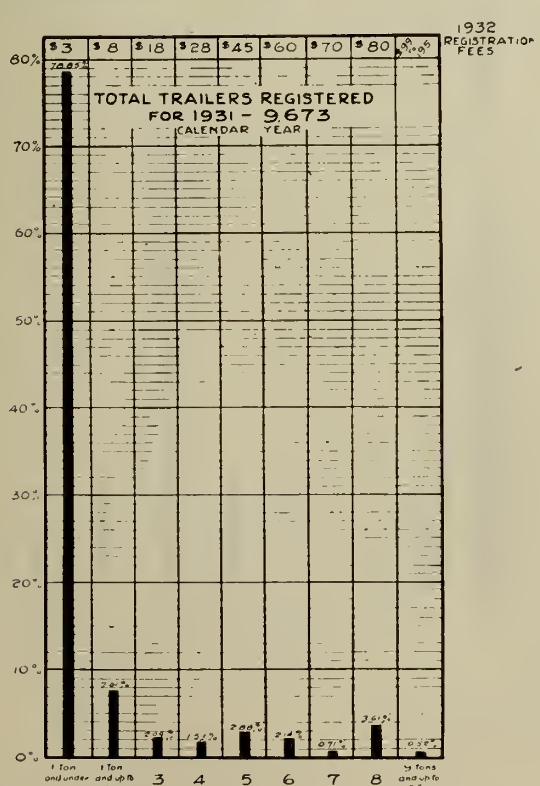

Fig. 5—Percentage Distribution of Trailers by Gross Weight.

The total of all trucks and trailers registered amount to 70,673. Of this number 94.48 per cent are privately owned and operated for the conveyance of the owner's goods or are trucks operated for hire exclusively in urban municipalities.

A traffic census taken by the Department over a number of years discloses the fact that of all motor vehicle traffic on the highways truck travel represents but 10 per cent of the total, and it is observed in respect of truck operation that vehicles licensed as common carriers are not confined to one trip where they are engaged in short hauls, but operate several times daily over the same route. This and the operation of privately owned trucks accounts for the high percentage shown in our census of trucks using the highway in comparison with the percentage of 5.52 shown

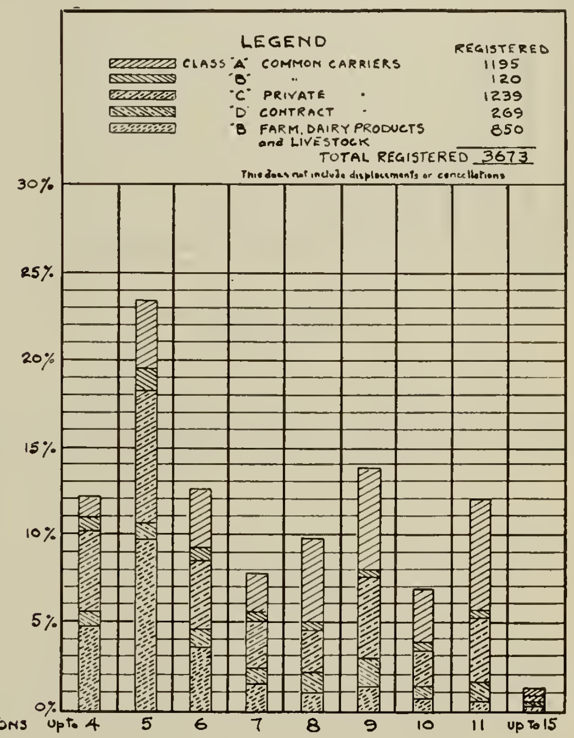

Fig. 6—Percentage Distribution of Trucks Operated as Public Commercial Vehicles by Gross Weight and Class.

as common carriers against total trucks registered. A comparison of tonnage carried by these two classes of vehicles is given in Fig. No. 4, 30.78 per cent being conveyed by the privately owned truck and 69.22 per cent by the licensed public commercial vehicle. These figures are the result of a survey in which the tonnage carried by every truck was recorded at the weight scale where check was in progress, which covered a twenty-four hour period daily at one of the following scales:

Eastview No. 17 Highway
Manotick No. 17 Highway
Britannia No. 16 Highway
West Hill No. 2 Highway
Long Branch No. 2 Highway

These scales were selected as points which would be indicative of light and heavy truck traffic. It was not the purpose to indicate the tonnage carried over all highways, but is believed to be a comparison of tonnage distributed between those vehicles engaged and licensed as public commercial vehicles and those owned privately conveying the owner's merchandise.

The proportion of tonnage carried by public commercial vehicles was found to be 69.22 per cent, as against 30.78 per cent conveyed by privately owned vehicles. The latter

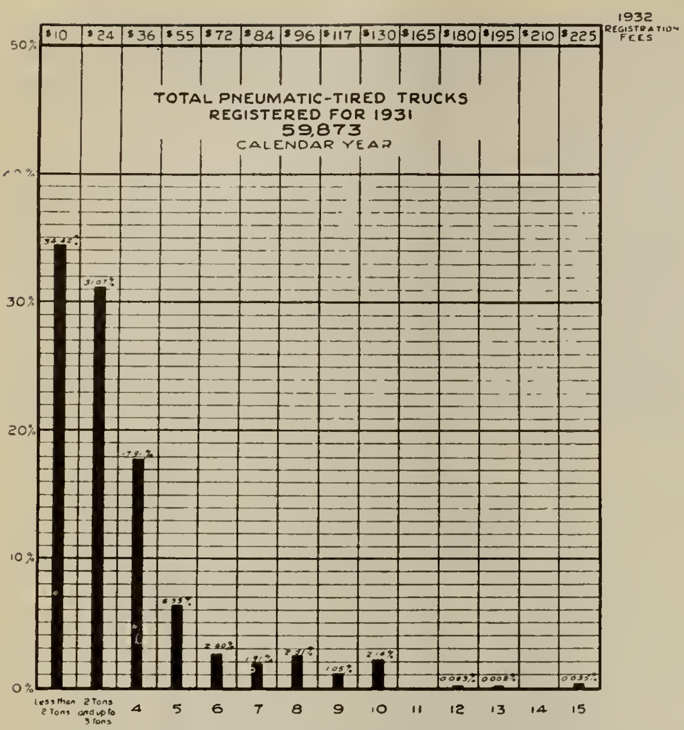

Fig. 7—Percentage Distribution of Pneumatic-Tired Trucks by Gross Weight.

figure may be compared with that of 5.52 per cent previously given as the proportion of common carrier trucks registered as compared with total truck registration. This indicates that the very large majority of trucks registered in this province confine their operations to the limits of one urban municipality.

Fig. 5 shows the gross weight of all trailers registered; nearly 79 per cent of which are of one ton gross weight or less; the total number being 9,673.

The registrations of the solid-tired truck, which is fast disappearing from our highways, show for 1925 a total of 5,690 vehicles of this class, but our 1931 registration shows a total of 1,127,25 per cent of which are in the 8-ton class.

Fig. 6 presents the percentage distribution of trucks licensed as common carriers by gross weight and class. These figures are inclusive of trailers, and the facts are disclosed that only 12.63 per cent of the total trucks licensed under the provisions of the Public Commercial Vehicle Act are above 10-ton gross weight, while nearly 36 per cent are 5 tons and under.

The total number of trucks registered in Ontario was 59,873, a number which is only 12.23 per cent of the total registration of 489,713 passenger cars. It is to be noted that of this small percentage the majority of trucks operate exclusively in urban municipalities.

Fig. 7 shows the percentage distribution of pneumatic-tired trucks.

	1931 Revenue from Motor Vehicles		1931 Registrations of Motor Vehicles	
Passenger Cars........	$3,066,140.00 —	52.90%	491,918 —	86.58%
Commercial Vehicles... other than	1,247,979.00 —	21.52%	71,834 —	12.64%
Public Commercial Vehicles				
Registration fees....	248,736.00 —	4.31%	3,673 —	0.64%
P.C.V. Act fees.....	23,748.00 —	.43%		
Public Vehicles				
Registration fees....	51,601.00 —	1.71%	768 —	0.14%
P.V. Act fees.......	99,322.00 —	0.89%		
Miscellaneous.........	1,057,761.00 —	18.24%		
	$5,795,307.00 —	100.00%	568,193 —	100.00%

Fig. 8 shows the total revenue collected by the Motor Vehicles Branch which includes all motor vehicle and other license fees, and also includes the revenue derived from the gasoline tax for the same period.

For the purpose of revenue distribution the figures used in Fig. 8 are for the fiscal year November 1st, 1930 to October 1931. In Figs. 1 to 7 registration figures for the calendar year have been used.

Under the title of miscellaneous are included fees for operators' and chauffeurs' licenses, for transfers, duplicate permits, garage licenses, motor cycle permits, in transit markers, and fines collected for conviction for offences under the Highway Traffic Act.

The registration of each class of vehicle is shown together with the percentage distribution of motor vehicle revenue, but this percentage does not include gasoline tax revenue which is dealt with separately. The gasoline tax amounting to $10,950,645.00 is distributed by an estimated percentage into three classes as follows: passenger cars, commercial vehicles (including public commercial vehicles and buses) and tourist's vehicles. In arriving at this percentage the following data collected in 1930 are used in the absence of other more accurate information:

American cars in Ontario for more than 24 hours.	700,000
American cars in Ontario for less than 24 hours...	3,400,000
From questionnaires returned the average of cars staying more than 24 hours travelled.......	704 miles
and stayed an average of..................	5.2 days
Net gasoline sales to vehicular traffic in 1930.....	222,066,711 gals.
Tax paid by:	
American cars staying for more than 24 hours and averaging 20 miles to the gallon.......	$ 1,210,085.00
Passenger cars registered in Ontario averaging 6,400 miles per year and averaging 20 miles to the gallon..............................	$ 7,799,103.00
Commercial vehicles registered in Ontario averaging 7,000 miles per year and averaging 12 miles to the gallon.....................	$ 1,941,457.00
Total gas tax for 1931................	$10,950,645.00

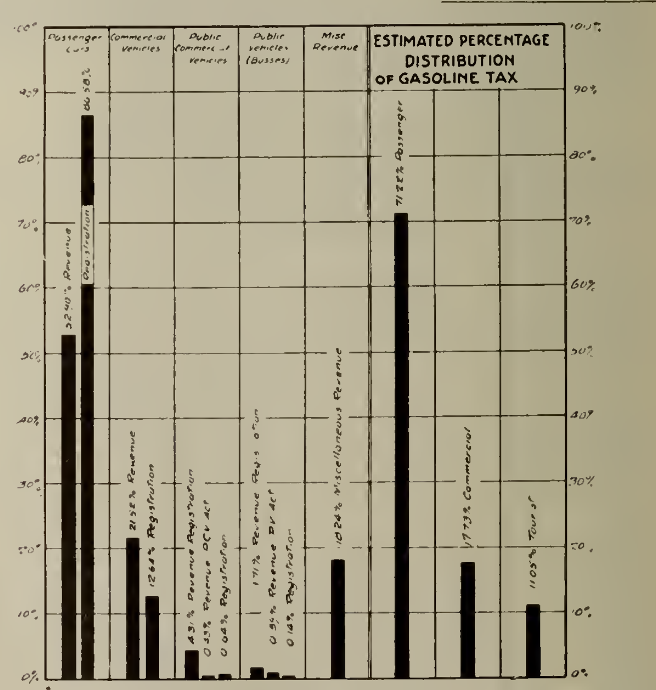

Fig. 8—Motor Vehicle Registrations and Revenue for 1931 Fiscal Year.

	Registration	Revenue
Passenger Cars................	491,918	$ 3,066,140
Commercial Vehicles...........	71,834	1,247,979
Public Commercial Vehicles..........	3,673	272,504
Public Vehicles (Busses)............	768	150,923
Miscellaneous................	..	1,057,761
	568,193	$ 5,795,307
Plus Gas Tax..................		10,950,645
		$16,745,952

Some Problems in Canadian Transportation

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, February 5th, 1932*

SUMMARY.—This address draws attention to the problem arising from the activity of motor carriers upon the highways and their competition with railways, pointing out the onerous conditions under which railway operation is conducted and the heavy contribution of the railways as regards taxation compared with the insignificant amount paid by motor trucks. The permanent welfare of the railways is considered essential for the transportation system of the country, and the author, after touching on the subject of government ownership of railways, suggests that all carriers on highways should be taxed sufficiently to cover the costs of highway construction and maintenance.

One of the most vital problems for Canada at the present time is that of transportation and, like agriculture, it is in dire straits. The roots of the present trouble began to show themselves many years before the existing period of depression; and, while a few voices were raised at certain courses which were then taken, and these few showed what would be the inevitable economic consequences of these courses, those who gave expression to words of economic wisdom and caution were regarded in the light of pessimists, when the gloom of war seemed to be exchanged for the brighter day.

However, it is not the past that is to be dealt with at this time. The present bulks so large that the past has almost faded into insignificance; and the present conditions are so vitally important, not merely because of the immediate financial conditions of the country as a whole and of the railways in particular, but also because of what the existing circumstances portend for the future.

Motor Carriers on the Highways

One of the most important problems in the field of transportation is as to what should be the relation of the railways and the motor carriers upon the highways. The development of highway transportation has been so rapid that it has amounted virtually to a revolution, with all the elements of instability and uncertainty which characterize such a change. Vast expenditures have been made on capital account in the construction of great trunk-line concrete roads and heavy additional expenditures have been incurred for the maintenance of such main channels of communication. These improved roads were made for the convenience of the public and were not intended to be the avenues of operation by motor vehicle carriers for private profit.

But, with business acumen, and seeing an opportunity of using the public highways for their own private profit, great numbers of operators have come upon these highways to engage in carrying freight and passengers. They have been permitted to operate without paying a reasonable compensation for the use of the roads and this has attracted into the business many of an adventurous and speculative turn, as well as some who sought a line of work which seemed to promise a reasonably good living with possibilities of future growth.

Referring only to motor truck operators—for of all highway carriers these are causing the greatest concern—we find three classes. The common carriers hold themselves out to carry all kinds of appropriate traffic for the public generally. The contract carrier is one who acts as the agent for the carriage of the goods of one or more companies but does not carry for the public in general. The private carrier is one who carries the goods of his own firm only. He constitutes merely a department of the firm and as long as the firm carries on its business, including its highway operations, in compliance with the law, it is not subject to any regulation or control by the government.

*Presented (in an extended form) before the Hamilton Branch of The Institute, December 3rd, 1931.

It is the common and the contract carriers which are engaging a great deal of attention, and it is these which come into intimate competition with the railways. Because the private carrier has no right to carry for others than its own firm, it is not vested with a public interest in the same way as the common or the contract carrier. Because of the competition of the latter types of carriers with the railways, which has now become acute, we must note some of the differences between the railway and the highway carrier.

1. The railway has provided at great cost its own right of way, with appurtenant stations, terminals and other structures; and the annual expense of maintenance of these involves the enormous sum of approximately one-sixth of the gross earnings. On the other hand, the highway carrier gets a free right of way provided out of the public taxes and does not have to spend anything for maintenance of that highway.

2. The railway has to pay annual interest on the cost of construction of its roadway; but the highway carrier gets the benefit of a free roadway constructed by public funds and has no liability for interest on the cost of construction.

3. The railways contribute heavily in the way of taxation but the motor trucks contribute but an insignificant amount in taxation. Fo example, the provincial revenue obtained through the distribution and operation of motor vehicles for the year 1928—the last year for which complete returns from all the provinces are available—shows that out of the total revenue of $31,551,349, passenger cars paid $14,472,620 and the gasoline tax was $12,547,073. Consequently, the remainder, $4,531,656, was the amount paid by trucks, motor cycles, dealers' licenses, garages, operators' and chauffeurs' permits, and fines; and it will be readily appreciated that of this latter amount the tax paid by trucks was small indeed. For the year 1928, in the province of Ontario, which had the largest total revenue from motor vehicles, only 14 per cent was contributed by the motor trucks.

It is evident that in the minds of many the gasoline tax, so-called, is regarded as a tax, and a very heavy one at that. It is utterly absurd for a business concern like a trucking company to think of this in terms of taxation. The fact is that for them it is not a tax at all, but an expense of doing business. The manufacturer might as well think of his coal bill, or his bill for electrical energy, as a tax.

4. The railways spend large amounts for improvements and additions to their property, and these great expenditures are a very substantial contribution to Canadian prosperity. The purchases of steel rails, of great numbers of freight and passenger cars, the construction of new and stronger bridges, the improvement of the roadway, and many other forms which these expenditures take, furnish abundant employment to Canadian rolling mills, car shops, bridge construction companies, and tens of thousands of workers in all lines. For example, in 1928, the Canadian railways spent for additions and betterments of their existing roads and equipment $47,699,981 and for new lines and equipment $30,843,793, or a total

of $78,543,774. In 1930, when railway revenues had reached a low ebb, the Canadian Pacific expended on railway improvements and expansion $14,867,689 and the Canadian National a little less than this amount. In the ten years 1920-1930, the Canadian Pacific made capital expenditures out of its revenues in excess of $386,000,000.

But in contrast to this, did anyone ever hear of motor trucking companies making analogous expenditures for the public welfare and for the future interest of their business? The fact is, that with all the assistance they have obtained from the government in release from taxation and without responsibility for any contribution toward the upkeep of their free highways, they are still in most cases financially unstable.

5. The railways, through their payment of taxes and their expenditures for the country's welfare, are helping to subsidize the motor carriers and furnish traffic for them. On the contrary, the motor carriers are skimming the cream from the railways' traffic and taking more and more of it, without giving anything in return.

Not to go further into this particular phase, it is very clear that the inequity of this competition should be brought to a close. The railways are recognized as the backbone and a good many of the other vital bones of the transportation system, and so far as human judgment can now discern they will always retain this essential relation. They are the most economical means of long-distance transportation and they are absolutely essential for mass transportation of the raw and many of the finished products of agriculture and industry. In view of their universally acknowledged permanent position, they have invested vast sums to assure to the public the utmost in the way of service for the future. These facilities may prove to be greatly in excess of the requirements of the traffic which would be left to them if the motor vehicles continue to make the inroads upon them which they have been making recently.

Conceding, then, that the railways are a permanent essential to the business and general public welfare, how is their continuance to be asured?

They must obtain traffic and revenue to meet all their responsibilities. If competing agencies abstract a substantial part of their traffic, the railways will have to earn enough on what is left to enable them to perform adequate and effective service. But, if the cream—the best-paying traffic—goes to the motor carriers, the railway rates would have to be increased on the remaining traffic; and both the railways and the public are anxious to avoid this.

What is the remedy? There are some who believe that if the motor carriers were taxed on a basis commensurate with the railways, so that the terms of competition would be fair and equal, the whole issue would solve itself by the survival of the most efficient and economical transport agency. But, in reality, both systems are desirable. Moreover, the diversity of taxation is only one element in the present chaotic condition.

There seems no way in which two things which are so essentially unlike as the railway and the motor truck could be equalized competitively by taxation. It is wholly impossible to tell how much tax should be charged against the motor truck in order to pay for its share of the cost and for the damage it does to the roads and for the repair and maintenance of these highways. The road is used for many widely different types of vehicle, and it is not hard to see, for example, that more injury might be done by a heavy load with horses and wagon than by a much heavier load on a motor truck equipped with balloon tires. Or, again, what is the relative injury done by two trucks of 10,000-pounds load, one equipped with pneumatic tires and the other with solid tires? It is impossible to ascertain this. It will not be surprising if in a short time a scheme of taxation is put forth based upon the weight carrying capacity and the speed of the motor vehicle. But such a system is absolutely devoid of any economic basis. The fact is that the road is being used by all classes and its use is so varied that no equitable basis of taxation could be devised which would be fair and reasonable to all. Of course, estimates could be given but these would be largely arbitrary.

There are many others who think that regulation is the solution of these ills; that since the railways are rigidly regulated the motor carriers also should be regulated. But these two types of carrier are essentially unlike, and there is no justification for saying that this course should be taken with the motor carrier because it has been taken with the railway. Of course, we will all admit that provision must be made for the safety of persons and property on the highways.

Some reasons may be stated as to why any regulation of motor carriers beyond this minimum would not succeed:

1. In the case of the railways we have dominion-wide operation and, therefore, only one regulative authority is required. But the motor carrier is authorized by his license to operate only in one province, and, therefore, there are as many jurisdictions having control over the motor carriers as there are provinces. In the case of motor carriers engaged in interprovincial business, e.g., between Toronto and Montreal, there would have to be some control by the Dominion or else the provinces concerned would have to come to some agreement by which a carrier licensed in one province would be allowed to operate over the roads of the other upon paying reasonable compensation therefor. In the case of a carrier operating between Ontario and Quebec points control would be exercised by two jurisdictions and according to two different legal codes.

2. If the motor carriers were to be subjected to effective regulation, it would require an army of men to attend to the multiplicity of the details. In addition to those now engaged in attending to the registration of motor vehicles and the collection of the dues for licenses, permits, etc., there would have to be highway officers on all the roads to see that the carriers did not transgress any of the regulations regarding speed, width of vehicle and load, length of vehicle or combination of vehicles, weight of load, proper equipment of lights, brakes, mirrors, noise mufflers, etc.

There are so many opportunities for transgression, wittingly or unwittingly, that if offences were treated as laid down in the law there would have to be such vast numbers of lawyers and magistrates employed, with all the other officials of the courts, that the regulative machinery would be encumbered with the mass of personal and material detail.

If anyone wishes to test these statements, let him turn to the Highway Traffic Act of Ontario and see the infinite aggregation of details which must be attended to by highway operators and the continuous enumeration of the "penalty" provided for breach of these endless sections and sub-sections of rules. It is frankly acknowledged by most of the state public service commissions of the United States that their state highway regulatory laws are not observed nor enforced. In many cases there is no disposition to enforce them because this could not be done. It is equally true in our own provinces; and the truth is not transcended when it is said that adequate provision for enforcing regulation would involve such a mass of machinery and officialdom and expense that it would break down utterly.

We are impressed by the recent report of the British Royal Commission on Transport, and anyone who knows the British regard for the observance of law will connect this with the fact that the Commission made no suggestion in favour of regulation of highway carriers, except for the safeguarding of life and property.

3. But even if regulation were to be instituted and a classification of traffic were to be worked out, with appropriate rates for each class of traffic, would this solve the problem?

The author is convinced that it would not. Would all the carriers live up to the requirements concerning rates and divide up the traffic among them, when one of them, by cutting the rate secretly the least shade, could be deluged with traffic? Or, on the other hand, when shippers are so keen to get the lowest possible rates and there are so many carriers bidding for their traffic, many of the shippers would give their traffic to those who would get down to the lowest rate. Thus there is pressure from the side of the shippers to induce the carriers to cut rates. In the face of these conditions, with many carriers seeking business and many shippers seeking the lowest rates, all the forces of economic life would be at work to nullify a system of regulation.

4. Again, suppose, for example, that the motor carriers between Toronto and Guelph were to agree upon a certain rate below the railway rate and the Ontario regulative authority were favourable to that rate. The normal outcome would be that the railways, in danger of losing all that traffic, would seek from the Board of Railway Commissioners of Canada authority to put into effect a lower competitive rate in order to hold a share of the traffic. The motor carriers would then push for still lower rates and the result would be the continuous seesawing of rates and the clashing of the jurisdictions of the Board of Railway Commissioners and the Ontario regulative authority.

If such regulation would be nugatory, should the railways hand over all the traffic to the motor trucks within a reasonable radius around the large central terminals and endeavour to keep the remainder of the traffic? This course would seem to be unwise, for two reasons: first, because a large share of its terminal expenses will go on whether it takes the traffic or allows it to go to the motor truck competitor and it is better to get something from this short-haul traffic than to get nothing; and, second, the tendency of the motor truck is to keep widening its range of operation, so that the railway would lose more and more.

Two suggestions are made as a solution of this problem. One is to put an end to the system of discrimination in rates which is now so prevalent among the motor carriers in their competitive struggle, by putting an end to the cause of this discrimination. This could be done by allowing only one or two strong companies to act as public carriers on the highway and having it or them under strict regulation as to all the essentials of rates and service. This would place the service upon a basis of stability and responsibility which is highly desirable. It would be an easy matter to police this system for there would be every reason then for the observance of the law.

The other suggestion seems preferable, namely, to have the railway companies carry on the operations on the highways and by the co-ordination of the two services to give the public the benefit of the most satisfactory rates and service obtainable. Since the shippers are furnishing the traffic, they have a right to say whether they want the faster door to door service of the motor truck or the slower and occasionally antiquated service of the railway. If the railway will undertake to give the improved service it can hold the traffic, but if it will not change its methods the traffic will inevitably go to the highway carrier which will give the service. There need be no mistake about this. It would take too long to indicate the details of this plan; but, in brief, the railway should constitute its own subsidiary to carry on the highway operation, or else should have a close working agreement with a strong company not under its ownership—preferably the former. Since the railway is subject to rigid regulation by the Board of Railway Commissioners, its subsidiary would be held up to the same careful control and thus regulation of the subsidiary would be virtually unnecessary.

A question arises here, namely, Why should the railway, with its present large capital expenditures and abundant facilities, engage in highway transport and thus compete with itself? The answer to that is, that the highway operations would not be competitive with but complementary to the rail transport. If the traffic goes as now to a common carrier on the highway, it is lost to the railway, but if the railway did the carrying on the highway the traffic would still be tributary to the railway interest as well as advantageous to the public.

Government Ownership

There are one or two other aspects of our transportation which merit careful study followed by appropriate action.

First, Can government ownership and private ownership continue side by side with reasonable opportunities and conditions for both? This is a problem which has a very direct interest for us all. Let us see the way in which this has worked out during the last ten years or more, since we have tried government ownership on such an extensive scale. At the time these roads were taken over by the government—part of the mileage having been assumed in order to save certain financial interests from disaster—much of the property and equipment had been allowed to deteriorate. It was, therefore, necessary to spend freely to restore the properties to good operating condition. This was done during the years following 1917 and 1918 when the Canadian Northern and the Grand Trunk Pacific came into government hands and had to be continued after the parent Grand Trunk was taken over; so that in the annual report of the Canadian National Railways for 1922 it was stated that the three groups of lines constituting the system "enter the consolidation in excellent physical condition and operating at a high mark of efficiency." From 1923 to 1931 the country's capital investment and debt was increased by some $400,000,000, which has added almost $20,000,000 to the fixed charges. In the same eight-year period there has been a loss of $346,000,000. "To realize that in 1930 the gross revenues of the system were less than in the year 1923, notwithstanding the addition of $400,000,000 to the investment in the property, serves only to impress the seriousness of the problem" (Hansard, June 1, 1931, page 2,331).

In this connection it may be asked whether the government of the country is a suitable administration for a great railway system? If the government is the guardian of the people's interests, why should it keep adding continually to the debt of this railway system, thus increasing the burden upon the people and making it all the more difficult for the railway management to reach that time when the road will become solvent? The Governor-in-Council takes the place of the shareholders in this case and it is the business of the shareholders to scrutinize carefully every item of expenditure by the management. This is not a criticism of the railway management; an enterprising management invariably desires to put the property entrusted to it into the very best operating condition. But when scores and hundreds of communities are pressing the people's railway for local improvements in service and facilities and the government, in response to this pressure, grants all that is asked without any inhibitory restraint, can we say that such a system contains the fundamental elements essential to success? We are not here dealing in personalities, for many of the finest men and most competent officials are found in the Canadian National as in the Canadian Pacific railway. It is the *system* concerning which we express doubt. Nor do we speak of one or the other political party composing the government, for it was a government of one political stripe which saddled the country with these railways and a government of a different political stripe which has been in control in recent years. Governments act from pressure, and if communities by their potential voting power can and will force the government to accede to their wishes for fine stations, great terminals, expensive hotels, de luxe passenger service, etc., is this a *system* that can provide economical administration for a great transcontinental railway?

Moreover, when a government-owned system, with all the government's resources and taxing power behind it, is induced to provide fine passenger car equipment and service, fine hotels, good publicity agents, excellent freight service, etc., to increase the patronage of the railway, its competitor—depending upon its own resources—must meet that competition or fall behind in its hold upon the public patronage. If the government-owned system is not solvent, how long can the privately-owned road survive this unequal struggle? Can government ownership and private ownership continue side by side under conditions of reasonable competition and without detriment to either or to the country?

The Future

The last point, which must be approached with the utmost circumspection, is, what of the future? Along what lines are we likely to obtain a solution of our present railway problem? It is to find an answer to this question that the Royal Commission on Railways and Transportation has been appointed. Without attempting to forecast what the substance of its report may be, some suggestions may be helpful in thinking our way through the complexity of the problem.

What has brought the railways to their present financial emergency? Three things particularly: first, lack of traffic, due to the world depression and to the competition of government subsidized highway carriers taking away the cream of the traffic that remains; second, the enormous programme of capital expenditures by the Canadian National in recent years and the vast increase of its debt without a corresponding increase in earning capacity; and, third, the wastes of competition. Let us look at these in turn.

Lack of Traffic

So far as this is due to the depression which is affecting all countries, very little can be done by direct action in Canada, except to lend our influence in support of the cancellation of the Great War debts and the freeing of the world's trade channels from the shackles of what are virtually prohibitive tariffs.

So far as the competition of the highway carriers has been responsible for the railways' lack of traffic, it is suggested, as previously shown, that all carriers on the highway should be taxed sufficiently to pay for the costs of construction and maintenance of the highway and according to the benefit they obtain from the use of the highway. Then, the disastrous and immoral discriminations in rates charged by motor truck carriers, together with many other evils of their competition, should be stopped by permitting the use of the highway for public commercial purposes to a very narrowly limited number, over which supervision could be easily exercised. Above all, the co-ordination of highway and railway service by the two railway companies should be accompanied by a change in railway methods of operation to keep pace with the present-day methods of business. If railway rates change according to business conditions, why should the railway operating methods not change also?

The Canadian National Debt

Since there is no prospect that this railway system will ever be able to repay any portion of this debt due to the government, it is highly essential that the debt should not be increased. Two alternatives seem possible.

(*a*) Establish the Canadian National on a fair basis of recapitalization—a basis which would be comparable with that of the Canadian Pacific—and then divorce it absolutely and forever from any connection with the government, requiring it to do its own financing and to be responsible like any other company. Let the government assume that portion of the railway's debt which could not constitute a part of the capitalization of the railway under the reasonable recapitalization terms. Or,

(*b*) Provide, by statute if necessary, that there should be no further capital expenditures, except such as would be immediately productive, and that any future increases of debt or of government contributions should bear a definite relation to the net revenue (after payment of fixed charges) for the three preceding years.

Of these two, the former should be the more satisfactory from all points of view, both to the management and to the government.

Competitive Wastes

Much has already been accomplished by the co-operation of the two managements in the elimination of useless freight and passenger train mileage. The agreement of the two companies to work together in the advertising and solicitation of freight, passenger and express traffic for Canadian Pacific ships to and from Atlantic ports, with compensating advantages to the Canadian National in the rail haul to and from these ports, is another important step in the right direction. But there are still great realms of co-operation which could be entered with mutual advantage and which could be more easily accomplished if the Canadian National were a private company divorced from the government.

Until that desirable end is attained, it is suggested that significant results would flow from having a certain number of Canadian Pacific directors appointed by the government upon the board of directors of the Canadian National, replacing political appointments on that board, or else let the government and the Canadian Pacific confer as to certain men who would be acceptable to both as directors. By full consideration of their mutual interests, each company's board of directors would be apprised of the policy of the other and, with some strong directors in common to the two companies, they would be able to co-operate for the elimination of practices, services and expenditures which would be injudicious.

Lest it be thought that this power might be wielded to the disadvantage of the public, it must be remembered that the Board of Railway Commissioners has always been the guardian of the public welfare so far as railway operation and rates are concerned.

The Vehicle and the Road

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SUMMARY.—After tracing the historical development of the road system in Canada, the author discusses the effect of the development of the motor car upon modern life, particularly in the country. He gives figures dealing with the revenue and expenditure connected with the Canadian highway system and concludes that Canadian highway construction as a whole is on a sound financial basis, that motor vehicle taxation contributes an amount in excess of the total annual cost of Canadian highways, and that the competition of motor trucks and buses with the railways cannot be overcome by crippling the highway service. He considers that the Canadian highway system is far from being over-built.

The vehicle and the road on which it travels are essential parts of one machine. The railway train and the railway track are complementary to one another. The type of track construction should be in keeping with the rolling stock it carries. So the horse-drawn vehicle requires a certain standard of road. And so, also, the motor vehicle (if we are to avail ourselves of the advantages of its greater efficiency) requires a road or pavement in keeping therewith. Railway tracks have been improved and strengthened the meet the requirements of heavier and faster rolling stock. It is equally logical that the common road should be improved to accord with the greater usefulness of the motor vehicle as compared with the horse-drawn vehicle.

When roads were first built in this country, the range of travel was limited to the strength, endurance and speed of the horse. Twenty or thirty miles a day was commonly recognized as the limit of a horse's endurance—and quite sufficient for the driver.

The private motor car is commonly driven two or three hundred miles a day and can carry four or five passengers. It is capable of transcontinental use. The motor truck has similarly increased driving range, with increased carrying capacity. To say that the motor vehicle coupled with its road has ten times the transportation value of the horse-drawn vehicle and its road is a moderate estimate of the increased transportation value.

Railways Embarrassed

Railways, at one time strong advocates of better roads to bring goods, particularly farm produce, to and from their stations, complain of competition from the paved road and motor vehicle. Railway service on many branch lines has been recently curtailed to overcome operating loss due to reduction in freight and passenger traffic.

Electric railway lines for radial and inter-urban service have everywhere been disappearing before the paved road plus motor vehicle competition.

The discontinuance of electric railways and the curtailment of steam railway service have created a serious public loss, particularly during the winter season when motor vehicle service operates at a disadvantage. Added to this, is the loss of capital investment. Electric railways have been abandoned and scrapped by their owners, with little salvage return. Steam railways have been constructed, improved and equipped to provide a certain service, and with the lessening of that traffic their capital is seriously depreciated, if not jeopardized. And it would appear that the end is not yet.

The entire situation is serious and calls for careful study and consideration. Electric railways have disappeared without much public inconvenience. But steam railway service is a necessity even on branch lines. There are many commodities which cannot be economically carried by motor truck. The travelling public cannot be adequately served by motor bus or privately-owned motor car alone. The disappearance of capital investment in steam railways is a calamity not to be lightly entertained.

That Canada is over-built with respect to steam railways under present conditions, is a fact too well known to elaborate upon. It was once our pride that Canada had three transcontinental lines. We no longer boast. But the fault may be found to be only in a minor degree with the paved road and motor vehicle. The general business depression is no doubt largely responsible. Goods and produce are not moving, the public are not travelling.

The railway situation together with the influence thereon of the motor truck and the motor bus are at the present time being investigated by a Royal Commission, and the situation is therefore in a sense *sub judice*. In any event we can afford to await the findings of the Commission, which will no doubt be based on a review of carefully assembled facts.

In the meantime we can agree that the steam railway is a necessity. Apart from water carriage, it is the cheapest method of long-travel transportation, and Canada is a country of magnificent distances. We must retain the steam railway—but in so doing it would be folly to deprive ourselves of the convenience and flexibility of the motor vehicle whether privately owned, or operated as a public carrier.

Have We Over-Built Our Highways?

The statement has been prominently made, and the idea somewhat spread, that in Canada we have over-built with respect to highways. If true, it is a great misfortune, for there are still roads which many citizens think should be improved. But, during a period of depression such as the present, it is desirable to scrutinize all important branches of expenditure. Banks are advising caution in creation of public debt. Loans are more than usually unpopular. On the other hand, there is much unemployment, and there are those who think it better to give employment in useful public work, rather than to support men and their families in idleness by direct relief or doles. Before coming to any conclusion, it is necessary to assemble the essential facts.

Briefly Historical

In the older provinces of Canada, the opening of roads was one of the first considerations of early settlers. The history of roads varied somewhat with local and governmental conditions in the several provinces. But taking Ontario (formerly Upper Canada) as an example, some of the first roads were opened by British regiments stationed in Canada. The government appropriated considerable sums to carry on the work. The settlers themselves, by private subscriptions, made important contributions. A little later, toll road companies were formed, and by 1850 the province was served by a network of toll roads, macadamized or gravelled. These roads led largely to lake or river points from which grain or other produce was shipped. Some small canals were constructed by private companies to shorten wagon haul. Stage coaches travelled the roads; and after the autumn harvest the main roads streamed with wagons or sleighs carrying out grain and bringing back supplies.

Then the steam railway came. In 1850 there had been constructed only 66 miles of railway in Canada, but in that year pronounced activity began. These railways were naturally built parallel to the routes of the old main stage and wagon roads. Toll roads gradually fell into disuse. As an investment their value disappeared; many were abandoned by their owners or were taken over by township and county municipalities.

With the coming of the steam railway, long distance travel by stage coach and horse-drawn wagon disappeared. The capital investment in toll roads, once very considerable, gradually shrunk, but the transformation was gradual, the loss was therefore minimized and not seriously felt.

At the beginning of the present century, the motor car came into being and a period of road-building has returned. It is this last phase with which we are concerned.

Cities, towns, and villages, following the tendencies of early settlement, grew up along the first main roads. These urban centres are the market and shipping points of a greater or less area of surrounding country. It is manifest that economic conditions require the paving of main roads for a certain distance from such urban centres. But motor traffic, from whatever source, will not remain within these radii, and inevitably uses the connecting links of such roads. And these connecting links have to be maintained. In other words, the paving of certain main roads from end to end becomes economically justified merely from the standpoint of essential service and maintenance cost.

Why Build Roads?

The building of roads throughout history has been a means toward, and an evidence of, commercial advancement, social progress, and civilization.

Without means of access and egress, lands are worthless. Without roads reaching out to his lands from the market town or place of shipment, a farmer cannot dispose of his produce or return with the necessities of home life from the town. The existence of both farm and town is largely dependent on roads. It is a primary axiom that roads of some type are necessary to give value to the lands of a country, whether the produce is that of agriculture, the forest, or mine.

The most rudimentary forms of road and transportation which we need consider are the horse-drawn wagon and the earth road. That is, the graded earth road is the cheapest type of wagon track, and nothing less can be devised for the accommodation of horse-drawn traffic.

The next step in construction is the gravelling of such a road. Observation shows that a teamster steadily occupied throughout the year can do in one day on a gravel road what it would take two days to do on an earth road, having regard to tractive power required and seasonal conditions. Taking 24 miles per day (loaded one way, light the other) as the measure of work for a team, it is a simple computation to show that the teamster engaged for 300 days of the year on an earth road can save 150 days of the year when the earth road has been given a gravelled surface. Assuming such a gravelled surface to cost $2,500 per mile, this, at $5 per day for man and team, is equivalent to five hundred days of labour per mile, or six thousand days for 12 miles. If an average of forty teams per day use the road, the time saved, if devoted to road construction, would convert the road into a gravelled road, 12 miles in length, in one year.

Similarly, ten times that number of teams (four hundred) would save sixty thousand days in one year, this time being equivalent to $300,000 or the cost of 12 miles of concrete pavement.

There are those who will say that such a measuring stick is not accurate, because the teamster will not have use for the time saved; that he will be jobless for half the time, and the time wasted. But it does mean, in a practical world, that only one half the number of men and teams need be employed on the gravel or concrete road.

If these figures appear to be overdrawn as to the economy of the improved road, the writer is willing that any reasonable factor of safety be applied, and the result will still be sufficiently convincing.

The conclusion is obvious, that, even for horse-drawn traffic alone, good roads are a labour-saving device of tremendous value. The advantages of the motor vehicle still further increase their value many fold. As a means of economizing time and effort, roads suited to the traffic over them are a national necessity.

We build roads (in part) at a comparatively small expenditure of time and effort, in order to save a vastly greater amount of time and effort in hauling or travelling over them.

Occupational Ownership

Statistics of ownership of motor cars according to an occupational classification are not available for Canada as a whole, and the last compiled list was that of Ontario for 1926. The Ontario statistics with regard to passenger cars in that year was as follows:—

Farmers	29	per cent
Merchants, manufacturers, managers	15	"
Professions	6	"
Liveries and garages	1	"
Salesmen and commercial travellers	6	"
Mechanics and trades	15	"
Occupation not stated	10	"
Other occupations	18	"

The term "pleasure car," as applied to the automobile, has outlived its usefulness and is objectionable in that it seeks to imply a lack of real utility on the part of the motor car. The motor car is undoubtedly used for purposes of recreation, but so also is the railway coach, the old horse and buggy, the carriage and pair. Because the automobile is used on Sunday and holidays for purposes of enjoyment, it is not, for that reason, less economic than the railway.

Reference to occupational statistics previously given indicates that the motor car is owned primarily by those who have serious use for it in business affairs. Who will criticize the doctor, or the merchant and manufacturer, for using the time-saving motor car? There are those of the engineering profession who find the motor indispensable. The motor car in the great majority of cases is owned by those who have proper use for it in advancing business interests, and it has become a business necessity.

Extravagant Farmers

Heretofore the Canadian farmer has not been regarded as a spendthrift, but to-day he is frequently criticized as extravagant for owning a motor car. He was held to be within his rights in having a driving horse with a good outfit of buggy and harness. Such a driving outfit would cost the farmer $150 a year, in feed (which would otherwise be sold), depreciation, shoeing, repairs, etc. A suitable motor car need not cost more than $300 a year, with a great saving of time, and benefit in other ways. There is no one better entitled to a motor car, from the nature of his occupation, than is the farmer, and there is no car from which the country derives greater economic advantage.

Farming operations of seeding, cultivation and harvest are seasonal and usually have to be carried on at maximum speed. Repair parts for farm equipment may be quickly obtained by use of the automobile. If subjected to the delay of horse-drawn communication, serious loss would frequently result.

The farmer must not only produce. He must also sell. Farmers, like manufacturers, are learning that any one may produce, but that success or failure depends on ability to sell. The motor car is of the greatest value to the farmer in keeping abreast of his selling operations.

A well-known Canadian farmer, who resides on a paved road some twelve miles from the city limits of Toronto, related to the writer several years ago his experience as regards the farmer's truck. It was regularly necessary for him to reach the city market with his produce about six o'clock in the morning. To do so, he had to get up at three o'clock to feed the horses and get away from the farm at four o'clock, taking the remaining two hours to drive 12 miles. There, it was necessary to rest the horses for a couple of hours, transact his business, feed the horses, and he was rarely back at the farm before noon. But the horses had had a day's work (24 miles); he himself was tired by the drive and early rising, and a day was practically lost by the journey. With a motor truck, he gets up at the reasonable farm hour of five o'clock, has breakfast, is ready to leave in forty minutes, and is at his Toronto destination by six o'clock. His business is usually finished by eight o'clock, and he is back at the farm before nine. He himself is not tired, his horses have been feeding and resting, and all are ready for a substantial amount of work on the farm.

The isolation of rural life has always been regarded as one of the serious drawbacks of farming as an occupation. Every nation owes its virility and permanence as a nation to contact with the soil. The average urban family does not survive the third generation. A country home is the ordinary ambition of the English, Scottish and Irish family. To live in the country, to hunt, shoot, breed horses and cattle, and enjoy life in open air surroundings, is a natural tendency of the Anglo-Saxon race—a tendency to which is credited their virility and strength as a nation. The paved road is more and more drawing the urban dwellers of Canada to country life. Their families are more and more spending at least part of the year in the summer cottage by lake or river. Farming is becoming more and more a desirable occupation. It is being made so by the telephone, radio, rural mail delivery, but most of all by the paved road, which satisfies the social desires of the human race. The radius of rural social life is increased by the efficiency of the motor car. Under horse-drawn traffic, eight or ten miles was a considerable drive: to-day, that distance over good roads is a pleasant relaxation of twenty minutes, and families within a radius of ten or fifteen miles join in local social activities.

The motor car is revolutionizing country life. If it is uneconomic for the farmer to drive a motor car, it is the fault of an economic system, and not the fault of the farmer or the car.

Various Economic Values

Economic values are not necessarily measured in terms of dollars and cents alone. The conserving of time and energy, the widening of cultural and social opportunities, improved conditions of health and sanitation, opportunities for recreation, are all in a proper degree to be regarded in any study of economic advantage. If it is not so, the world is wasting much money, time and effort, education, scientific training and research, in the attainment of such advantages. Some benefits are to be desired beyond any monetary valuation, and that they have a substantial existence is beyond dispute.

The diffusion of city population, particularly to suburban areas, is a national benefit. The man of moderate wealth is enabled to have a home, with large grounds surrounding it, ten, fifteen, twenty miles or even a greater distance from his place of business. Measured in time, these distances by motor car mean twenty to forty minutes night and morning, according to traffic conditions. The labouring man using thrift and a hundred-dollar Ford, may buy a small lot in the outskirts of a city, and, commencing with a lean-to, in a short time becomes the owner of a respectable home where his family has the benefit of sanitary surroundings instead of the city slum. "Shack Town" is one of the most commendable benefits of the suburban paved road, for, beginning with a collection of shacks and small gardens, it tends ultimately to become a region of comfortable homes owned by the occupants.

The price of real estate fluctuates as do other commodities. Paved roads will not prevent that fluctuation. At the present time farm lands are in the trough of the depression. But the writer has frequently asked real estate brokers their opinion of the effect of paved roads on farm land values. Replies have varied but all have agreed that, in an agricultural district, a 100-acre farm on a paved road will bring at least $1,000 more than will a similar farm not so favourably situated, while sales can be much more readily effected. That is, assuming eight farms to the mile, there is an increase of at least $8,000 per mile, not including nearby farms a mile or two distant, the value of which is proportionately benefited.

Tourist Travel

Life is characterized by activity. Absence of movement represents stagnation. The life, the progress of a nation or of an age, is indicated by the movement and activity of its people.

The motor vehicle coupled with the road has enabled the people of this age to intermingle as never before in the world's history, and such movement is one of the outstanding guarantors of the permanence of our civilization. To unduly check the building of roads is to limit the growth of civilization.

An indication of the international as well as national intermingling of people is illustrated by the statistics of American tourist travel entering Canada.

Estimates of the Dominion Bureau of Statistics show that American automobile tourist travel in 1930 brought into Canada the sum of $202,409,000; and that Canadian motor tourists spent in the United States $63,489,000, a trade balance of $138,920,000 in favour of Canada. Col. Oscar Gilbert, president of the Province of Quebec Hotel Association, says,—"Out of $100 spent by tourists, hotels receive $23, restaurants and rooming houses, $16; stores, $31; garages, $10, theatres $8, and various other branches of business, $10." A study of these divisions shows that this amount of over $200,000,000 is expended almost entirely for service. The cost of most materials in the final analysis merely means the value of labour for production. The meaning of this is that American tourists in the course of a year and a half spend such an amount for service as would defray the entire funded debts of the highway system—a consideration of immense importance in a period of unemployment.

Use of Motor Vehicles in Canada

The use of motor cars in Canada has grown as follows:—

Registration in Ontario in 1903	220
" for all Canada, 1910	8,967
" " " " 1920	407,064
" " " " 1930	1,239,888

Of the 1930 registration, 165,468—or over 13 per cent—were motor trucks. In relation to population, there is one motor vehicle for each eight persons. The investment value in motor vehicles may be broadly estimated at $500 per car (although replacement value would be greater) or a total of $600,000,000. Coupled with the investment in highway development, we find a total highway investment for roadbed and rolling stock of $1,127,000,000, as compared with a railway capital investment of $3,153,350,558.

Canadian Motor Vehicle Revenue

Provincial governments derive revenue from motor vehicle registration, etc., and from gasoline consumed.

Revenue from these sources in Canada for the nine years 1922 to 1930 inclusive was:—

1922, all provinces	$ 9,222,057
1923, " "	11,427,510
1924, " "	12,681,721
1925, " "	17,508,359
1926, " "	21,795,184
1927, " "	24,735,706
1928, " "	31,551,349
1929, " "	41,256,441
1930, " "	42,821,508
Total	$222,799,835

The Dominion government, from customs and excise duties on motor vehicle parts and accessories, for the period of 1904 to 1930, has collected the sum of $229,475,514.

These two items of Dominion and provincial revenue aggregate $452,275,349, an amount approaching the entire estimated value of the Canadian highway system.

Dominion and provincial revenue from motor vehicles in the year 1929 amounted to $66,993,857, and in 1930 to $56,430,515.

Looked at from an economic standpoint, it is immaterial whether these monies are applied directly to road-building, or used to defray other necessary expenses of government. The fact remains that these are funds contributed in taxation by owners of motor vehicles.

Canadian Highway Mileage and Valuation

What is commonly regarded as the "highway system" has regard principally to roads in the open country, including township, county and provincial roads. Town and city streets financed as local improvements are not included, as they are built to serve other than transportation purposes—beautification, sanitation, cleanliness, etc.

The total length of highways in Canada is stated by the Dominion Bureau of Statistics to be 394,373 miles. This includes 158,640 miles of "unimproved earth" roads included, principally, in statistics for Saskatchewan, Alberta and Quebec. There is a very great mileage of such road allowances in Ontario for which no statistics are available.

In the writer's view, a road is not a road until it has at least been graded. If we accept that line of division, the roads of Canada total 235,733 miles. Of these, 155,234 miles are unsurfaced roads, while surfaced roads total 80,499 miles.

The writer's estimate of the cost of the Canadian system is approximately $527,000,000, as follows:—

Class	Mileage	Value per mile	Total
Improved earth roads	155,234	$ 700	$108,663,800
Gravel and loose stone	70,942	3,000	212,826,000
Oiled gravel	406	4,000	1,624,000
Water-bound Macadam	4,992	5,000	24,960,000
Bituminous Macadam	1,445	20,000	28,900,000
Bituminous concrete	1,275	30,000	38,250,000
Cement concrete	1,421	30,000	42,630,000
Other	17	20,000	340,000
Bridges and miscellaneous construction, 15 per cent	......	......	68,727,720
Total	....	....	$526,921,520

The roads of Canada generally and the character of work on them are well known to the writer. It has been his privilege from time to time to travel over a substantial mileage in every province. The unit costs per mile in the foregoing estimate are average figures. For example, "improved earth roads" as a class are little more than levelled with earth from shallow ditches. Where this class of work is exceeded on a limited mileage the additional cost is amply covered by the last item for "Bridges and Miscellaneous Construction."

Looking at the situation from the standpoint of type of construction, it can hardly be imputed that the condition of being "over-built" can rest with any part of the road system which is merely graded, or with any part of the system which is merely surfaced with gravel or loose crushed stone; nor with water-bound macadam. These are merely the types of surface required for horse-drawn traffic, and are the least expensive in cost per mile. The charge that we are "over-built" must assuredly rest with some part of the balance, of 4,158.4 miles, which has cost in all about $150,000,000. This is less than two per cent of the total road mileage and it is not to be credited that the economic limits of paved roads have been exceeded or even reached by any such proportion, or that the financial stability of Canada is endangered by some part of an expenditure of $150,000,000.

Built Out of Revenue

A substantial part of the highway system of Canada has been paid for out of annual revenue. Thus the townships of Ontario have roads the estimated value of which is over $100,000,000, and on which there is practically no municipal debt. Counties have roads valued at $54,000,000 on which the county debenture debt is $10,075,000. The provincial system (King's Highways) may be valued at $80,000,000. The total bonded debt of the province and rural municipalities for the Ontario system, valued at $234,000,000, is $67,919,175. The greater part has been paid for by taxes on property assessment, coupled with taxes on motor vehicles.

As elsewhere shown, the entire Canadian highway system is valued at $527,000,000, and the funded debt on December 31st, 1930, was as follows:—

Prince Edward Island	$ 1,300,000
Nova Scotia (Provincial)	20,828,870
New Brunswick (Provincial)	20,516,450
Quebec (Provincial)	45,877,000
Ontario (Provincial)	51,570,175
Counties for county roads	10,075,000
Counties for Provincial highways	6,270,000
Manitoba (Provincial)	16,746,333
Rural municipalities	3,927,837
Saskatchewan (Provincial)	20,445,000
Rural municipalities	15,495,000
Alberta (Provincial)	27,000,000
British Columbia (Provincial)	33,389,255
Districts	3,616,722
Dominion of Canada Provincial grants	20,000,000
Agregate for all Canada	$297,057,642

An annual payment of $24,000,000 would retire the foregoing debts, principal and interest, in twenty years.

From the foregoing has been omitted expenditure on colonization roads in northern Ontario, the cost of which development work is properly chargeable to revenue from mines, timber, sale of lands, etc., and for which road construction is regarded as partial compensation.

Maintenance Costs

Much highway construction is of a permanent character requiring little or no maintenance. Hills are cut down, at considerable expense, and will not grow up again. Turnpiking and drainage is of indefinite life. Bridges and culverts are now largely built of concrete, requiring little maintenance for a long and indefinite life. The road surface is the principal detail on which real maintenance has to be applied.

Road surfaces require maintenance in proportion to the traffic over them. Some roads, lightly travelled, require very little expenditure for repairs. Drainage and sub-soil conditions affect others. Averaging all roads, with necessary resurfacing and maintenance for a life of twenty years, a charge of five per cent, in the opinion of the writer, is a reasonable anticipation.

It has been estimated elsewhere that the value of Canadian roads is $527,000,000, on which $26,350,000 annually should therefore be expected as a maintenance charge. The Dominion Bureau of Statistics shows that in 1930 the sum of $23,102,817 was actually spent in maintenance and is in close agreement with the writer's estimate of probable requirements.

Annual Cost

The annual cost of the Canadian highway system is made up of two items, the cost of repair and maintenance and an amount sufficient to pay interest on and retire the existing indebtedness. These amounts are:—

Cost of repair and maintenance................	$26,350,000
Annual levy to cover indebtedness.............	24,000,000
	$50,350,000

This is an amount equivalent to $5.00 per capita of population annually. The annual expenditure on roads in England (United Kingdom) amounts to $6 per capita.

Having regard to the comparative mileage of new roads to be built in Canada, and to our diffusion of population, with consequent greater road mileage, a greater expenditure in Canada would be justifiable.

Motor Truck Competition

Railway criticism is largely devoted to the motor truck operated as a public carrier. In Ontario there are 165,468 registered motor trucks, yet only 3,900, or 5½ per cent of the total, are operated as public carriers. The remaining 94½ per cent. are privately owned, and are operated in the owner's business. Interference with privately owned trucks has not been suggested by the railways. The proposal is that the public carrier trucks be heavily taxed and regulated.

Yet it is hardly conceivable that a few motor trucks can wholly disorganize the branch line service of the railways and deplete their revenues. The real explanation is probably that the inroads on railway traffic are being made chiefly by privately owned trucks rather than by those operated as public carriers.

In the matter of long distance carload freight, railways have made distinct progress by the adoption of heavier engines, larger cars, longer trains, grade reduction, increased strength of track and roadbed, etc., all tending to better and cheaper service. But this tendency has been the reverse of that required for the short-haul distribution of merchandise and package freight. The needs of l.c.l. or package freight have been better served by the facilities offered by the motor truck, such as a light, rapid vehicle, giving complete door-to-door service; packing requirements are minimized; there is flexibility of shipping schedule; interminable delays are avoided, and there is a minimum of destructive handling.

The writer recognizes the gravity of the situation. The railways need the revenue. The public want the railways to have the revenue, and would be pleased to have the motor freight off the highway.

But the public do not want to see this attempted by taxing the truck out of existence, or shackling its service with unnecessary red tape bondage. The public want to see the railways rise to the occasion by giving a service equal to, or better than, that which the motor truck can offer.

Motor Bus Competition

The motor bus is largely accused as the chief competitor of the railway for passenger traffic. In Ontario there are 491,007 passenger cars of which 629, or less than ⅛ of 1 per cent are motor busses operating outside of urban centres. As with the motor truck, it is scarcely conceivable that such a number of motor busses alone can disorganize branch line railway service. A study of the situation would probably disclose that the privately-owned motor car is the chief culprit.

High taxation of the motor bus, and severe regulation, will not remove the competition of the private motor car. Motor busses compete for short distance traffic, not for long distance travel. Difference in cost enters into consideration, but motor busses have several advantages. They give service from centre to centre of towns, or from hotel to hotel, or passengers are allowed to enter and leave where they wish along the route. Railway stations are usually some distance from the business centres and hotels, and travellers generally have to use a street car or taxi at each terminal.

A large part of the motor bus patronage is from persons living along the route who use the bus in preference to the farm horse and buggy, and is undoubtedly travel which in any event would not patronize the railway. Motor busses have largely created their own traffic.

The Remedy

Steam railways are now asking that motor bus and truck transport be taxed and regulated, in the expectation that, by this means, highway competition will be crippled.

The most complete system of regulation so far in force on the continent is imposed in the state of California. The result has been the opposite to that anticipated by the railways. The effect has been that management of the public motor bus and truck has been stabilized, has been placed on a more efficient basis, public confidence has been created, and competition with railway traffic has been increased rather than diminished.

A decade ago the Hydro-Electric Commission of Ontario proposed to add to their activities a system of radial electric railways throughout the province. This proposal was opposed by the steam railways, and its defeat was due in part to the assurance given by responsible railway executives that the steam railways would themselves provide rapid suburban and inter-urban railway service. That assurance has never been implemented.

Instead, the steam railways withdrew from the picture, and sat back while systems of highway motor bus and truck transportation were established to give the public what they desire and need. Railways had an opportunity to themselves to step in and give this or a better service but did not do so. They have now awakened to the situation and their sudden cry reminds one of that of the silversmiths of Ephesus—"Our craft is in danger—Great is Diana of the Ephesians."

Railways must be prepared to meet the price of progress. That price is well known to engineers under the term "obsolescence." If trucks and busses are taking away railway traffic, there is strong ground for believing that the motor vehicle is rendering a service which the steam railways do not give.

That the flexibility of the motor vehicle fills a place in the scheme of transportation where the steam engine cannot possibly compete, is fully apparent. It is useless for the railways to suppose that the public can be induced to await the convenience of the railways in the matter, or that the public will permit the motor bus or truck to be driven off the highway by excessive taxation.

The situation has become complicated by the past lethargy of the railways in the matter, but there is still opportunity to retrieve their position if they see fit to do so. There are various lines along which they can act. Highway and railway service can be co-ordinated to give a public service that either one alone cannot render.

We are living in an age of marvellous transportation and communication facilities. In this respect it is an era outstanding in world history. Transportation, movement of population, and rapid communication are the life blood of commerce. At the moment we are passing through a financial depression of unprecedented magnitude. But the writer is of the opinion that, when the story of this depression is written, it will be found that recovery is due in a large part to the common highway and its new-found efficiency when coupled with the motor vehicle.

Comments of Sir Alexander Gibb

A speech by Sir Alexander Gibb, a distinguished English harbour engineer, delivered at an Empire Club luncheon in Toronto in September last, has been largely quoted (misquoted?), in the Canadian press, with respect to Canadian highways. I have carefully read the verbatim report of this address and have been entirely unable to find many of the statements attributed to him, except by a free exercise of one's imagination. Sir Alexander Gibb's address was on the subject of "Transportation," including water, canal, railway, highway and air. Speaking of our transportation system as a whole, including railways and canals, he said, "If you will forgive the criticism, you have to a certain extent over-spent yourselves. In some ways, at the present time, your facilities are in excess of your means"—an observation with which all will heartily agree, when railways and canals are included in the indictment.

Sir Alexander Gibb's chief reference to highways was as follows:—

"I would point out if I may, one fallacy that sometimes persists, and that is, that though you charge no canal dues, you are nevertheless quite as definitely paying for your transport as you do on the railways.

"This is true, too, of highways. You are projecting a great national highway from sea to sea. In this province (Ontario) you have already built an admirable network of roads. I am not fully acquainted with their locations, but some of them I know well; and they are just what they should be—essentially pioneer roads to open up new territories. If and when they cease to be that, and become parallel and duplicate lines to the existing means of traffic, which were provided by the labours of your fathers, so soon may you be piling up a debt which you or your children may find it difficult to bear."

The writer must confess inability to follow this criticism of Sir Alexander Gibb with respect to the roads of old Ontario. The provincial highways have been a main object of recent expenditure. They are not pioneer roads, and make no pretence as such. Frankly, they are the old main roads provided originally as main roads "by the labour of our fathers." Many were converted into toll roads. Then the railways built their main lines and branch lines parallel to and duplicating them. Then the motor vehicle came, and these roads have been re-built to enable us to reap the advantage of the greater efficiency of the motor vehicle. The question naturally arises, "Which is the sinner,—the railways which built their roads parallel to and duplicating the old toll road, or the present generation who wish to reconstruct these roads for the use of their motor cars?"

The main highways of Ontario have been re-built in old and settled territory, where the people are, and where they can use the roads they want to travel—the old roads paralled and duplicated by the railways. Any other roads would be useless.

Sir Alexander Gibb, in his reference to the duplication of lines, may have had more definite thought of the proposed all-Canada highway of which a link through the Lake Superior country is one of the suggested routes, paralleling in some degree the Canadian Pacific Railway.

Experience shows that all roads, for the most part, make their own traffic. The unopened link around Lake Superior, some 300 miles in length, through rugged country, is not one which could in any appreciable degree take traffic from the railways. Travel on such a trans-continental highway will be supplementary to railway traffic. A chief advantage will be the circular route around lakes Superior, Michigan and Huron, offered to the residents of such cities as Chicago, Milwaukee, Minneapolis, St. Paul, Duluth, Detroit and many other large American centres. It will immeasurably increase our tourist traffic, with very little, if any, ultimate detriment to the railways.

A Summary

Summarizing foregoing data, we find as follows:—

Estimated value of Canadian highway system, Dec. 31, 1930	$527,000,000
Funded debt, Dec. 31, 1930	300,000,000
Annual cost of maintenance	26,350,000
Annual levy required to meet indebtedness	24,000,000
Total annual cost	50,350,000
Paid by motor vehicles annually (1930)	56,430,515
Total paid by motor vehicles exceeds	452,275,349

These figures show:—

(1) That Canadian highway construction as a whole is on a sound financial basis. This is due largely to the fact that road construction is not being carried out wholly out of borrowed money, but has been and still is being substantially paid for out of annual levy.

(2) That motor vehicle taxation is now annually contributing through provincial and Dominion lines an amount in excess of the total annual cost of Canadian highways.

(3) That the total taxation paid by motor vehicles to date closely approaches the cost of constructing the entire Canadian highway system and is substantially in excess of the funded debt.

(4) That the annual cost of highways to the Canadian people is $5 per capita, while the cost in England is $6. per capita. A reverse of proportions would be more in keeping with comparative needs and conditions in the two countries.

(5) The competition of motor trucks and busses, of which steam railways complain, cannot be overcome by crippling the highway service, but by the steam railways themselves co-ordinating railway and highway traffic, and rendering a superior service that will itself defeat competition.

(6) That the Canadian highway system is far from over-built, and that there is much important work still to be undertaken.

DISCUSSION

Following the papers by

Messrs. S. W. Fairweather, R. M. Smith, A.M.E.I.C., W. T. Jackman and W. A. McLean, M.E.I.C.

Dr. W. W. Colpitts, M.E.I.C.[1]

The chairman at the conclusion of the reading of the papers remarked that he hoped those present would indulge in free discussion as he could not impress too strongly upon all the importance of the subject, not only from the standpoint of the transportation systems of Canada, but of the United States. In Canada the situation had become so critical that a Royal Commission was engaged in studying the problem, and he felt certain that the papers presented and the discussion which would follow would be very helpful to that Commission in arriving at their findings.

The Interstate Commerce Commission had already nearly completed a study of the problems in the United States, and an examiner had made a very comprehensive report to the Commission. He understood the studies were being continued in other directions, so that with the work the Royal Commission and The Institute was doing in Canada and the work which the Interstate Commerce Commission was doing in the United States, a satisfactory solution should be reached. The problems in the two countries were somewhat similar, at least they touched at a number of points, although it must be admitted that conditions in Canada were different in many respects from those in the United States.

R. M. Smith, A.M.E.I.C.[2]

Mr. R. M. Smith on completing his paper stated that he did not want those present to feel that he was alone in his convictions and wished to draw attention to the following extracts from recent speeches by Sir Henry Thornton and Mr. E. W. Beatty.

Sir Henry Thornton—"There has been reference tonight to the competition between the highway and the railway. I have no quarrel with the automobile in any of its forms. I should say that if the railway systems in the United States and Canada should count the total revenue they receive from the moving of traffic relating to automobile manufacture it would be a thousand times more than any loss in business due to bus competition. The great automobile factories of this country and the United States are daily turning out thousands of automobiles. We profit from the material which enters into the construction of these machines. We haul the finished product; we derive revenue from the road materials which are hauled for the purpose of improving the highways. We derive revenue from the hauling of road-making machines and their manufacture, and last but not least, we derive a large indirect traffic from the thousands and thousands of people that are employed in automobile manufacture, and in the construction and reconstruction of good roads. So that I, for one, have no quarrel with bus competition or with the automobile. I am glad it is here, and I hope that instead of a million, we shall have two million next year with increasing numbers each following year.

The part which the bus and the motor lorry play in transport can well be an adjunct to railway transport, and I have no doubt that in the gradual development in highway travel for commercial purposes that eventually there will develop some form of a working arrangement between the highways and the railways which will be equally useful to both."

(*Extract from address given at the Annual Banquet of The Ontario Good Roads Association, February 28th, 1929.*)

Mr. E. W. Beatty—"You have been spoken to on numerous occasions on the value of tourist business in Canada. It has been estimated that last year between two hundred and fifty million and three hundred million new dollars were left in this country in consequence of visits by tourists. I think those figures are, on the whole, conservative. Undoubtedly it is true that it is increasing, not because Canada is comparably any more attractive than it was a few years ago, but because Canada through good roads and better hotels is now able to offer an easy and safe method of transportation via good roads, and to entertain visitors better than ever before. There is one thing in respect to tourist traffic by motors which I feel that sometimes in some official quarters is not entirely appreciated. The owner of a motor car in the United States who has time and the money to take a vacation has the whole of North America at his disposal. The progress in hard surfaced good roads in the United States has been great, and it has come to pass now that the tourist will go where he can get all he desires, in the way of safety and comfort in travel through the medium of the motor car, which he has chosen for his vacation. It is therefore necessary that hard surfaced roads and the programme in respect of them be speeded up to a reasonable extent if Canada is to retain its share of this traffic. I know that is appreciated in Ontario, but I wonder sometimes if it is fully appreciated in other parts of the country which have their own peculiar but very definite attractions for the tourists. I suggest to you, gentlemen, who have the ability and the means for propaganda and education that the necessity of hard surfaced roads should be emphasized on every occasion.

You have been told that good roads and railways are in a measure in competition, in that the former supports the motor car, and the motor car is an agent of competition, of some electric railways in a measure, and in certain places in particular that is true, but no railway official who is wise, and who is sensible of the progress which is taking place in this country, can object to the motor car industry, or motor car competition. A very prominent vice-president of a great American railway told me a short time ago that his road had lost through bus and truck competition in that year over \$8,000,000, but that during the same period his road had carried motor cars and motor parts, and other ingredients of the motor cars, in excess of \$80,000,000, so you can see that the railways are bound to gain by the introduction of such a substantial industry as the motor industry has become, and in comparison with other lines of traffic their gain is very great."

(*Extract from address given at the Annual Banquet of The Ontario Good Roads Association, February 27th, 1930.*)

Professor W. T. Jackman[3]

Professor Jackman stated in connection with Mr. R. M. Smith's discussion that he had referred in very enthusiastic terms to an early statement by Sir Henry Thornton in favour of the automobile and the bus. In order to be fair, he should also have referred to some views of Sir Henry as given in "The Saturday Evening Post," Jan. 23rd, 1932, in which the railroad president had said that another cause of the railway troubles was "the widespread illy regulated and often irresponsible mushrooming of truck and highway competition," and that "trucks and busses were running willy-nilly over our highways" (p. 14). Again (on p. 15) Sir Henry says: "Bigger companies (on the highways) do transport more quickly in some instances than railroads, and more cheaply, but it was being done by a system of invisible contribution in which everyone in a community paid for the fact that the corner grocer was getting his goods hauled for less. Motor transportation taxes to-day were by no means commensurate with the costs to the public. Most highway costs and repairs could be traced to trucks and busses which did not even begin to pay taxes or license fees to balance the charges. But somebody footed the bill—the taxpayer."

He thought Mr. Smith should have been fair enough to Sir Henry to include such a recent statement.

Similar statements to those of Sir Henry had been forthcoming from President Beatty of the Canadian Pacific Railway and should have been noted in fairness to the latter.

Gordon M. Pitts, A.M.E.I.C.[4]

Mr. Pitts observed that for some months past there had been presentations of a great volume of statistics and protracted discussions on the subject of "Railway and Highway Competition."

As in all questions of a contentious nature, the conclusions arrived at reflected the affiliations of the party presenting them, with the result that the railroad interests had stressed the economic necessity of applying heavy taxes to highway transportation, while the motor industry and its adherents protested that they were already taxed to carry the major portion of highway expenditure.

(1) Coverdale and Colpitts, New York, N.Y.
(2) Deputy Minister of Highways, Ontario, Toronto, Ont.
(3) Professor of Transportation, University of Toronto, Toronto.
(4) Maxwell and Pitts, Architects, Montreal.

Conditions relative to this controversy might be summed up as follows:

The modern highway had been and was being developed primarily for the use and pleasure of our private motor car owners.

The highways were not and never would have been developed to their present state of perfection for the exclusive use of trucks and busses.

The truck and bus were at present a minor activity on the highway which had more or less surreptitiously slipped in to capitalize the possibilities of this public utility.

The great majority of our motor driving public looked upon the bus and truck as a menace and an inconvenience on the highway and were in favour of its reduction to a minimum.

The truck and bus did not necessarily provide the cheapest form of transportation but their directness, flexibility and frequency gave a value to their service and modern business required these combined features in transportation and would pay a premium for them.

Good business would always avail itself of new and more economic conditions and certain forms of transportation had been lost to the railways on account of their failure to provide a service of a speed, directness and frequency comparable with the small unit of the highway.

The railroads, as transportation specialists, with all the facilities for transportation development at their disposal, had not made full use of their opportunities in the past. They must now, by foresight and ingenuity, re-establish themselves in their own business.

All things considered, the route which was the safest, the most direct, the cheapest and the most dependable in all seasons was the roadbed of the railways, certain local movements being a possible exception.

Mr. Pitts further stated that the foregoing indicated the development of a method of providing the speed and flexibility of the small unit of the highway through the medium of the rails.

This called for a transportation unit to form a practical, serviceable and economic liaison between the rails and the highways, but it had not yet been developed.

This unit was made up of three parts—a container, a motor chassis for the highway and a flat or gondola car for the rails.

This much-discussed container should be a light, indestructible, weather-proof, secure metal box, with a capacity of about 420 cubic feet, some 7 feet wide, 7 feet high and about 9 feet long, with ball-bearing ball casters and emergency lifting straps on the top. Its design should be such as to permit its being manufactured in large numbers at very low cost. Its weight should not exceed a ton, and its carrying capacity should be from 8,000 to 10,000 pounds.

The chassis forming the highway unit should correspond to a normal 5-ton truck chassis with all the modern appliances of present practice in the motor industry. It should, however, contain within itself the means of moving a container from a shipping platform or flat car to its chassis frame and conversely, from its chassis frame to a shipping platform or flat car, without the aid of any mechanical appliance other than that incorporated in its own mechanism, and without any special preparation in the approach at the car or loading platform. Each chassis should have the capacity of one container.

The flat car should be of a special low and light construction, designed to accommodate one and possibly two containers. There should be no special mechanism on it for the moving of containers, but it should be so designed as to securely retain the containers after they have been placed upon it.

These flat cars should be moved along the rails by small stream-lined tractor units controlled by one operator and driven by a Diesel engine. The service should be frequent at comparatively high speeds and special facilities should be developed for picking up and distributing containers rapidly at pre-determined points along the route and at terminals. The operators of these trains should be in continuous communication with despatchers by telephone-radio combination and their movements otherwise perfectly controlled and protected to obviate the necessity of train crews.

Such a development would reduce truck traffic on the highways. It would produce a speedy form of transportation in small units by which delays would be reduced to a minimum. The cost of these miniature units would be low in original outlay, maintenance and operation. The personnel would be at the irreducible minimum. This train unit would have the capacity of twenty trucks and would move at a sustained speed and with a safety factor through its control system and isolated right-of-way unattainable by any truck service.

From the viewpoint of the manufacturer and the merchant, a door-to-door and container service would be provided by a responsible organization in the shortest possible time, with the fewest handlings, lowest packing costs and greatest security. Reduced stocks on the merchants' shelves means reduced capitalization in his business.

From the point of view of the public, there would be greater safety on the highways, commodity movements would have a tendency to return to the large responsible operators which were and can be properly controlled in the best interests of the community.

From the viewpoint of the railroads, they would re-establish themselves by covering the whole range of transportation service including the contested L.C.L. field. They would do this in an economic manner with profit to themselves and the maximum of service to the public. They would develop a more frequent use of their rights-of-way to provide a better service which was a real economic factor.

From the point of view of the motor industry, a new field would be opened up in the development and production of container trucks, not to mention the small secondary unit for use in terminals, large warehouses and manufacturing plants. The car companies would probably claim the containers and flat cars, but the motor industry might contribute something to the development of the stream-lined Diesel motor locomotives. The commercial radio corporations have the problem of perfecting the telephone control system.

Professor W. T. Jackman

Professor Jackman observed that Mr. Gordon M. Pitts referred to the use of the container. These were in abundant use on some roads in the United States (e.g., P.R.R., and N.Y.C.) but the Canadian railway presidents and operating officials stated that there was not enough traffic in Canada to warrant their use; and in this they were on secure ground.

F. I. Ker, M.E.I.C.[5]

Mr. F. I. Ker stated that he presumed the whole discussion had arisen out of the difficulties which presently confront the railways. He felt that whether those difficulties were due to bus competition or other causes had been covered in such detail in the excellent papers which had been read, that he hesitated to touch upon them at all; that was, upon the question of railway difficulties in the light of bus and truck competition. He

[5] Managing Director, "The Spectator," Hamilton, Ont.

thought, however, that a close analysis of the railway situation in Canada covering not only the Canadian National but the Canadian Pacific would reveal the fact that the so-called railway problem was in reality a political problem.

The railways, particularly the Canadian National Railways, were charged with creating a problem, but the problem which existed—and the problem did exist— was not of the Canadian National Railways Company's making. In the last analysis, the difficulties of the railways today, and the difficulties which the Canadian public suffered through the embarrassment of the railways, and the Canadian taxpayers through the embarrassment of the Canadian National, could be traced directly to one thing, namely, inadequacy of revenue.

He observed that as an engineer, he was a backslider and though a member of The Institute and actively engaged in engineering work for a number of years, for the last eleven years he had been a newspaper man, and as such had to consider such problems as the railway problem more from the public point of view and from the newspaper man's than from the point of view of an engineer. He reminded the meeting of what Doctor Hamilton Fyfe had said at the Annual Dinner in respect to the interest which engineers—which this Institute—might well take in the public affairs of the country.

Nearly all Canadian major public questions had to do directly or indirectly with large engineering enterprises. The engineer had an analytical mind, which was well adapted to consider the economic as well as the technical aspects of the case, and indeed the technical aspects would not obtain much support financially if the economic aspects were unsound.

Mr. Ker considered it well within the scope of The Institute and of the individual members of The Institute to take an active interest and not hesitate to express opinions or to bring pressure to bear on friends who might be in a position to express themselves in connection with matters pertaining to public welfare, such as this railway problem.

An editorial on this subject which appeared in a recent issue of The Engineering Journal should have been published in every paper in this country. Very few of the Canadian public see The Engineering Journal and when members know the editors of the papers in our cities, why should not their attention be drawn to such articles as the one in the last issue of The Journal on the transportation question?

Now, if there was one problem which needed the consideration of the public at the present time, it was the railway question. He had had to give the matter some consideration in an editorial way and in order to save time would read two of his recent articles as follows:

Railway Rates*

The onetime great and romantic business of railroading in North America has fallen upon evil days. The fast express train, which thrilled us 25 years ago, has given place in the popular imagination to fast motor cars, speed boats and airplanes. Railway presidents and general managers used to be the nearest approach we had to kings and princes on this continent. Vanderbilt, Gould, Harriman and Van Horne were names to conjure with. They were powerful autocrats with more personal prestige and influence than many contemporary national rulers. They exalted the railroad business above all others—a railroad became a kingdom in itself to the crown of which any hard-working, clear-headed young man might aspire. This has all been changed in recent years. His freedom of economic effort circumscribed by interstate commerce commissions, railway boards and arbitrary railway unions backed up by the vote-catching labour departments of government, the glory of the railway king has departed. One of the things that this country needs most at the present time is the liberation of the railroads from the uneconomic restrictions to which they have been subjected by governments during the past thirty years. Motor trucks, busses, improved highways, airplanes, wireless telephones and telegraphs are all competing with the railways for public patronage in one branch or another of their services. The more or less exclusive franchise which railroads were supposed to enjoy, in exchange for which concessions were exacted when their charters were granted, no longer exists under present-day competitive conditions, nevertheless the railroads are still being held to the letter of these old undertakings without receiving any consideration for the changed conditions. One direct result is that railway rates need a complete overhauling. They are far too high in some instances and far too low in others. Indeed, it may be said without unfairness to the railways that their rates have never been anything but an unscientific jumble, the outgrowth of expediency and political pressure and taking little or no cognizance of the two fundamentals upon which transportation rate structures should ultimately rest—viz., cost of service to the carrier and value of service to the shipper. It is to be hoped that the royal commission which has recently been appointed to investigate the whole railway situation will give due consideration to the unhappy effects upon the internal trade of this country and the well-being of the railways of crazy patchwork rate structure which was never sound and which has not been fundamentally altered since its inception.

Home to Roost**

Insofar as the ability of our Canadian railways to serve the country efficiently and economically is concerned, there is no railway problem in Canada. If our railways are in trouble, if the country itself is in trouble because of the railways, the accusing finger of the Canadian public should not be pointed at the railway managements, but at the politicians, provincial and federal, particularly the latter, who, to promote their own local or party interests during the past thirty years, have sand-bagged and slugged the railways at every corner. Political exigency has been a dominant consideration in capital expenditures and rate structures, Montreal must have as fine a terminal as Toronto; Halifax must have railway hotels, grain elevators, and its share of the grain traffic regardless of rail haul.

Saskatoon, Regina and Prince Albert, each claiming to be its inland terminal, must have the Hudson's Bay railway. There must be no discrimination. The Crow's Nest pass rates must apply everywhere. It is considered perfectly fair to offset tariff protection in one section of the country by low freight rates in another. Railway wrongs are given a halo as Maritime rights. It has been the policy of successive governments to thrust the burden of opening up and developing this vast country upon the railways. This policy is sound only in the degree that the railways are allowed to secure their just share of the fruits of development. This was the incentive, the economic basis upon which investors participated in financing the construction of our railways. They reckoned without their hosts—our politicians. Without dwelling upon the orgy of construction, the needless duplication and triplication of lines for the glory of the politicians and the profit of their contractor friends between 1900 and 1914, which ended in the bankruptcy of the Grand Trunk and Canadian Northern systems, let us recognize the fact that whatever the past may have been, the railways are not now getting fair treatment from the Canadian people. We have "muzzled the ox that treadeth out the corn," and our sin has found us out. The hatchings of our "Crow's Nests" have come home to roost.

It is to be hoped that the royal commission, now in session at Ottawa, will not overlook this aspect of the railway question nor permit it to be subordinated, for, unless restrained by an awakened public opinion, politicians will eventually break both the Canadian National and the C.P.R. and leave the Canadian taxpayer with a real railway problem to figure out.

He was glad to note in the morning papers that the Board of Railway Commissioners were very rightly unswayed by the propaganda for giving the Maritime ports the trunk line rate from Buffalo to New York, or a corresponding rate from the head of the lakes to Halifax. They had turned the proposition down, and not only did so, but actually increased the rate by six cents a bushel. An unbiased consideration of this subject would lead to the conclusion that they were quite justified in so doing.

In conclusion Mr. Ker considered that engineers were not discharging their obligations properly to The Institute to their profession or to their country unless they sought to make their views felt in the community.

Professor W. T. Jackman

Professor Jackman was of the opinion that Mr. F. I. Ker's first editorial was grossly unfair, when he spoke of railway rates as having never been anything but an unscientific jumble, and mentioned the "crazy patchwork rate

*Hamilton "Spectator," November 26, 1931.

**Hamilton "Spectator," December 10, 1931.

structure which was never sound and which has not been fundamentally altered since its inception." He did not think that all the science had its basis in Mr. Ker's mind.

The second editorial by Mr. Ker was very strongly pertinent and to the point. The politicians in many cases had betrayed the public interest and the railways' welfare.

D. Crombie[6]

Mr. Crombie stated that in listening to the conversations and discussions on this subject, he had felt that mentally we are in the petticoat stage, fearful lest we be obliterated in the wreck of this big, beautiful institution—the railways.

As a railway officer it had been his function to discover some way of extracting from gross revenues a net from which to meet fixed charges and pay maintenance charges which the engineers imposed upon the railroad. Now that there was no net for interest, he had feared perhaps that it was his department that was at fault, for it was only from the transportation of goods that a net could be obtained.

Therefore, as there appeared to be so much confusion of thought regarding present day transportation profits, he had endeavoured to set the facts down in a consecutive and analytical manner from his point of view.

In 1867, the fringe of people scattered along the waterfront in widely separated and independent provinces, resolved to combine and build a Canadian nation. The overseas commerce of the scattered provinces was to be supplemented by an east and west commerce within the new Dominion. The natural economic flow of commerce was north and south, and the objects of confederation could only be achieved through supplanting this natural flow and by overcoming the physical handicaps of distance. Through co-ordinated effort and the exploitation of national sentiment this had been accomplished.

With the object of fostering the internal development of the waterfront provinces, many scattered railway projects had been promoted prior to confederation. The joining up of these lines, and their extension further into the hinterland, became the most important factor in the success of the national aims of the new confederation. The ensuing sixty years, culminating in the prosperity of 1928, had demonstrated the wisdom of this policy and formed the measure of the success which had attended their efforts.

The acceptance of transportation as a state need justified either direct state construction of, or financial assistance for, railway building concurrently with or in advance of settlement. This had been a consistent and continuing policy recognized by every government, federal, provincial and municipal. It was not, however, so definitely recognized that to keep the settlers contented and continuously productive, assistance in this long-distance land transportation cost was also obligatory. Because of this, uncompensatory rates had been forced on the railways, and it was this state interference with railway economics without a quid pro quo in the way of direct assistance to railway operating expenses, which had resulted in a national —mis-called—railway problem of today.

Canada's national wealth consisted of immense resources of raw materials, which must be converted into consumable commodities and carried to the world markets or prosperity did not ensue. The weight and bulk of these raw products combined with their great overland distances from markets formed the real reason why Canadians required and used more ton miles of railway freight service per capita than other people. If prosperity was to be enjoyed, Canada would inevitably require more freight service than others. If this view was accepted, namely that railways were a necessity prior to and for the conversion of natural resources from frozen assets into marketable products, it followed that years of light railway traffic should be anticipated during the development period and it might be that these lean years would be of some considerable duration. Lines with very light traffic density naturally were prone to, and would be the first, to fall into financial difficulties and the intervention of the government became a necessity if service was to be maintained. This in a concise manner explained the public ownership of the Canadian National Railways.

Since land transport was more costly than water transportation, geography still remained Canada's greatest handicap. The wheat fields of Argentina and Australia averaged slightly more than one hundred miles from ocean ports. This geographical fact was equivalent to a bonus of 20 cents per bushel to the wheat growers of the southern hemisphere when compared to those in Montana and Dakota. For the good reasons of state already explained Canadian railways through these forced uncompensatory rates had been required to bonus Canadian farmers to the extent of nine cents per bushel—the difference between prairie grain rates and those of contiguous United States lines. This was the governmental manner of equalizing opportunity between the Canadian and Argentine farmer. The railways of the United States were admittedly operated efficiently and yet both the Supreme Court and the Interstate Commerce Commission ruled during the last month that even a 10 per cent reduction in their grain rates was not justified, and this despite the fact that their rates were 75 per cent higher than Canadian grain rates. The need of farm relief and this method of aiding farmers required Canadian railways (C.N.R. $17,000,000, C.P.R. $18,000,000) to forego some $35,000,000 per annum in freight revenues from grain alone. This was in reality the major national problem.

If done for good reasons of state—in his opinion that was sufficient reason—this imposition of uncompensatory grain rates formed a parallel to the 20 per cent freight rate reductions accorded to shippers of the Maritime Provinces The government, in the case of the latter, however, reimbursed the railways for the reduction in rates and why should not a similar procedure be adopted in regard to grain shipments?

In order that a proper concrete picture of the effect of this grain subsidy might be conveyed, it might be said that the Canadian National Railways would receive $17,000,000 additional earnings from the prairie grain by using the same rates per ton mile as those enjoyed by United States railways immediately south of the border.

It must be borne in mind, further, that at its inception the Canadian National Railways was loaded with all the mistakes and burdens of the past and with all of the government's forced advances during the war period and its aftermath. The railway was charged with over thirty million dollars interest per annum on Dominion government advances made previous to 1923,—these might fairly and properly be considered as the accumulated result of war time conditions. In the United States and all other countries which participated in the war, charges such as these were eliminated either through receivership proceedings or by direct absorption by the governments. Canada alone does not permit the 'recording angel' to wipe out any misdeeds or failures in the past. If this annual interest burden of $30,000,000 is neglected, and if the Canadian National Railways had enjoyed the same grain rates as United States railways, the following results would have been obtained for the period 1926 to 1931, inclusive:—

(*a*) Interest charges on all bonds issued from 1855-1923 would have been paid,

(*b*) Interest charges on moneys advanced since 1923 would have been paid,

[6] Chief of Transportation, Canadian National Railways, Montreal.

(*c*) Interest charges on moneys raised since 1923 would have been paid,

and in addition $17,000,000 surplus would have been given to the government at the close of 1931. These results included operation during the unparalleled years of 1930 and 1931.

As far as grain rates were concerned an impasse had been reached. The values of the mutual considerations constituting the original Crow's Nest Pass Agreement of 1897 were so inconsistent with the changed dollar values, the changed transportation costs, and the changed volume of traffic of today, that it was unfair and quite impracticable to expect railways to carry on now (and forever) at the arbitrary figures of 1897 which, although agreed to voluntarily, were based on conditions at that time. The Statute of 1925, which permanently imposed these 1897 arbitraries on the railways, made the railway's finances of today a premier responsibility of the state and warranted a direct subsidy to equalize the conditions of 1932 with 1897. The extent of the changed conditions during these 35 years was admirably illustrated by the 75 per cent higher prairie grain rates recently confirmed and now in effect in the United States.

If the view was accepted that regardless of cost the rates for such long distances and on such raw products must remain so low as to be uncompensatory, it followed that the cost of the railways' freight service must be made up either from unduly high freight rates on other traffic (manufacture and merchandise) or from direct government assistance. With the coming of highway commercialization, the high freight rates on merchandise and manufactures and on short haul freight in general, which were so much in excess of actual costs of transportation were now found to be higher than the traffic could bear. The absence of this highly remunerative traffic in its usual volume arising from truck competition and from general trade depression aggravated today's situation.

The following theories had almost become axiomatic regarding Canada:—

(*a*) Development of national prosperity required premature railway building and therefore compelled railway operation before sufficient density of traffic existed to furnish adequate support.

(*b*) Farm products constituted our main industry and the general welfare of the state was more influenced by the relative prosperity of our farmers than by any other factor.

(*c*) In this industry Canada competed in world markets and at the present prices for wheat no addition to the grain rates could be tolerated.

Through these factors, the well being of the state completely upset, in railway business at least, the ordinary relationships of volume of business and margins of profit. It was the logical conclusion that the state should supply the "quid pro quo" by contributing directly to railway operating costs. In his opinion a suggestion was that this could best be done through a direct subsidy of five cents a bushel to the railways to aid in maintaining these necessarily low transportation charges on grain and grain products. This subsidy was only necessary, and should only be contributed if, and when, and to the extent that, "density" was lacking,—the rich rate was not needed if there was plenty of traffic. The measure of the need could be accurately determined from the factor of earnings per mile of track per day and this subsidy need be accorded only when the revenues were less than $35 per mile per day. The problem was only one of spreading the load and it might be fair to add that, if and when the price of wheat on the Winnipeg Grain Exchange rose to eighty cents a bushel, the freight rates could be advanced one cent a bushel, and further advanced one cent a bushel for every five cents above eighty to which the wheat price rose.

On all other products of the farm, forest and mines, and on all traffic moving over 200 miles, let there be a general increase in freight rates of 10 per cent, with a minimum increase of one mill per ton mile. This latter factor of distance in spreading the burden involved the much discussed highway problem.

In the past the failure to collect compensatory revenue from bulk and low grade commodities was offset by the imposition of higher rates on manufactured articles, merchandise and short haul traffic generally. This spread of load was feasible and proper while the railways enjoyed a monopoly of land transportation; but, since the loss of such monopoly through the commercialization of highways such a condition was impracticable.

Unduly high tariffs on short haul traffic formed the crux of the highway problem. Under monopoly, the railways spread the costs of services so unevenly that much of the long distance service was sold below cost while short distance service was charged as much as five times the cost. In this short haul field, where excessively high selling prices prevailed, the railways were made vulnerable only by their venerable and venerated rate structure and this situation provided a rich field for the highway man.

In Canada the average earnings per carload mile were 23 cents and if a 10 per cent increase was allowed as an adequate average earning, if in sufficient volume (1.2 cents per ton mile), the railways could be assured that, from the cost view point, they had nothing to fear from highway vehicles. The railways could not afford to, and need not, forego this traffic. Somewhere in the wide disparity between railway costs and truck costs, the railway could quote a profitable selling price of transportation which the traffic could bear. This shifting of the load, however, compelled the railways to assess compensatory rates on low grade long haul traffic. There was no other highway problem than this of our own making, except that highway users should be required to pay directly, in proportion to use, all highway costs. When this was done, the railway and the highway would compete on fair and honest terms, and they should be permitted so to do without tariff restrictions or control, and as was usual under such fair competitive conditions co-ordination would follow.

In conclusion, Canada had only one problem,—the same problem as had to be met by every father of nine children, endowed by very nature with a lusty desire to create, regardless of the burdens which it imposed upon him until they are of age.

In Canada no measures could fully control or prevent the building of railways. Depression came and there might be moments of regret; but, with the upward swing of the pendulum railway construction again was pushed ahead.

To cite the most recent illustration,—it was only about eighteen months ago that the leaders of both the political parties in Canada expressed the unanimous feeling of their countrymen, and voiced their desire to function as creators —of more railways.

If, mentally, engineers were bewildered between the track and the safe highway, they had better get clear, as the railways would continue on their way.

Professor A. T. Laing[7]

Professor A. T. Laing stated that he had listened with much interest to the discussions which had taken place, but felt at a disadvantage when asked to discuss questions which had been touched upon by men who must be regarded

[7] Department of Civil Engineering, University of Toronto, Toronto.

as specialists in the study of the situation. The character of the papers presented entitled the writers to be classified as specialists.

He was strongly of the opinion that Mr. Crombie was correct when he said that many of the difficulties with which the railways are confronted at the present time are those which are common to nearly every industry, namely, the falling off of business and consequently of revenue. It was the decline in earnings which had made the situation so acute, and that was a common experience with nearly every industry in the country.

In connection with the development of the highway programme of the province of Ontario, it was interesting to note the attitude of railway men to the project—they were deeply sympathetic and gave every encouragement to the enterprise. A president of a southern railroad was at one time president of the American Road Builders' Association. Those were the days when the highway was regarded as a feeder and not as a competitor of the railroad. It was also interesting to note—and it had been borne out in the discussion—that even at present when the highway was a competitor, there was no evidence of a hostile attitude on the part of either party.

The present period will necessitate many readjustments, some of a very drastic character, no vested interests should be allowed to block the way of progress.

As Professor Jackman had expressed it much might be accomplished towards a solution of the situation by the development of a co-operative plan. There was a demand for both types of service, and these must be co-ordinated. Governments had given to railway companies certain rights in the transportation enterprise and these franchises were a kind of guarantee against unreasonable competition. On the other hand the same governments had built up a system of high class highways which had diverted considerable traffic and indirectly had become themselves competitors of the companies to whom they gave exclusive rights—further proof of the need of co-ordination. It would appear that part of the cause of the troubles of the railways at the present time in the matter lay in not having taken advantage of the change in conditions, namely, the demand for a more elastic and prompt service than was possible with standard railroad equipment, especially with reference to short haul. Many industries within recent years had made similar readjustments to advantage.

It would seem that the desired co-ordination of truck and train service as far as common carrier business was concerned, could be carried out most satisfactorily by placing both services in the hands of one organization—the railway or railways. Set up a monopoly if desired, at the same time reserving regulatory power both as to service and to rates. In principle there was no difference between a long haul monopoly and a short haul monopoly. This point is illustrated in the postal service. The Postal Department assumes all responsibility for carrying mail and for local distribution—a co-ordinated service. Why should not a similar service be established with reference to passengers and freight.

In Ontario, trucking began with the building of the Toronto-Hamilton highway about 1914 and the prevailing rates were the same as those of the railways. The efficiency of this service was quickly recognized. It gave a door to door service and the time consumed was reduced from days by the railway to fewer hours by the bus. One could readily understand that, with the facilities thus offered, there was bound to be a marked change in the transportation industry. That precisely was the point where the railways should have stepped in and sought the control of the situation. They were entitled to a monopoly on the ground that in such a monopoly only lay the possibilities of economic co-ordination.

Norman D. Wilson, m.e.i.c.[8]

Mr. Wilson observed that he had listened with a great deal of interest and pleasure to all that had been said on both sides of this very vital subject, vital both to the Canadian people as a whole and to the engineering profession.

Mr. Crombie had probably covered the whole ground with the statement that lack of revenue was the main cause of present troubles. In fact, the railways were tied by political obligations to a freight rate structure made twenty or thirty years ago, but which was now, under existing conditions, wholly unremunerative. To compensate for the cheap, if not unremunerative rates for long haul freight which were essential for the development of Canada, there had had to be an increase in rates above what would normally be required for the short haul business, and it was this business which had been attacked by motor truck competition.

His own experience latterly had been almost entirely with urban transportation and the same thing had applied there, though the remedy was not generally recognized. The street railway companies had been held to fixed fares under long term franchises and had suffered from competition almost piratical in character against their short haul and only lucrative traffic, by motor vehicles assuming absolutely no responsibilities, making their own rates and running as they pleased, yet in themselves unable to replace the service they slowly bleed to death.

The immediate result of this unfair competition had been, of course, that the transportation service as a whole had suffered. The final result had been a realization that co-ordination under responsible control of the two types of services as being essentially complementary to one another was the only real solution.

He believed the same formula would be found to provide the basic solution in the larger field. The railways were suffering in their passenger business, not so much from bus competition as from competition from private automobiles. With regard to truck and bus competition, he thought the answer was to be found, as Professor Jackman had pointed out, along the lines of co-ordination of rail and highway services.

Mr. Geo. H. Bevan[9]

Mr. Bevan observed that the papers delivered by the authors on this very controversial subject of Highway versus Railway Transportation were extremely interesting. The papers, however, had treated the subject from one angle only, that of economics, and it would seem to be the general opinion that a transportation system could rise or fall only on economic grounds. The economic viewpoint had recently been given considerable attention, both by the press and by the supporters of each particular transportation field. However, there was an all-important phase of the transportation problem which had received little or no consideration, namely the Safety First aspect. The time was fast approaching when this side of the question would assume a greater importance than the economic aspect.

When George Stephenson in England first introduced his steam driven train, the public, while welcoming the new era of transportation, considered that it would never be practical or safe to allow such trains on or near the public highways, and, accordingly, Acts of Parliament were immediately passed giving protection to the users of highways and compelling all railways to operate their trains on private right-of-way. This practice had been closely followed in almost every country in the world. Starting from this point, the railways throughout the world

[8] Wilson, Bunnell and Borgstrom Ltd., Toronto, Ont.
[9] 1550 Bathurst Street, Toronto.

evolved from the small trains of Stephenson's time the present wonderful railroad systems.

Always in the minds of both the railway owners and the using public was the balanced combination of speed, safety, cost and comfort. The attitude of the public to the railways had consistently been a demand for safety: safety to the public and safety to the railway worker. Governments considered that one of their major problems was the proper protection of the public as applied to transportation. Most countries appointed boards or commissions comprised of thoroughly qualified men whose sole duty was to enact regulations and to have them enforced in the interests of the public. The study of safety was of paramount importance to these authorities. Anything considered to be unsafe was condemned. Cases of increased speed due to the excessive zeal in competition had even been corrected and the offending railway companies ordered to run their trains at proper speeds in the interests of safety. Accidents involving the death of one or more persons had been carefully investigated by these boards or commissions at great expense, and where it was found that the accident was caused by the negligence of some employee or employees the offending party was punished and in many cases imprisoned.

Such safety devices as the Westinghouse air brake, modern signal system, train despatching, automatic train control; all-steel equipment, heavy steel rails and well maintained road bed are just a few of the engineering features adopted by the railways in their search for absolute safety. In addition to these, and not the least important, was the thorough and efficiently trained personnel which operates any railroad. Every railroad employee, no matter what position he held, served a thorough apprenticeship. Only those physically fit and thoroughly competent were allowed to hold any position of responsibility. All employees were taught special safety rules, and both in the interests of the public and the employee himself, he was assigned to duties at regular hours and a living wage.

With the railways today it might be said that safety first was more than a duty—it was a habit. This habit of safety first had been in a great measure due to the attitude of the public during the last hundred years. This attitude, particularly as it was applied to Canada and other British countries, had been one of the sanctity of human life.

During the last twenty-five years considerable speeding up of the mechanical and industrial age had been due to a large extent to the development of the internal combustion engine. This development, which had been rapid, had resulted in a new means of transportation—the motor driven vehicle. Owing to the relatively small size of the vehicle and its early adoption for pleasure travel only, its use of the public highway was considered to be quite the logical thing and quite safe for such a means of transportation. Within a few years, however, the situation greatly changed. Public highways, formerly built for slow moving stage coach traffic and for the use of pedestrians, were almost overnight filled with fast moving automobiles, freight trucks and passenger coaches. Most of these vehicles were today capable of speeds in excess of that of an express train.

Today, the general order of things involving automobiles, buses, and heavy freight trucks with trailers, driven at a speed of over 50 miles an hour on a highway used by pedestrians was accepted. This outlook should be compared to that taken in George Stephenson's time, when his almost toy locomotive, weighing only a few tons travelling at 20 miles an hour, was considered a menace and a hazard to safety, and compelled to run on private right-of-way. The general public and even governments in this age appear to have lost that sense of balance between safety, speed and economics, which was so diligently applied to our railroads and steamboats, and which brought these service to their present high state of perfection as economic and safe methods of transportation.

The suddenness with which this new era of transportation forced itself upon the public left no time to really form a proper outlook in regard to the balance of safety, speed and economy.

The following comparative figures were furnished by the Dominion Bureau of Statistics, Ottawa.

Accidents on Railways and Highways

		Railways		*Highways*	
	Year	*Killed*	*Injured*	*Killed*	*Injured*
Canada.....	1926	249	2,797	606	7,200
"	1930	195	2,351	1,300	15,600
U.S.A.......	1926	2,127	120,736	23,264	280,000
"	1930	1,320	39,760	34,000	408,000

The figures given under the last column were estimated and assumed a proportion of from 12 to 14 persons injured to every death, which was the rate quoted by several provincial authorities.

From this table it was evident that while accidents on railroads were decreasing and were reasonably small considering the enormous volume of combined freight and passengers carried, those on the highways were increasing at an alarming rate—a rate far greater than the increase in the consumption of gasoline. Mr. S. W. Fairweather mentioned in his paper that, today, only four per cent of the freight in Canada was handled by truck, the balance being carried by rail. One could visualize the appalling increase in highway accidents that would take place if railways were eliminated and all our freight carried on the public highway.

In the table above, figures have been included for the United States, as that country is the most highly motorized of any in the world. According to a recent pamphlet issued by the Travellers' Insurance Company of Hartford, Conn., 50,510 members of the American Army were killed in action and 182,674 were wounded during eighteen months of the Great War. In a period of eighteen months ending December 31, 1931, there were 53,650 persons killed in motor vehicle accidents and 1,576,840 injured in the United States. Apparently the auto-vehicle menace of the public highway was fast becoming more dangerous than war. It should be remembered that forty per cent of the deaths on the highways were those of pedestrians and forty-one per cent of these pedestrians were children.

Another factor which he believed had helped to increase the toll of highway accidents was the changing outlook on the so-called rights of the individual. This changed outlook was even found with some of our high governmental officials, and he wished to comment on a statement made by R. M. Smith, A.M.E.I.C. In his paper the author had stated that, "It is a man's own concern whether he owns a motor car or not," and this statement, at the meeting, appeared to receive considerable enthusiastic approval. He presumed that this statement implied owning and operating a car. If such was the case, then he strongly objected to the statement.

It was Mr. Bevan's contention that every owner of a motor vehicle, whether it be a private automobile, a truck, or bus, owned and operated the same on a public highway only with the sanction and approval of the state. To say that "It is a man's own concern" was far from being right. In our democracy, the liberty of the individual was subordinated to the well being of the state. An individual may have his own ideas upon his rights or individual liberty; he may object to sending his children to school, to paying taxes, but the state compels him to do these and many other things against which he, as an individual, might object. It was fortunate that such was the case.

In countries where the liberty or freedom of the individual was not subordinate to the will of the state, it was seen that the so-called freedom of the individual became only license to do wrong. It became freedom to own a gun, freedom to kill, corruption in politics and law, and a total disregard of the rights of one's fellow man in all phases of life and as exemplified in the conduct of many drivers of auto vehicles.

Experts had agreed that the increasing toll of accidents was due mainly to better highways, improved motor vehicles, and faster speeds. If this was the case, then the country was undoubtedly heading for a still greater increase in this appalling slaughter.

Must this menace be accepted as a part of our civilization and as something unalterable? Could that safety consciousness never be regained, that outlook on the sanctity of human life. Must this problem remain unsolved? Surely the best brains of this country could find a solution.

S. W. Fairweather [10]

Mr. Fairweather considered that Mr. Smith would appear to be at considerable divergence of opinion from himself with regard to a good many points, and yet he felt that if the two papers were critically compared, that there would be a larger measure of agreement found than of disagreement.

He believed his presentation of the problem agreed to a remarkable extent with the presentation which Mr. Smith had put forward. The private automobiles and the motor buses, particularly the private automobile, provided a luxury service which the public was willing to pay for, and the railway could have no quarrel with that. The motor bus provided a type of transportation at least as cheap as that afforded by the railways, and in a good many cases much more convenient, and the railways could have no objection to that.

But with regard to the motor and motor truck competition, the public could and would, in the last analysis, determine whether or not it desired to move by truck or by railway, and that determination would in the course of time be reflected through the relative cost, and that brought to a focus the practical difference between Mr. Smith's paper and his own. And yet even there, there would be found very little real difference. It was simply a difference in the point of view. His own standpoint of the economist was that he did not care whether the capital was raised at all; he was not interested in that; he simply knew that if capital had been invested, that it represented a burden upon the productive economy of the country which must be justified in some form or another, or it would become an intolerable burden.

He had arranged an estimate of the economic cost of our highway system. That estimate was frankly an estimate. However, it was an engineer's estimate, and engineers' estimates are usually noted for being too small. At least, that had been his experience of them.

Mr. Smith's estimate was arrived at by excluding certain things. Mr. Fairweather stated that his was an all-inclusive one, but in order that the picture might be perfectly fair, his own picture of the railways was also all-inclusive, and he had simply tried to put the two systems largely on a comparable basis. It did not matter where the money came from, whether it came from subsidies, bonuses of one kind or another; whether bonds were floated or the taxes increased. That was really immaterial. That only changed the source of the existence of the burden; it did not change the burden, and if he wanted to be critical of the methods which Mr. Smith had used, he might mention his exclusion of the development of highways. It was not part of his picture at all.

Mr. Fairweather did not feel that a very desperate problem was being faced, or that all the troubles of the railways arose from highway competition. As he had stated, if the railways of this country had to choose between the automobile and the highways system, with all the petty annoyances which it had brought, and the condition, say, of 1910, there could be but one answer; it would be a most retrograde step, but he did wish to emphasize that perhaps this country had bitten off a trifle more than it could chew at the present time, and that in the present more or less chaotic conditions which arose out of the injection of the new economic force into an old established medium of transportation, there were problems which unless they were intelligently dealt with might cost the country a lot of money.

The automobile was not as yet a very serious competitor; it might become so, as Mr. Crombie had pointed out, because the railways in acting as an equalizer of opportunities had laid a heavy burden upon the short-haul traffic, and they might be vulnerable to the motor vehicle.

The traffic which was in jeopardy was not the L.C.L. at all; the L.C.L. was relatively unprofitable. It was only the fact that it was necessary to maintain the L.C.L. services for the remnants which the trucks did not want to carry which made the thing serious. However, the real danger came not from the L.C.L. traffic, but from the carload traffic and there at any time a perfectly effective remedy could be put in force, because the railways in general held the dominant position in cost, and could get a freight rate to a point where the trucks could not compete, and still make money on carload business, but by doing this the net revenues would be affected. That, in essence, was the problem.

He had been very diffident about mentioning any remedy, because he felt a major economic force was being dealt with and when up against a situation like that, one had to be careful and not do more damage than good. It was his experience that people were apt to say: "Oh, you railroad people; if you would only be up to date, you would not have any problem on your hands now." There was only one effective solution of this problem from the economic point of view, and he was not sure it was the correct one, but there was only one real effective remedy, and that would be to create a monopoly either in the hands of the railways or in the hands of trucking companies.

If the situation five years ago was considered, and one had then started to propose that there should be a monopoly in "over the road" trucking, how would that have been received? By "monopoly" he meant a real monopoly; where it would not be possible for an individual to buy a truck and use it in his own business, because the thing was deeper than just the trucking for hire. How far would any railway system have gotten if it had proposed or favoured a monopoly.

On the other hand, if in this country the lead of the railways in the United States had been followed where they went into the business of trucking and competed on the highways, this would simply have tied up a large amount of capital and as a result accumulated a substantial deficit. This was the history of every railway that ventured into trucking, and he could not recall a single instance where a railway had gone into trucking as a business and made money. There had been cases where they had been able to credit to the trucking operations a reduced cost in trade service, and saved a loss, but the trucking operations were always carried on at a loss. Why? Because of wild-cat competition, and so long as this condition existed, there was not an incentive for any

[10] Director, Bureau of Economics, Canadian National Railways, Montreal.

business man, whether a railway operator or any other capitalist, to put capital into a field in which of necessity the profit must be marginal. It was exactly the same as farming. Those farmers happily located with regard to markets or enjoying a particular fertility of the soil did this or that or the other thing and succeeded, but farming at large was certainly not a profitable business undertaking. The same elements were in evidence regarding promiscuous trucking, a wide-open opportunity, small capital required to start, and individual initiative; in fact, a man could carry his office in his hat when engaged in trucking operations; he did not need more than about $100 capital to start, and under conditions like that how far could any form of regulation with regard to rates or any other of the panaceas which had been tried in the various states of the United States, be expected to succeed?

W. A. McLean, M.E.I.C.[11]

Mr. McLean in reply observed that Mr. Fairweather's use of the term "economic burden" and his sweeping generalities as to "productive economy" were unfortunate. Good roads were built to reduce the economic burden of transportation. Without roads as feeders and distributing arteries, railways could not exist. Nations and commerce had flourished without railways—but not without highways. The motor vehicle had added immensely to the economic value of the common road. Motor cars were no longer a luxury. They had progressed far beyond the luxury stage and were a necessity of modern life and business methods.

The term "economic burden" was destructive and the problem should be approached from a constructive viewpoint with fair consideration of economic values. When this was done, the issue would be simplified. Roads were an asset not a liability.

Transportation was to-day drawing dividends from the roads built and paid for by our fathers and it was not correct to say that interest charges were being paid on them. The present generation were in the position of lenders not borrowers, with respect to such roads and the large amount of capital wiped off. Yet Mr. Fairweather, by piling up interest charges, said that the true cost of our highways was $146,000,000 per annum. Mr. McLean further stated that his own paper had showed the actual cost as $50,350,000 per annum. Fortunately it was on the basis of actual cost the budgets were balanced. We were not concerned with charges on assets bequeathed to us clear of debt.

By similar methods, Mr. Fairweather had reached what he described as "the amazing total of $946,000,000" as the economic burden of the highway and the motor vehicle. Many engineers had learned the folly of underestimating and Mr. Fairweather was clearly one of these. Most businesses would be wrecked by merely making a total of liabilities and expenditures, without any consideration of assets and income.

Professor W. T. Jackman

Professor Jackman stated that he saw the problem as two-fold: First, lack of traffic. If conditions at the present time were the same as in 1928, the volume of traffic would be sufficient to enable both roads to carry on satisfactorily. That was one thing, however, which had been deficient in the last two years, and which could not be controlled. The lack of traffic and the lack of employment was something which depended upon the very wide international conditions.

The second factor, in the difficulties of the present time, was the fact that the amount of high class traffic which was most productive was being depleted by other agencies of transportation, and, as Mr. Crombie had said, our rates were so much lower than those of the neighbouring republic that it was very difficult to obtain this long distance transportation of low-class traffic which moved in enormous volume and at low rates, to yield enough revenue for the railways' needs.

When considering possible improvements, Professor Jackman's suggestion would be first of all, that the Canadian National Railway should be put upon a competitive equitable basis with the Canadian Pacific. The former road had been loaded up with obligations which it could not bear economically.

The entire organizations of the preceding separate companies were taken over and all their obligations including operating expenses were taken over with them. If that aggregation of loads with that enormous development of operating expenses and fixed charges was to be borne by a railway system which has not enough traffic to carry it reasonably when organized with a proper capitalization, there would be a continuous problem, but if the road was to be placed on a satisfactory basis it was decidedly necessary that the capitalization be changed.

The enormous capitalization of the Canadian National Railways should be written down to a point which would make it reasonably comparative with that of its strong competitor, and when that had been done, this road should be divorced absolutely and for all time from the government and placed on a basis that was strictly economical, also it should be given rates like the other roads which would be reasonably compensatory. He stated that he was convinced that every member of the Canadian National Railways and every member of the Canadian Pacific Railway would consider that a fair and reasonable adjustment of the interests of the two companies. In addition there was no reason why this country should be paying the deficits of the Canadian National and some of the deficits of the Canadian Pacific—the 20 per cent reduction of the Maritimes Freight Rates Act—and subsidize other agencies such as highway carriers, to still further take away their traffic.

Directly related with this it was only reasonable to give the Canadian National and the Canadian Pacific the opportunity of competing on an equitable basis with the other interests on the highways, and to allow them to operate under the economies which were possible through such co-ordinated services.

Mention was made about the difficulty of putting the additional facilities on the highways, and of the possibilities of that kind of highway competition being competitive with the railways. He fully agreed with the viewpoint, but so long as these subsidized competitive carriers were allowed on the highways, and to take away the traffic which should more economically have gone by the co-ordinated rail-motor service, the country was getting deeper and deeper into the morass.

Would it not be advantageous if the railway companies would use their express organizations in co-ordinating this highway service with the railways and in so doing, enable them to utilize to the fullest extent all the facilities which they now had, with some additions, to give that type of co-ordinated service which the public desired, and which it looked for.

Dr. W. W. Colpitts, M.E.I.C.

The chairman remarked that in his opinion more had been accomplished towards a solution of transportation problems here than in the United States. Possibly the problem was easier of solution because in Canada the railroads were a series of long ribbons extending from the Atlantic to the Pacific, and there were not the complications of direction that there were across the border; however, in both countries the situation was critical and the problems demanded an early solution.

[11] Wynne-Roberts, Son and McLean, Toronto, Ont.

He believed that the difficulties in Canada arose initially from having built railways too lavishly, and now that the traffic had declined to more normal dimensions it was found that there was a great surplus of transportation facilities. There was no doubt that the country was in the depths of a business depression, but there was also no question but that the years 1926 to 1929 were super-normal and that it would be quite a while before the point was reached where traffic of the volume handled in 1929 would be regarded as a normal amount. Therefore the problem ought to be viewed from the standpoint that somewhere between the present volume of traffic and the traffic of 1930 was a situation that represented normal present transportation requirements. If that was the case, then the amount of over-production of transportation was measurable and that in itself was a step in the direction of solving the problem.

In the United States the situation had become so critical as a result of the business depression that a two billion dollar corporation, known as the Reconstruction Finance Corporation, had been formed to aid railroads, banks, farmers and industry generally. It was expected that the railways would be the largest borrowers, principally lines with early maturities and those whose earnings had so declined that prospectively they would be unable to meet their interest charges. The money that would be loaned to banks was expected to release large quantities of frozen assets and to relieve distress in agricultural communities and so help to turn the tide from depression back to prosperity. In Washington a short time ago when assisting in organizing the railway department of the Reconstruction Finance Corporation, and even before the directors of the corporation had been named, a number of railroads were preparing to file applications for loans. As a matter of fact, many railroads that were formerly regarded as among the strongest in the country were now in a desperate situation for lack of funds to meet maturities and interest requirements. Even the great Pennsylvania Railroad had been obliged to suspend its electrification work between New York and Washington. This had been brought about through decline of traffic and through the competition of unregulated new agencies, principally the private automobile and the motor truck. Considerable talk had been heard about the bus, but as a matter of fact its competitive effect was so small as hardly to be worthy of mention, but the competition of the truck was growing every day. It appeared that trucks now carry about 12 per cent of the freight traffic of the country that would otherwise move by rail. All these competitive conditions were also present in Canada and must be dealt with in a proper and constructive manner to the end that the public would finally be given the cheapest, the best and the most suitable form of transportation. A feeling has been growing throughout the United States, and he thought that those present, including Mr. Crombie and the other railroad operators present must share it, that although the railroads have done a splendid job in increasing the efficiency of their individual operations since the war, and in reducing unit costs of every nature, for which they were deserving of the greatest credit, nevertheless in the matter of co-ordination and co-operation between the different companies to reduce expenses, which was a wide field presenting great opportunities, they had accomplished very little.

He would not be surprised if this applied to the Canadian Pacific and the Canadian National; it certainly applied very largely throughout the United States. It would almost seem that railroad men were brought up in the belief that their own road was bound to be benefited if its neighbour was injured. Competition had been carried to the point where to put the other fellow out of business entirely was regarded as the desirable thing to do. Competition in transportation had gone beyond all sound limits of restraint, and all of that had to be changed; railroad officials had to learn that it was by co-operation between themselves, by co-ordinating their own facilities, as well as by co-ordinating the railroads and other transportation agencies, that the transportation business of the country could be most cheaply handled. That, after all, was what all were striving for. Whether for short-haul or long-haul, for slow delivery or quick delivery, one could rest assured that the people were going to have the best and cheapest form of transportation sooner or later and it was up to the railroads as well as other agencies to co-operate and co-ordinate so as to provide it.

He did not think the railroads had any right to complain because a new transportation agency had been developed to the point where it performed certain functions more satisfactorily than the railroads. That was an investment hazard inherent in all business and the only just criticism of the investor in this respect was that the railroads had been too slow in co-ordinating the new utility with their own operations.

In concluding his remarks the chairman stated that he was amazed sometimes at the attitude the public had assumed in respect of the future of the railroads. Many people actually believed that the railways had become obsolete and were soon to go the way of the ox-cart, the horse car and the sailing vessel. But that was not the situation. The railroads had not become obsolete at all; in fact there was nothing on the horizon or in remote prospect that bid fair to take their place in the movement of the great bulk of the country's commerce. Though not a prophet he ventured to state that so far as ourselves and our children were concerned the railroads were here to stay. It was therefore imperative that those upon whom the responsibility for regulating them rested should treat them justly, otherwise the capital they need for improvements would not be forthcoming and their service would deteriorate. It was imperative also in common fairness that their competitors be equally regulated and supervised. And railroad officers must do their part in reducing cost of transportation on their respective lines, in eliminating the wastes of competition and in co-ordinating the operations of other agencies with their own in every case where it was advantageous in the interest of lowering transportation costs to do so.

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Our Coal Supply

While Canada is not as yet industrialized to the same extent as Great Britain or the more densely populated areas in the United States, an ever-increasing proportion of our population lives by industry rather than agriculture, and for its welfare, therefore, depends largely upon our fuel supply. It is true that the industrial power of Canada is not based entirely on coal, as was the case in Great Britain during its remarkable industrial development in the nineteenth century, for our supply of water power gives us a considerable degree of independence in that respect. Over the greater part of Canada climatic conditions, however, call for the expenditure of a good deal of fuel for heating rather than power, and unfortunately for the householder, no substitute for coal or oil has yet been found for this purpose. We possess ample supplies of bituminous coal, though they are by no means conveniently located, immense deposits of lignite, which for various reasons cannot be transported economically, and oil fields which as yet produce more gas than oil. Anthracite exists in Canada, but in small quantity and far from the points of demand. It is noteworthy that Canada's production of coal, averaging 15,000,000 tons per annum, covers less than one-half of our total consumption.

Just across the border to the south lies the country which in point of coal resources and annual output leads the world. With an annual production of over 400,000,000 tons of bituminous coal and lignite, and nearly 60,000,000 tons of anthracite, it is estimated that the bituminous coal fields of the United States will outlast those of all other countries, though as regards anthracite, the available supply may not last more than about one hundred years. The principal coal export business of the United States is with Canada, to which some 17,000,000 tons were sent in 1929.

In Great Britain, of course, coal is definitely the predominant factor in industry. That country is the second largest producer of coal and by far the largest exporter, although the British coal trade has been severely affected by the course of events since the War, the coal output dropping from 287,000,000 tons in 1913 to 243,000,000 in 1930, and the exports falling during this period from 50 per cent of the world's coal exports to 40 per cent.

The productive capacity of the British coal mines is some 60,000,000 tons in excess of their present annual output, a condition which is even more marked in the United States, whose mines are probably capable of producing an additional 400,000,000 tons annually. In both countries this situation has been complicated by troublesome labour problems involving a large amount of unemployment, and industrial difficulties have resulted for which no remedies have yet been found. The effect of this state of affairs on the general prosperity of these countries has been very great, as may be imagined from the magnitude of the figures given above.

It might be supposed that in Canada, with fuel requirements on a more modest scale, our difficulties would have been less pressing and easily solved. This is not so. We have coal in the east and coal in the west, but the central region of Canada, where the bulk of our industries are carried on, has practically no fuel of its own, although it is not far from some of the largest and best coal fields in the United States. The productive capacity of the four hundred coal mines in Canada is not largely in excess of the total consumption, as is the case in the United States and Great Britain, but their capacity does greatly exceed the actual requirements of the areas near them to which transportation is economically possible. Our coal areas have not been free from labour difficulties. The extraction of coal from many of our mines is necessarily expensive because of physical and geological limitations.

The Canadian coal industry has long been the subject of argument and propaganda due to conflicting interests. In consequence the question of our fuel supply has been the basis of many inquiries on the part of committees and commissions, federal, provincial and industrial, trying to find out, among other things, why, with immense reserves of fuel, we import more than one-half our coal, whether this state of things can or should be changed, and if so, how it should be done.

Members of The Institute have been able to assist effectively in this matter. Council took action in 1923, and appointed a representative Fuel Committee which in 1924 gave an admirable summary of the situation as it then existed, with definite recommendations, a number of which have since been acted upon. More recently six of our members contributed to the Fuel Symposium, which has just been held by McGill University, papers constituting the major portion of the volume* recording its proceedings, a book which is reviewed elsewhere in this issue. The bibliographies attached to the various papers of that Symposium give impressive lists of reports and writings bearing on the technical, industrial and economic aspects of the Canadian coal problem.

In the concluding paper of the Symposium, dealing with the economic aspects of the Canadian coal problem, the author asks whether Canada can be made completely independent of other-than-Canadian sources of coal and oil supply, and, if this is possible, what price would have to be paid in the form of an increased coal bill, over and above the corresponding expenditure if the coal market were absolutely free. He comes to the conclusion that an all-Canadian fuel policy, rigorously carried out, would involve an increased annual outlay of from 40 to 60 million dollars, "a considerable sum to add to the cost of living and manu-

*Proceedings of the Symposium on Fuel and Coal, McGill University, 1931.

facturing in this country." Those who urge the adoption of this solution of our fuel problem should count the cost of economic nationalism if carried to such an extent. It is pointed out that the amount would naturally depend largely on the cost of moving Canadian coal in large quantities over long distances and hence is bound up with the operation of our transportation systems; the situation has grown even more complex during the last decade owing to the action of the Federal government in increasing tariffs, giving subventions on transportation, drawbacks, bounties on production for certain specific services, and so on. Mr. Lesslie Thomson proposes, in view of the complexity of the whole matter, that there should be established a national fuel and coal commission having jurisdiction over the whole coal and fuel industry (and perhaps power), in much the same manner as the Board of Railway Commissioners has over transportation.

This suggestion has much to recommend it, provided, of course, that the Commission would be a non-political board composed of the best available men, and clothed with executive as well as advisory powers for the exercise of which it would be responsible only to Parliament. The Board would have to deal principally with economic questions, for it is these, rather than technological matters, which present the greatest difficulties and on which wise action must be taken if real progress is to be made.

Recent events, particularly in the Maritime Provinces, indicate that the coal situation in Canada has lost none of its urgency, and that the people of this country as a whole still fail to realize the economic difficulties which confront Canadian mine operators and miners, the complications connected with transportation costs, and the extent to which the tax-payers' money has been employed to bolster up our coal industry.

As engineers we are apt to believe that when full investigation has pointed out a course which is entirely justifiable on technological and economic grounds, an industrial problem is solved. Such a conclusion may be wrong, and serious difficulty may still be ahead, in a case where political implications arise. The operation of a fuel commission, for example, under federal direction, could not give the desired results if the provinces were to insist so firmly on their undoubted rights as to imperil the well-being of the whole industry.

Is it too much to hope that as regards the Canadian coal question, a truly national rather than a local viewpoint will be taken by all concerned?

OBITUARIES

Richard Hall, M.E.I.C.

Members of The Institute will learn with regret of the death of Richard Hall, M.E.I.C., which occurred at Vancouver, B.C., on February 21st, 1932.

Mr. Hall was born at Gatineau Mills, on March 25th, 1850, and was educated at McGill University, Montreal, graduating with the degree of B.A.Sc., in 1878.

Following graduation, Mr. Hall was connected with Messrs. Gilmour and Company at Trenton, Ont., being engaged on remodelling, designing and erecting steam sawmills. In 1882 he was head draughtsman with the Wm. Hamilton Manufacturing Company at Peterborough, Ont. Following this, Mr. Hall lived for a number of years at Rat Portage where he was engaged in general engineering work. In 1895 he opened up a coal mine for the Souris Coal Mining Company at Souris. Mr. Hall settled in Vancouver in 1907, and was for many years connected with the Department of Public Works, being for ten years superintendent of dredging.

He joined The Institute (then the Canadian Society of Civil Engineers) as a Member on May 25th, 1899, and was placed on the retired list in 1922.

George Wyon Rogers, A.M.E.I.C.

Regret is expressed in recording the death at Brownsville, Texas, of George Wyon Rogers, A.M.E.I.C., on February 14th, 1932.

Mr. Rogers was born near London, England, on February 17th, 1869, and was educated at the Crystal Palace School of Engineering, and King's College, London. He was for three years articled pupil to the late W. Santo Crimp.

Later he was for a time assistant to the late Sir F. Bramwell and subsequently to the late Rogers Field, being engaged on engineering works in different parts of England and on underground work in London. Coming to Canada in 1908, Mr. Rogers was for some years an engineer in the service of the government of the province of Manitoba. In 1924 he was appointed engineer on the Donna Irrigation District, Texas, U.S.A., and later became city engineer of Brownsville, Texas, which position he held at the time of his death.

Mr. Rogers joined The Institute as an Associate Member on July 23rd, 1918.

Hugh Chester Williams, A.M.E.I.C.

We regret to have to put on record the death of Hugh Chester Williams, A.M.E.I.C., which occurred at Grimsby, Ont., on February 11th, 1932.

Mr. Williams was born at London, Ont., on March 8th, 1891, and was educated at private and boarding schools.

From 1911 to 1914, Mr. Williams was with the Canadian Pacific Railway Company, being engaged on construction work. In 1915 he went overseas as a lieutenant with the Canadian Engineers and Pioneer Company on railroad construction. Returning to Canada after the war, he became attached to the staff of the Department of Public Highways, Ontario, with which he remained until his death, at which time he was assistant engineer at Grimsby, Ont.

Mr. Williams joined The Institute as an Associate Member on July 18th, 1927.

PERSONALS

Ellwood Wilson, M.E.I.C., has been appointed professor of sylviculture at Cornell University, Ithaca, N.Y. Mr. Wilson graduated from the University of the South, Sewanee, Tenn., in 1893, with the degrees of B.A., B.Sc., in chemistry, and certificates in civil engineering subjects. In 1894-1896, he was engaged on post graduate work at the University of Pennsylvania, and from March to October 1896 he studied in Germany.

During the years 1897-1900, Mr. Wilson was engaged on the construction of a plant for the Walker-Gordon Laboratory Co. Ltd., of London, England, and from 1901 to 1905 he practised civil engineering and surveying at Saranac Lake, N.Y. In 1905-1907 he mapped timber limits for the Union Bag and Paper Company Ltd. and the Laurentide Co. Ltd. Joining the staff of the Laurentide Company in 1907, as manager of the Forestry division, Mr. Wilson remained with that firm until 1922 when he accepted the position of Chief Forester with the Laurentide division of the Canada Power and Paper Company. In 1931 he became Head Forester with the Consolidated Paper Company Ltd., at Grand'Mere, Que. Mr. Wilson has taken a keen interest in the affairs of The Institute, and is chairman of the St. Maurice Valley Branch.

Paul F. Sise, M.E.I.C., president of the Northern Electric Company, Montreal, has been elected a member of

Newly-Elected Members of The Council of The Engineering Institute of Canada

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Vice-President,
Zone B.

R. L. Dobbin, M.E.I.C.,
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Councillor,
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S. C. Mifflen, M.E.I.C.,
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J. R. Morrison, A.M.E.I.C.,
Councillor,
Cape Breton Branch.

F. C. Green, M.E.I.C.,
Councillor,
Victoria Branch.

the board of directors of the Dominion Engineering Works, Ltd., Montreal. Mr. Sise is a graduate of McGill University of the year 1901. He entered the employ of the Northern Electric and Manufacturing Company in 1904 as Secretary-Treasurer, which position he held until 1910, when he became managing director. From 1914 to 1919 he was vice-president and general manager of the company and in 1919 was appointed to his present office.

G. E. Bell, M.E.I.C., has left for England, where he will be connected with the Deloro Smelting and Refining Company Ltd., in London. Mr. Bell was formerly assistant to the managing director of M. J. O'Brien Limited, and had been with that firm since 1925. Mr. Bell, who is an honours graduate in civil engineering of McGill University of the year 1907, was for a time western manager of the Dominion Bridge Company, Ltd., at Winnipeg, Man., being subsequently assistant to the president of the Dominion Engineering Works, Ltd., at Lachine Que., and later with the Seaman Kent Company, Ltd., at Toronto.

W. F. Drysdale, M.E.I.C., has been appointed a vice-president of the Montreal Locomotive Works Ltd. Mr. Drysdale graduated from McGill University in 1904 with the degree of B.Sc., and entered the employ of the American Locomotive Company remaining with that concern until 1911 as draughtsman, calculator and cost estimator and assistant to the chief engineer. In 1911 he became mechanical engineer of the North Railroad of Costa Rica and the Ferrocaril de Costa Rica, Central America, which position, together with the position of superintendent of buildings for the United Fruit Company in Costa Rica, he held until 1914, when he accepted the position of assistant works manager of the Steel Company of Canada, Montreal. In 1915 Mr. Drysdale was made special representative in Europe for the Montreal Locomotive Works Ltd., and the American Locomotive Company. In 1919 he was appointed managing director of the Worthington Pump and Machinery Company's interests in Belgium, France, Italy, Switzerland, Spain and Portugal, and in 1924 was one of the organizers of the Brazilian Portland Cement Company.

F. D. Farnsworth, A.M.E.I.C., is now city manager of the City of Brewer, Maine, U.S.A. From May 1913 to December 1914, Mr. Farnsworth was assistant engineer to the late H. N. Ruttan, Hon.M.E.I.C., Winnipeg, Man. For the next three years he was on the engineering staff of the Canadian Overseas Railway Corps, following which he was connected with the Nova Scotia Provincial Highway Board. He was chief engineer of the firm of Reid, Farnsworth and Shafner Ltd. from 1920 until 1926, when he became resident engineer with the State Highway Commission of Maine. He was later made town manager of Fort Fairfield, Maine, from which position he has just resigned.

H. C. Jenkinson, S.E.I.C., is with the Dominion Construction Company at Fraserdale, Ont. Mr. Jenkinson, who graduated from Queen's University in 1927 with the degree of B.Sc., was for a time with the American District Steam Company at N. Tonawanda, N.Y., and was later at Arvida, Que., with the Alcoa Power Company. In 1931 he was with the Beauharnois Construction Company at Beauharnois, Que.

Jules Joyal, A.M.E.I.C., who was formerly with Price Brothers and Company Ltd., at Chicoutimi Centre, Que., is engineer of the Quebec Public Service Commission at Quebec, Que. Mr. Joyal graduated from the University of Montreal in 1920 with the degree of B.A.Sc.

J. C. Nutter, A.M.E.I.C., has joined the staff of the Canadian Paperboard Company, Toronto, Ont. Prior to accepting his present position, Mr. Nutter was with Price Brothers and Company Ltd., at Quebec, Que., and was at one time superintendent of the Nashwaak Pulp and Paper Company Ltd., at Saint John, N.B.

F. E. Palmer, Jr.E.I.C., who was formerly a draughtsman on the staff of Price Brothers and Company Ltd., at Riverbend, Que., is now with the Kirk-Allen Company, Montreal.

H. A. Thompson, A.M.E.I.C., is now designer and engineer on the layout of construction at the mill of the Abitibi Pulp and Paper Company at Smooth Rock Falls, Ont. Mr. Thompson who is a graduate of McGill University of the year 1927, was formerly construction engineer with Morrow and Beatty, at Fitzroy Harbour, Ont.

CORRESPONDENCE

March 8th, 1932.

The Editor,
The Engineering Journal.

Sir:

The Committee on Development has been drawn to my attention by Mr. Busfield and Mr. Muntz in their letters published in recent issues of The Engineering Journal concerning the aims and future of The Engineering Institute, which are declared to be first and foremost the acquirement and interchange of professional knowledge. For some years past, however, doubts have arisen in my mind on this subject, not only as regards The Engineering Institute but other similar well known institutions to which I belong.

Judging from results it appears that the policy followed in all cases has been to enroll the largest possible membership and to produce the most impressive publication. In addition to this the universities, with the encouragement of institutions and large engineering firms, have, and still are, turning out many more trained engineers than can possibly be absorbed into engineering practice. Today we find that engineers are two-a-penny and the future of a large number of them is gloomily uncertain despite their undoubted engineering qualifications. The truth of these statements is shown by the increased yearly membership of engineering institutions and faculties in the past.

The welfare of the engineering profession is the welfare of the individual, whose welfare in turn depends on his ability to find profitable employment in his profession, which is increasingly menaced by its over-population. Should not we then, as a body of engineers, strive to regulate the numbers of our profession and to make it more exclusive? What is the use of exchanging knowledge if we shall not be allowed to benefit thereby.

In my opinion we, as a body, should make it our business to see that engineers are rewarded suitably for their labours, we should not allow our profesion to be degraded by mass commercialization of its members. The supply of trained engineers should be made to equal the demand and engineers themselves should be bound to observe the ethics of their profession more closely. Our Institute requires more teeth so that its bark may be followed up by a good big bite.

I make this strong suggestion to the Committee on Development, that they seriously consider the welfare of the engineer as being of equal or greater importance than the distribution of knowledge, which latter function is already well performed. Otherwise I fear our profession will fall on evil days if allowed to continue unregulated. The provincial professional associations have no powers to act in such matters, therefore it will remain to The Engineering Institute and kindred organizations to seek the means of dealing with this important situation.

Yours very truly,

O. W. BARTLETT, A.M.E.I.C.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Royal Society of Canada: Transactions, Third Series, Vol. 25, Section 4, May, 1931: Geological Sciences, Including Mineralogy.
Symposium on Fuel and Coal, McGill University; Proceedings, Oct. and Nov., 1931.
The Society of Engineers, (Inc.): Transactions for 1931.
International Conference on Bituminous Coal: Proceedings, Vols. 1 and 2, November 16 to 21, 1931.

Reports, etc.

Department of Labour, Canada:
Report of the Department of Labour for the Fiscal Year Ending March 31, 1931.
Strikes and Lockouts in Canada and in Other Countries during 1931.
Bureau of Statistics, Dept. of Trade and Commerce, Canada:
Trade of Canada, Fiscal Year Ended March 31, 1931.
Topographical Survey, Dept. of the Interior, Canada:
[Map of] Kississing, Saskatchewan-Manitoba, 1931.

FOREST SERVICE, DEPT. OF THE INTERIOR, CANADA:
Circular 33: Effect of Moisture Content and Storage on the Heating Value of Sawdust.
34: The Strength and Spike-Retention Properties of Jack Pine Ties Affected with Red Stain and Red Rot.

AIR MINISTRY, AERONAUTICAL RESEARCH COMMITTEE, GREAT BRITAIN:
Reports and Memoranda, No. 1380: Pressure and Force Measurements on Airscrew-Body Combinations.
1402: Growth of Circulation About a Wing and an Apparatus for Measuring Fluid Motion.
1414: Drag and Interference of a Nacelle when Installed on the Upper Surface of a Wing.

BUREAU OF MINES, UNITED STATES:
Asbestos in 1930.
Lime in 1930.
Tin in 1930.
Cobalt, Molybdenum, Tantalum, Titanium and Various Rare Metals in 1930.
Barite and Barium Products in 1930.
Stone in 1930.
Manganese and Manganiferous Ores in 1930.
Phosphate Rock in 1930.
Mica in 1930.
Gold, Silver, Copper, Lead and Zinc in Montana in 1930.
List of Publications, Bureau of Mines, 1910-1931.
Technical Paper 510: Results of Some Magnetic Measurements on Dikes . . .
Bulletin 346: Physical Testing of Explosives . .

GEOLOGICAL SURVEY, UNITED STATES:
Water-Supply Paper 675: Surface Water Supply of Hawaii, July 1, 1927 to June 30, 1928.
Bulletin 834: Bibliography of North American Geology, 1929 and 1930.

BUREAU OF STANDARDS, UNITED STATES:
Commercial Standard CS32-31: Cotton Cloth for Rubber and Pyroxylin Coating.
CS36-31: Fourdrinier Wire Cloth.
Circular No. 395: Zinc and Its Alloys.
396: Architectural Acoustics.

LIBRARY OF CONGRESS, UNITED STATES:
Guide to the Cataloguing of the Serial Publications of Societies and Institutions, 2nd ed., 1931.

NATIONAL ELECTRIC LIGHT ASSOCIATION:
Railway Electrification Committee: Electrification of Steam Railroads.
Overhead Systems Committee, Eng'g National Section: Construction and Maintenance Equipment, and Methods.

UNIVERSITY OF MICHIGAN:
Eng'g Research Bulletin No. 21: Influence of Atmosphere and Temperature on the Behaviour of Steel in Forging Furnaces.

OHIO STATE UNIVERSITY:
Eng'g Experiment Station Circular No. 27: The Usefulness of Mathematics to Engineers.

UNIVERSITY OF CALIFORNIA:
Dept. of Geological Sciences, Bulletin: Paleozoic Eruptive Rocks of the Southern Klamath Mountains, Calif.
The History and Character of Volcanic Domes.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LTD.:
Annual Report for the Fiscal Year ended December 31, 1931.

Technical Books, etc.

PRESENTED BY THE INTERNATIONAL NICKEL COMPANY, INC.:
The Story of Nickel [44 pp.]—Reprinted from Journal of Chemical Education, Sept., Oct. and Dec., 1931.

PRESENTED BY UNITED STATES STEEL PRODUCTS COMPANY:
Bayonne Bridge Over the Kill Van Kull... Addresses delivered at Dedication, Nov. 14, 1931.
George Washington Bridge Over the Hudson River ... Addresses delivered at Dedication, Oct. 24, 1931.

PRESENTED BY PROPRIETORS OF "THE ENGINEER":
"The Engineer" Directory and Buyers' Guide, 1932.

PRESENTED BY UNITED STATES STEEL CORPORATION:
The Martinez-Benicia Bridge... [34 pp.], by Chas. F. Goodrich.
The Kill Van Kull Bridge... [67 pp.], by H. W. Troelsch.

PRESENTED BY DORMAN, LONG & CO. LTD.:
Handbook for Constructional Engineers Containing Tables Relating to Steel, 1930 (second imprint).

PRESENTED BY BRITISH STEELWORK ASSOCIATION:
How to Recognize British Steel [4 pp.].
Modern Steelwork, 1930 [255 pp.].

PRESENTED BY CANADIAN MANUFACTURERS' ASSOCIATION:
Canadian Trade Index, 1932.

PRESENTED BY SOCIETATEA POLITECNICA DIN ROMANIA:
Historique de la Société Polytechnique, 1881-1931, par Ion Ionescu.
Semicentenarul, 1881-1931: Vol. 1: Istoricul Societatii Politecnice Stiinte Pure Si Aplicate Architectura. Lucrari Publice.
2: Mecanica. Masini. Industrii. Electricitate.
3: Geologie. Mine. Fizica Si Chimie Industriala Invatamant Tecnic Chestiuni Sociale, Economice Si Legislatie.

PRESENTED BY THE NORWEGIAN CONSULATE GENERAL:
Norges Industri—Special Number: Norwegian Hydro-Electric Industry, 1932.

PURCHASED:
Symposium on Effect of Temperature on the Properties of Metals, Published jointly by the American Society of Mechanical Engineers and the American Society for Testing Materials, 1931.
The Electric Journal, Vols. 27 and 28, 1930 and 1931.
The Bridges of the Rhine: Roman, Mediaeval and Modern, by Karl Mohringer. Published by Joh. Mohringer, 1931.

Catalogues

PARKER-KALON CORPORATION:
Parker-Kalon Products [Screws and Nails] [28 pp.].

EDWARDS AND CO., INC.:
The Flushcall Line... [Doorbells, Buzzers, etc.] [12 pp.].

BOOK REVIEWS

Proceedings of the Symposium on Fuel and Coal, McGill University, 1931

Published by McGill University, 1931, paper, 6 x 9 in., 474 pp., photos, figs., tables, map, $1.50.

The authors of the eight papers contained in this volume are all well qualified to write on the subjects selected, and their collective work has provided a systematic and very readable summary of our present knowledge as regards the important problems connected with the fuel supply of this country. The papers and their authors are as follows:

TITLES	AUTHOR
Origin, Physical Character, and Distribution of Canadian Coals.	Dr. E. S. Moore, Professor of Economic Geology, University of Toronto, Toronto.
Chemical Composition and Classification of Canadian Coals.	Edgar Stansfield, M.E.I.C., Research Professor on Fuels, University of Alberta, Edmonton.
Gasification.	J. J. Humphreys, M.E.I.C., Chief Engineer, Gas Division, Montreal Light, Heat & Power Cons., Montreal.
High Temperature Carbonization.	A. T. Leavitt, M.E.I.C., President, Hamilton By-Product Coke Ovens, Ltd., Hamilton.
Low Temperature Carbonization.	C. Tasker, Research Fellow in Fuels, The Ontario Research Foundation, Toronto.
Relation of Petroleum and Its Allied Products to Coal. Hydrogenation, etc.	Ls.-Chs. Lajoie, Chemist, The Imperial Oil Refineries, Ltd., Montreal.
Relation of Electricity to Coal.	F. A. Combe, M.E.I.C., Consulting Engineer, Montreal. and J. T. Farmer, M.E.I.C., Engineer, Montreal Engineering Co. Ltd., Montreal.
Some Economic Aspects of the Canadian Coal Problem.	Lesslie R. Thomson, M.E.I.C., Professor of Fuel Engineering, McGill University, Montreal.

While all of these papers will repay careful study, the first and last, "Origin, Physical Character, and Distribution of Canadian Coals," by Dr. E. S. Moore, and, "Some Economic Aspects of the Canadian Coal Problem," by Professor Lesslie R. Thomson, M.E.I.C., respectively, are not so technical as to present any difficulty to the general reader, and contain information which should be in the hands of everyone who desires to form an intelligent opinion on Canada's fuel problem. Mr. Tasker in his paper on "Low Temperature Carbonization" has collected the most recent information available as to the technical progress made in this very difficult method of utilizing our coal supplies, and Messrs. Combe and Farmer give an admirable sketch of the economic pros and cons as between hydro-electric and steam-electric power generation.

McGill University is certainly to be congratulated upon the issue of a volume which gives in compendious form such pertinent and up-to-date information and presents it in such a clear and impartial manner. A copy of these Proceedings should be in the hands of everyone who is interested in our fuel problem, a question of vital importance to Canada at the present time.

Materials Handbook

By George S. Brady. McGraw-Hill, New York, 1931, leatherette, 4 x 7 in., 588 pp., charts, tables, $5.00. 2nd edition.

Reviewed by Lieut.-Col. L. F. Goodwin, m.e.i.c.*

This book has now reached its second edition, and aims to give "the purchasing agent and industrial executive quick reference data that will aid in distinguishing and selecting materials, etc." The book would appear to fulfil its purpose very thoroughly. It deals more particularly with abrasives, bearing metals, brasses and bronzes, corrosion-resisting and other alloys, fabrics and fibres, lubricants and industrial chemicals, and with other materials of construction.

To test the usefulness of such a book it is best to look up a number of materials with which the reviewer is familiar, or which readily spring to mind. In nearly every case the information sought for was obtained. On the other hand, it is well to point out what appears to be an inequality of treatment. In looking up, for instance, the non-corroding alloys, we find staybrite and stainless iron listed, but not non-rusting steel. The following materials, which are of increasing industrial importance, are not listed: Ni-rosta, Krupp Steel, and V_2A, although they may be found under the heading, "Chromium Nickel Steel," but this would already pre-suppose a knowledge of their composition. On the other hand, such alloys as Enduro, Duraloy, Tantiron, and Duriron, are separately listed.

Ammonia, Ammonium Nitrate, are listed, but not Ammonium Sulphate. Neither can one find Glycol, but this may be discovered under Ethylene Glycol.

Quite a number of useful indications are given as regards prices. Thus, Beryllium, described as an "elementary metal" instead of as a metallic element,—a misnomer applied to several other elements,—is stated to have cost between fifty and one hundred dollars a pound in 1930. On the other hand, no prices are given for Furfural, and Ethylene Glycol, and yet both are of considerable industrial importance, and show a continually increasing number of applications. Selenium is described as an elementary metal once again, but is usually classed by chemists as a non-metallic element.

Beetle (the reviewer believes the correct name is Beatle), is stated to be a Thiourea, but one looks in vain for Fir, although Balsam Fir is listed.

It is, however, obvious, that in compiling a volume of this nature it is exceedingly difficult to adopt uniformity of treatment, nor can the compiler be expected to have everything absolutely correct.

The reviewer believes this Materials Handbook to fulfil adequately the purpose for which it is intended.

*Professor of Chemical Engineering, Queen's University, Kingston, Ontario.

Canadian Trade Index, 1932

Compiled and published by Canadian Manufacturers' Association, Inc., Toronto, 1932. Cloth, 6½ x 10½ in., 868 pp., tables, $6.00.

This is the eighth annual issue of the Canadian Trade Index. A special feature of the 1932 edition is the inclusion of a 60-page special export section, provided by the Department of Trade and Commerce of the Dominion government, and containing a survey of Canadian progress in commerce, with a discussion of methods of doing export business contributed by experienced exporting manufacturers.

The present edition contains an alphabetical and classified directory of over 10,000 Canadian manufacturers and their products, in which are indicated those firms interested in and prepared to do export trade; a directory of exporters of agricultural produce and allied lines; and, as indicated above, a summary statement of Canadian export trade.

This work is very valuable as a reference aid, and is the only comprehensive book of its kind published in Canada.

Hamilton Gear and Machine Company Ltd., 62-100 Van Horne street, Toronto 4, Ont., has published a 16-page booklet entitled "Roldweld" on electric welded steel spur gears. This contains the list prices, discounts, etc., for these gears in sizes ranging from 6 to 1½ diametral pitch and for various numbers of teeth. Formulae and tables for obtaining the horse power capacity and strength of gear teeth of various hardnesses are included. Copies of the booklet may be secured from the company at the address given above.

We have received from the offices of the British Steel Export Association, 1538 Sun Life building, Montreal, a copy of a handbook for Constructional Engineers, with tables giving dimensions and properties of both the new and old British Standard Sections for structural steel, together with an excellent selection of general information, formulae, tables, etc. Those relate particularly to the products of Dorman, Long and Company, Ltd., Middlesbrough, but as far as the standard sections are concerned, they of course apply equally to the products of other British steel makers.

ELECTIONS AND TRANSFERS

At the meeting of Council held on March 18th, 1932, the following elections and transfers were effected:

Members

COWIE, Alfred Henry, Lt.-Col., M.C., B.Eng., M.Eng., (Liverpool Univ.), asst. gen. manager, Dominion Bridge Company, Ltd., Montreal, Que.

PRICE, Joseph Lewis Edgar, president and managing director, J. L. E. Price & Company, Limited, Montreal, Que.

ROAST, Harold James, (City of London College), Proprietor, Roast Laboratories, Regd., sessional lecturer in charge of metallography and metallurgical analysis, Department of Metallurgy, McGill University, Montreal, Que.

RUNDLE, Lewis Philip, B.S. in E.E., (Case School of App. Sci.), senior assistant engineer, Welland Ship Canal, St. Catharines, Ont.

SAMPSON, William Thomas, chief engineer, Wright-Hargreaves Mines Ltd., Kirkland Lake, Ont.

TROWBRIDGE, Charles Bartlett, B.S., (Rose Polytech. Institute), sales manager, Canadian Mead-Morrison Mfg. Co., Montreal, Que.

Associate Members

ANDERSON, Clarence Aubrey, (N.S. Tech. Coll.), elect'l. supt., Halifax Harbour Commissioners, Halifax, N.S.

BREITHAUPT, Philip William, C.E., (Rensselaer Polytech. Institute), civil engineer, with W. H. Breithaupt, m.e.i.c., Kitchener, Ont.

BRYDON, Noel Morris, B.Sc. (Civil and Mech.), (St. Andrew's Univ.), president and general manager, Brydon Construction Co. Ltd., Toronto, Ont.

DESSERUD, Anton, C.E., (Tech. Univ. Norway), civil engineer, Power Corporation of Canada, Ltd., Montreal, Que.

ERIKSEN, Gudmund, (Oslo Tech. School), city engineer's dept., Port Arthur, Ont.

FORGAN, David, (Glasgow Tech. College), asst. engr., H.E.P.C. of Ontario, Toronto, Ont.

LEFEBVRE, Paul, B.A.Sc., (Ecole Polytech., Montreal), civil engineer, Provincial Fire Commissioner's Office, Department of Public Works, Quebec, Que.

MacDONALD, Donald Stewart, B.Sc., (Queen's Univ.), 255 Ossington Avenue, Toronto, Ont.

MUGAAS, Henrik, (Tech. College, Darmstadt), 2216 Souvenir Avenue, Montreal, Que.

ROGERS, Harry George, (McGill Univ.), bridge inspr., bridge engrg. dept., C.P.R., Montreal, Que.

WEBSTER, Charles William, (Acadia Univ.), instr'man and field engr., Dept. Public Highways Ontario, Grimsby, Ont.

Juniors

FEICK, Clayton George Emmerich, B.A.Sc., (Univ. of Toronto), P.O. Box 273, Wiarton, Ont.

JEPSEN, Viggo, (Tech. School Horsens), 2196 Dorchester St. West, Montreal, Que.

LEAK, Charles Richard William, D.L.S., office engr. and map dftsman., Dept. Natural Resources, Govt. of the Prov. of Sask., Regina, Sask.

Affiliate

TACHE, Guy, (Quebec Tech. School), chief dftsman., Price Bros. & Co. Ltd., Chicoutimi, Que.

Transferred from the class of Associate Member to that of Member

HUNT, Walter George, B.Sc., (McGill Univ.), president and managing director, Walter G. Hunt & Co. Ltd., Montreal, Que.

CROSS, Frederick George, Major, asst. supt., operation and mtce., Dept. Natural Resources, C.P.R., Brooks, Alta.

Transferred from the class of Junior to that of Associate Member

BOISVERT, Charles H., B.A.Sc., (Ecole Polytech., Montreal), acting chief engr., Quebec Public Service Commission, Quebec, Que.

DENNISON, George Henry Edward, (Grad. R.M.C.), dftsman., Algoma Steel Corporation, Sault Ste Marie, Ont.

IRETON, Joseph Maurice, B.Sc., (Queen's Univ.), teacher of maths. and dfting., Calgary Technical High School, Calgary, Alta.

MACDONALD, Albert Edward, B.Sc., (N.S. Tech. Coll.), M.Sc., (McGill Univ.), associate professor of civil engineering, University of Manitoba, Winnipeg, Man.

RAMSEY, Kenneth Macpherson, B.Sc., (McGill Univ.), manager, Montreal office, and consltg. engr. to Citadel Brick Limited, Montreal, Que.

TRUEMAN, James Cobden, B.Sc., (Univ. of Man.), M.Sc., (McGill Univ.), designing engr., Dominion Bridge Company, Ltd., Winnipeg, Man.

Transferred from the class of Student to that of Associate Member

CHENEY, Wayne Putnam, B.Sc., (Univ. of Man.), 2035 Montague St., Regina, Sask.

KAYE, John Robert, B.Sc., (McGill Univ.), 8 Oxford St., Halifax, N.S.

OGILVY, Robert Forrest, B.Sc., (McGill Univ.), 3489 Atwater Avenue, Montreal, Que.

Trasferred from the class of Student to that of Junior

PRICE, Frederick Avery, B.Sc., (Queen's Univ.), asst. plant engr., Donnacona Paper Co., Donnacona, Que.

Transferred from the class of Affiliate to that of Associate Member

CUNNINGHAM, John Ferguson, (Univ. of Man.), supt. of testing labs., University of Manitoba, Winnipeg, Man.

Students Admitted

BRITTAIN, Norman Westaway, (Univ. of N.B.), 318 Argyle Street, Fredericton, N.B.

CONNER, Howard, (McGill Univ.), 3485 McTavish St., Montreal, Que.

DENTON, Allan Leslie, (Univ. of N.B.), R.R. No. 2, Ripples, N.B.

DORE, Richard Francis, (Queen's Univ.), 16 Aylmer Ave., Ottawa, Ont.

GRAHAM, Albert Lloyd, B.A.Sc., (Univ. of Tor.), test course, Canadian General Electric Co. Ltd., Peterborough, Ont.

HOWE, Lawrence McLean, (Univ. of Man.), 2 College Block, Ellice Ave., Winnipeg, Man.

LAWRENCE, Edward Arthur, hydrographer and leveller, Dept. Natural Resources, C.P.R., Lethbridge, Alta.

LECKY, William John, (Grad. R.M.C.), (McGill Univ.), 3863 Cote des Neiges Rd., Montreal, Que.

STANFIELD, John Yorston, (Grad. R.M.C.), (N.S. Tech. Coll.), Truro, N.S.

WILSON, Thomas Whiteside, (Univ. of Tor.), 13 Fairview Blvd., Toronto, Ont.

Undergraduates at the University of Alberta:

HAWKINS, James Edward, Strome, Alta.

JACKSON, Kenneth Arthur, Pincher Creek, Alta.

McPHERSON, Ross Cody, 10017-114th St., Edmonton, Alta.

ORR, Walter Alyn, Wetaskiwin, Alta.

STANLEY, Thomas Douglas, B.Sc. (Arts), (Univ. of Alta.), P.O. Box 5, High River, Alta.

TOLLINGTON, Gordon Charles, 1518-16th Ave. West, Calgary, Alta.

Association of Professional Engineers of Nova Scotia

The annual meeting of the Association of Professional Engineers of N.S. was held on January 21st, with a fair attendance.

Minutes of previous meeting on motion approved.

The Council's report showed six meetings held during the year, Ballots for proposed amendments to the Act and Bye-laws had been sent out and would be reported on at this meeting. Amalgamation of the Provincial Associations and The Engineering Institute of Canada had received considerable consideration. The report of the Committee of four had been considered and would be up for discussion later on. A joint banquet with the Halifax Branch of The Engineering Institute following the annual meeting had been arranged for.

The Credentials Committee's report showed that eleven applications for membership had been received; of these three had been recommended to be registered as Civil Engineers, one as mechanical, two for examination, three rejected as being under age, two required to have more experience.

The Examining Board reported that no applications had been received for examination.

The financial statement showed collections for year $982.80, deficit for year $80.50. The balance sheet showed assets, $3,506.97; liabilities, nil.

The Registrar's report showed a membership of two hundred and twelve made up as follows: Civil one hundred and thirty-six, Mechanical thirty-seven, Mining nineteen, Electrical twenty.

Report from Committee of four as dealt with by Council was adopted. Result of ballots was as follows for amendments:

Sec. B, Clause 2, to amend by adding "Steam Power Boilers and Steam Power Boiler Apparatus and Steam Power Plant Accessories to carry more than twenty pounds Steam Gauge Pressure." Carried.

Sec. C, Clause 2, to amend by deleting all the words after the word $5,000 which would make it necessary for municipal works costing over $5,000 to be designed, supervised and constructed by a registered engineer. Carried.

Clause 1 of the By-laws to amend so that meeting might be held in the evening. Defeated.

Clause 8 of the By-laws to amend so that regular meeting of Council might be held on any one of the first 7 days of each month. Carried.

New officers elected by ballot as follows:

President: G. T. Medforth, A.M.E.I.C., Amherst.

Vice-President: Professor F. R. Faulkner, M.E.I.C., N.S. Technical College, Halifax, N.S.

Councillors: H. W. L. Doane, M.E.I.C., J. L. Allan, and E. L. Baillie, A.M.E.I.C., of Halifax, and J. R. Morrison, of Sydney.

Auditors appointed: J. E. DeWolfe, A.M.E.I.C., and H. F. Laurence, M.E.I.C.

A representative on the Council of eight was left for the incoming Council. The seven government appointees to Council have not yet been made.

In the evening a successful joint banquet with the Halifax Branch of The Engineering Institute of Canada was held in the Lord Nelson hotel, at which about one hundred and thirty were in attendance.

The High Speed Heavy Oil (Diesel) Engine

As an indication of the tremendous advance that has been made in England and Europe in the application of the Diesel engine to the automotive field, it is noteworthy that at the recent Motor Transport exhibition at Olympia in London, there were no less than sixteen bus and truck chassis manufacturers exhibiting chassis with Diesel engines, in addition to which there were some exhibits of engines alone. While some of these exhibits were still admittedly in the experimental or development stage, others had definitely advanced to an established, commercially satisfactory, position in the motor transport field, some engines being in actual operation in hundreds of vehicles.

One of the features that have led to the possibility of the application of the Diesel engine to transport work is the reduction of size and of specific weight, which has come about through the use of very much higher speeds than were considered possible only a short time ago. The size of a modern high-speed Diesel engine for this type of work is about 3 feet high, 3½ feet to 4½ feet long, depending on the number of cylinders, and about 2 feet wide. Of forty-three engines for which data are obtainable, the majority range between twenty and twenty-five pounds per horse power, but there are many examples considerably less in weight, even as low as ten pounds per horse power, notable examples of which are the A.E.C., Armstrong-Saurer, Gardner, Leyland, and Tangye.

Generally speaking, the engines which have proved themselves satisfactory in operation—with a life comparable to that of the gasoline engine—are run at maximum speeds of about 1,500 to 1,800 r.p.m. but there are examples of engines running as high as 2,200 r.p.m. It is also physically possible to obtain speeds as high as 3,000 r.p.m. but the results would not be satisfactory commercially. Similarly in cases where the increased dead weight is not a serious objection engines run as low as 1,200 r.p.m., and especially in heavy duty truck towing work, give very satisfactory results.

The majority of engines of this type are built in 4-, 5- or 6-cylinder sizes. They are practically all of the four-cycle type, with the noteworthy exception of the Petter engine, which is two-cycle with independent scavenging pumps. Furthermore, with the exception of the Junkers engine, they mostly conform to the conventional gasoline engine design, with, of course, many variations regarding injection systems, combustion chambers, and so forth.

A recent issue of "The Autocar" contained a very interesting description of a five-passenger pleasure car which had been equipped with a 4-cylinder Gardner bus engine, and the story of a country run written by one of the editorial staff is intriguing—as for example "—and the speedometer told 80 m.p.h., though the engine still seemed to be turning slowly."

The problem of efficient combustion of the fuel even at such high speeds would seem to have been solved in view of the fact that fuel consumptions are down in many engines to less than 0.4 pound per brake horse power hour. Each manufacturer, of course, has his own pet ideas as to how to accomplish the best results, hence there are as many different forms of injection systems and combustion chambers as there are makes.

While fuel consumptions per b.h.p. are interesting for comparative purposes, it is fuel consumption in operation that is of even greater importance, because idling consumption is then taken into account. As an actual instance a Crossley "Condor" bus, of the double deck type equipped with an 80-h.p. 6-cylinder Gardner engine and operating on a route in Leeds, used 2,499 gallons of oil for 30,207 miles—equivalent to 12 miles per gallon. The average gasoline consumption of a similar type gasoline bus on the same route is 5.8 miles per gallon. If to this saving in consumption the lower cost of Diesel oil is applied, the final result of saving in fuel cost is a very appreciable amount.

Shipping Transformers

In the shipping of 46,500 kv.a., 3-phase, outdoor, shell type transformers by the Canadian Westinghouse Company to the power house of the Beauharnois Construction Company at Beauharnois, Que., the lower section of the regular tank was equipped with a shipping cover. This was filled with nitrogen under 3 pounds pressure. The result of this was a shipping weight of about 30 tons less than it would have been if the transformers had been shipped with the oil.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.

The January meeting of the Border Cities Branch was held on Friday, January 15th, at 6:30 p.m., in the Prince Edward hotel.

Early Surveys of Essex County

The speaker on this occasion was Mr. Geo. F. Macdonald, Past-President of the Essex County Historical Society, who addressed the meeting on "Early Surveys of Essex County." Mr. Macdonald traced the history of the Border District from the early Indian settlements to the present day.

Following his address, he showed lantern slides of many local buildings, some of which are still standing, and recounted the incidents connected with them.

Later the members availed themselves of the opportunity to look over the old English and French maps and survey notes of Essex county, which Mr. Macdonald had in his possession.

Mr. Macdonald was able to throw light on some of the problems encountered by surveyors of this district. He was able to explain how Ouellette avenue was straightened out and to tell when the Talbot road was projected, bit by bit, as the settlements grew to the westward, from Wheatley.

Illustrating the historic interest which may surround a building, he recalled one that was demolished on the site of the old Grand Trunk freight sheds. Investigating, he learned that the beams were all hand-hewn and that the laths and shingles had all been whittled out of rough billets by hand. Search of records revealed that the house had at one time been owned by a Mr. Robinson, of Inches House, Invernessshire, and that it had been erected in 1805 by a man named Evarts, who built steamships in Chatham.

The first man to traverse this part of the country, Mr. Macdonald believes, was Brule, who was sent by Champlain from Georgian Bay in 1615 to collect Indian allies. At that time, this part of the country was occupied by neutral Indians owing allegiance to neither French nor English. Brule, Mr. Macdonald said, crossed the county on his way to Ohio.

In 1640, Fathers Brebeuf and Lalemonde spent the winter in this neighborhood. Father Brebeuf went to France in 1648 and described the country to a mapmaker, N. Sanson. As a result, the latter prepared a map, a copy of which Mr. Macdonald has in his possession, and which shows the form of Essex County fairly accurately. It was the first map of this part of the country that has been found.

The next map was made by Dollier and Galinee, two Frenchmen who, in 1670, paddled their batteaux down the Detroit river and into Lake Erie.

In 1750, there was a sizeable colony of French soldiers here and another survey was made. This survey was conducted, Mr. Macdonald recalled, by a French officer, who was sent to Canada to spy out the location and strength of British forts. The maps show the run of the farms and discloses what was later to be known as the Glengarry Farm. This survey was remarkably accurate and shows the soundings in the river, the rises of land, such as the Parent Avenue "hill," the location and shape of the houses, the patches of cultivated land and the fringe of forest which ringed the settlement.

The first map of Essex County under British rule, Mr. Macdonald said, was made by David William Smith, who was later elevated to the post of surveyor general and completed a gazetteer of Upper Canada. John Alexander Wilkinson was one of the first surveyors of Windsor and set the line for McDougal Street in 1835.

After a fire destroyed Detroit in 1806, Smith was employed as surveyor to design the new community, as no civil engineer could be spared from Washington at that time. Smith set the focal point of his street system by a boulder, now believed lying under the Soldiers' Monument in Cadillac Square. His plans for the outlying parts of the village were subsequently garbled but from the City Hall to the County Buildings, now being razed, the streets are according to his plan.

Mr. Macdonald also recalled that Francis Parkman came here to gather material for his book, "The Conspiracy of Pontiac," and interviewed Francois Baby to get much of his material. Baby was born within the stockade of Detroit and was succeeded by generations of Border residents.

At the close of the address a hearty vote of thanks was extended to Mr. Macdonald by the chairman, in appreciation of his coming to address the meeting, with the unanimous approval of all members present.

Calgary Branch

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

The Science of Agriculture

At a general meeting held in the Board of Trade Rooms, Calgary, on Thursday January, 21st, Mr. E. W. Jones, Superintendent of Agriculture and Animal Husbandry, Department of Natural Resources, C.P.R., gave a very interesting address on "The Science of Agriculture."

Mr. Jones had recently made an extensive journey through Britain, Holland, Russia, Germany and other European countries, and has collected a fine series of slides of the kinds of cattle, pigs, and sheep favoured in each. These slides, together with others of prize Canadian animals, were thrown on the screen and accompanied by a running talk from the speaker pointing out the good and bad points in each case and explaining why certain breeds do better in each country and climate than others do.

A hearty vote of thanks was accorded the speaker at the close of the very animated discussion that followed his talk.

The Future Possibilities of Mineral Development in Alberta

Dr. Allen gave the members who assembled in the Board of Trade Rooms, Calgary, on Thursday, February 11th, much food for thought by his very interesting talk on the above topic.

Commencing with the first discovery of "float" coal in the gravel of the Saskatchewan river 145 years ago, the speaker mentioned the discovery of coal 'in situ' by Mackenzie in 1789 in the banks of the Mackenzie and Peace rivers; by Fikler in 1871 at Drumheller, at Edmonton in 1800 and by Alexander Henry at Saunders in 1810.

The first gold 'rush' was to Edmonton in 1841. There have been several others since that time.

From 1870 to 1880 coal was discovered in various locations in the province, and had it not been stated that Alberta coal, like Picton coal, might yield about two ton of ash for each ton of coal, the eastern market might possibly have been secured for western coal at that time.

Natural gas was discovered at Medicine Hat in 1885 and is still being discovered in various parts of the province.

Alberta is essentially a 'Fuel' province, 90 per cent of the mineral value so far produced has been fuel: coal 80 per cent, gas 8 per cent, and petroleum 2.6 per cent, clay products 3.3 per cent, cement 3.8 per cent and the remainder 2.3 per cent of gold, salt and bituminous sand. In 1930, Alberta produced 38 per cent of the coal, 70 per cent of the natural gas and 92 per cent of the petroleum produced in the Dominion. While Alberta represents only 15 per cent of the capital invested in mining in the whole of Canada, it ranks fourth in the production of minerals.

The speaker saw the need for careful exploration and prospecting with working of any finds under strict government control that shall safeguard the interests of the people, to whom the minerals rightly belong, and also those of the shareholders who back the enterprise. The development should be controlled along safe and sane lines.

Iron has been sought in all parts of the province but the only ore so far located, that is of any appreciable extent, is in the foothills district near Hillcrest. It consists of about 2,000 acres of magnetite yielding from 15 to 55 per cent of metallic iron. It is a siliceous titaniferrus magnetite containing 5 to 45 per cent silicon and 5 to 12 per cent of titanium. This deposit is being investigated to find a means of separating the titanium from the iron.

Development of coal mining has been unfortunate for, while Alberta produces 38 per cent of the coal mined in Canada, 24 out of the 246 mines in operation produced 73 per cent of the coal mined, 164 mines producing only 1 per cent between them. Coal suitable for every purpose is mined, from high-grade bituminous to lignite, and the installed equipment could produce double its present output if a market were available.

Turning to petroleum and its products, while extensive exploration and some 53 miles of hole were drilled in 1930, the speaker thought that not more than 5 per cent of the possible oil-bearing territory in the province has been explored.

Since 1898, continued the speaker, less than 50 square miles of Alberta has produced for sale $46,320,000 worth of natural gas. There are many other fields not yet fully explored and these will inevitably lead to the progress of the province as more lucrative uses for the gas are discovered.

Dr. Allen's address evoked a very lively discussion among the members and visitors present, who accorded him hearty applause at its conclusion.

Interconnected Power Supply in Alberta

On Thursday, February 25th, a large number of members and friends gathered to hear G. H. Thompson, B.Sc., A.M.E.I.C., chief engineer, Calgary Power Company, describe how the small isolated plants in the various small towns in Alberta have been gradually eliminated by the supply from a few large hydro and steam plants placed in the larger load centres and interconnected so that a maximum use may be made of the larger and more efficient plants with a minimum amount of capital invested in standby equipment.

He described how the units are automatically cut in and out as the load changes, how the peaks occur in different geographical locations and how the voltage is stepped up and down for transmission at voltages of 13,500 to 135,000 and distribution at the emf's required by the consumer.

The discussion which ensued gave evidence of the interest of those present, as did also the hearty reception accorded a vote of thanks moved by Mr. R. A. Brown, electrical superintendent for the city of Calgary, and seconded by Mr. J. F. McCall, mechanical engineer of the Calgary Power Company.

Banking and Foreign Exchange

About one-half the meetings of the Calgary Branch during the present winter session have been addressed by speakers on non-engineering subjects. On the evening of March 10th, the members were favoured with an address by Mr. J. H. McDowell, manager of the Grain Exchange Branch of the Canadian Bank of Commerce, on the above subject.

The speaker outlined the growth of our Canadian banking system from 1817 when the Montreal Bank received its charter until the system became firmly established by the first Bank Act in 1871, which provided for revision every five years and so established legal flexibility with maximum security.

Our banking system grew out of the need for a medium of exchange following the war of 1812, during which the British government had paid its bills in Army notes, which when redeemed left the country with very little readily transferrable currency and that mostly in Spanish pieces of eight and other foreign mediums.

The soundness of our financial system, continued the speaker, was shown by the large domestic loans raised during the war years. Before the end of the war a loan of $700,000,000 was successfully placed while the first war loan of $50,000,000 was then considered to be a large one. Further, the deposits in banks have grown from one billion to two billion dollars since 1913 while the domestic investment in government securities has grown to six or seven times its value.

The speaker attributed the difficulty that the average Canadian has in understanding foreign exchange to his limited experience. He has always looked upon Canadian and United States currency as synonymous and of equal parity, while the European generally has had experience with exchanges of foreign countries which are known by different names. While the United States' and our dollar have the same name and each contains one hundred cents, these are about the only things they have in common.

The interest of those present in this address was evidenced by the very lively discussion that ensued and by the very hearty applause received by the speaker.

ANNUAL MEETING

About the usual number of members turned up at the Annual Meeting held in the Board of Trade rooms, Calgary, on Saturday, March 12th. It is regrettable that the members do not attend this meeting and express their satisfaction or otherwise at the way the affairs of the Branch are being conducted as some measure of guidance to the incoming officers.

The retiring chairman, R. C. Harris, M.E.I.C., thanked the officers and members of the various committees for their very willing and effective support during the past year. Especially the Secretary, A. W. P. Lowrie, A.M.E.I.C., who had carried a major part of the burden.

The various committees submitted reports on their work during the year and the scrutineers reported that the following slate of officers had been elected:

Chairman	F. M. Steel, M.E.I.C.
Vice-Chairman	H. J. McLean, A.M.E.I.C.
Secretary-Treasurer	H. W. Tooker, A.M.E.I.C.
Executive	C. C. Richards, M.E.I.C.
	S. Coultis, M.E.I.C.
	M. W. Jennings, A.M.E.I.C.
Auditors	B. L. Thorne, M.E.I.C.
	W. B. Trotter, A.M.E.I.C.

The retiring chairman relinquished the chair in favour of his newly elected successor who bespoke the same loyal support from his officers and committees that had been accorded to his predecessors in past years. Particularly he asked that engineers living in the district who are eligible for membership should be approached to submit their credentials for an expression of opinion by the credentials and executive committees without necessarily making formal application for membership. There was considerable discussion regarding the relative values of engineering and non-engineering addresses in holding the interest of the members on which honours appeared to be about equally divided.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

A regular meeting of the Hamilton Branch was held in the Royal Connaught hotel on Tuesday, February 16th with E. P. Muntz, M.E.I.C., in the chair. Previous to the lecture by Captain A. F. Ingram, Affil.E.I.C., of the Canadian Airways, Montreal, a dinner was held at which the Executive was present, also Stewart F. MacNaughton, secretary of the Hamilton Aero Club, and Captain Jack Sanderson of the Fleet Aircraft Company of Fort Erie.

AIR TRANSPORTATION

Following up the series of lectures being given during the year on Transportation, Captain Ingram chose as his subject, "Air Transportation.' He pointed out the great progress that has been made since the war both in equipment through landing fields, etc., and in the various types of machines used. A fact little known to Canadians was brought out that of all the British fighting pilots during the war, 62 per cent were Canadians, thus proving the ready adaptability of the Canadians for air transport.

At the conclusion of the war most of these pilots went back to their ordinary business life, but some endeavoured to start commercial flying in scattered districts. However, war machines were not economical for use as commercial machines and the ventures did not prove successful.

One of the earliest of the commercial enterprises was the Jack V. Elliott Company of Hamilton, which was later absorbed into International Airways. In Winnipeg the Western Canada Airways was formed quite early. These companies engaged in freighting and received some mail contracts. Later on, the eastern and western airways enterprises were amalgamated into a single company under the name "Canadian Airways."

Captain Ingram described some of the air mail routes that have been followed by the Canadian Airways. He predicted that inside of three years every European liner will be met at Belle Isle and mail and some passengers will be taken on to Montreal. The saving in time is apparent when one considers that this distance is one third that between Montreal and Liverpool.

One of the most interesting airway routes is that between Edmonton and Aklavik, a distance of over 1,600 miles. Yet the aeroplane covers this in fourteen hours flying time (forty-eight hours elapsed time). The only other means of reaching this outpost is by dog team and this takes seventy-two days.

Captain Ingram described a journey he took last summer in the United States during which he travelled 8,000 miles in eight days. He described the comforts of flying, showing by means of lantern slides the interiors of some of the planes with comfortable chairs, facilities for meals and for sleeping. A ticket office in Chicago exclusively dealing with air transport was shown which gave one the impression that one was looking on a scene of the future.

The speaker while pointing out that air transport in Canada has lagged behind the United States services by about ten years, yet remarkable progress has been made in the past two years. He showed a moving picture film "The Flying Postman," which described the air mail service in force in Canada (part of which has been temporarily discontinued). Until every landing field is adequately equipped there are bound to be many hazards to life and property. There are certain difficulties peculiar to Canada in the organization of an air mail route. Snow may necessitate the use of skis at the taking off point and yet the landing field some 300 miles away may be devoid of any snow. A combined wheel and ski has been tried out but has not yet been perfected.

The speaker showed other films which proved beyond a doubt that the saving in time is one of the greatest factors in the success of air transport to-day.

In the discussion which followed, it was brought out that engine overhaul every three hundred hours was the most satisfactory as well as the most economical. Regarding the question of safety the speaker stated that fatality on the present status of the industry might be theoretically explained by the following. A man might travel 20,000 miles by air in the course of a year and yet it would be two hundred and fifty years before he might be killed. The high rate of insurance is a serious item, some companies preferring to carry their own risks. The total value of the air transport industry in Canada is not much over $20,000,000, yet there are at least two companies in the United States with a capitalization of over $200,000,000.

Mr. Muntz then thanked the speaker for his instructive address and the meeting adjourned.

There were eighty-five present.

THE ST. LAWRENCE WATERWAYS PROJECT

A regular meeting of the Hamilton Branch of The Institute was held in the Royal Connaught hotel on Tuesday, March 15th. E. P. Muntz, M.E.I.C., occupied the chair. The speaker of the evening was F. I. Ker, M.E.I.C., managing editor of the "Spectator," who took as his subject, "The St. Lawrence Waterways Project." This address is part of a series on "Transportation" being given during this season.

Mr. Ker predicted that at an early date the people of Canada and the United States would be called upon to pass judgment upon this scheme.

"We are on the verge of being asked for a declaration," continued Mr. Ker. "We have been talking about it for ten years, and it seems now as though things have narrowed down to the point where the governments of Canada and the United States have their procedure cut and dried, and will present a treaty and ask us whether or not we are prepared to put it through."

Hamiltonians were commended by the speaker for their interest in the project, and Mr. Ker added that more consideration had been given the St. Lawrence development here than in any other city in Canada.

In the spending of millions to complete the gigantic undertaking trade and commerce would be revived and many unemployed would be profitably engaged in a work that would make an important contribution to the future progress of the Dominion. Reference was made to the huge orders which would be placed for materials and other benefits which would accrue.

Mr. Ker read several resolutions passed some time ago by the Hamilton Chamber of Commerce, and at the close of the meeting it was moved by J. J. MacKay, M.E.I.C., seconded by G. Moes, A.M.E.I.C., that the resolutions be referred to the Executive committee, to be forwarded to the interested authorities as endorsed by the Branch.

Dealing exhaustively with the whole development programme, the speaker first traced the history of navigation between the port of Montreal and the Great Lakes, and outlined the suggested plans for the completion of the work. He urged that in the negotiations, Canada, in the making and application of treaties with the United States, preserve her sovereign rights and provide for the continuity of the all-Canadian canal system. The work should be done in Canada by Canadians, Mr. Ker declared.

The United States must recognize that the project was being undertaken in a spirit of neighbourliness and largely for the benefit of American traffic. He added that it should be understood that tolls would be imposed which would cover operating and interest charges and which would apply equally to British and American shipping. The United States should be prepared to give the Dominion a guarantee as to the amount of revenue that would annually accrue to Canada from American traffic.

The suggestion that power be made to pay the total cost of the development was strongly opposed by the speaker.

Four-fifths of the power obtainable belongs to Ontario and Quebec and the power users in these provinces could not be expected to acquiesce in any agreement through which they would, for all time, carry the cost of navigation works provided, not only for the Dominion as a whole but in so large a measure for the benefit of United States.

The attempts that have been made—and are still being made—to discredit the Beauharnois development have their origin in the designs of hostile political and private interests, and should be condemned by those whose only desire in the matter is to see that the best interests of the people of Canada are properly served and safeguarded.

The immediate development of 500,000 horse power in the Soulanges section of the river, and the prospective development of an additional 1,300,000 horse power as and when required has, through the ensured participation of the province of Ontario in the benefits of this supply, removed the urgency of power shortage which was Ontario's first consideration in pressing for the construction of the deep waterways as the only means of securing her share (1,163,000 horse power) of the power available in the international section of the river.

Provided that the quantity and the duration of the supply of power available to Ontario from Beauharnois was adequate and assured, as it was understood to be, it was preferable that Ontario should co-operate with Quebec in the development of all-Canadian power, rather than with the State of New York in the development of international power.

Following Mr. Ker's address a very interesting discussion took place in which a large number of members of the local Branch and some of the visitors took part. During the discussion a number of different aspects of the subject were brought forward including certain political features.

The chairman thanked Mr. Ker for his very instructive paper and for the interesting discussion which it produced. He mentioned that this meeting was similar to the Transportation Session at the annual general professional meeting in that the discussion was as interesting as the paper, if not more so.

The attendance was 47.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.
G. W. Rowe, Jr.E.I.C., Branch News Editor.

Dr. E. H. Boomer, of the Department of Chemistry, University of Alberta, was the guest speaker at the regular dinner meeting of the Lethbridge Branch of The Engineering Institute of Canada, Saturday evening, February 6th, in the Marquis hotel.

Dr. Boomer's subject was "Uses of Natural Gas in the Chemical Industry" and was preceded by the usual dinner and social hour.

The orchestra under the direction of George Brown was again in attendance and furnished an excellent programme of music.

Gordon Henderson and J. Stewart were the soloists of the evening, the former presenting two delightful 'cello numbers while Mr. Stewart rendered two humorous Scotch vocal numbers. Mrs. George Brown provided the piano accompaniments.

Uses of Natural Gas in the Chemical Industry

Dr. Boomer first spoke on the conditions with regard to natural gas in this province that led him to initiate a variety of chemical researches on the utilization of the gas, and second, on the more promising of the researches that have been done and are under way.

There are developed resources outside of the Turner Valley field capable of producing possibly 400,000,000 feet of natural gas per day which enter only as a future consideration to this work. These gases are dry, containing little other than methane and the wells producing them are under control. The chief focus of attention is the Turner Valley field. When it first came to the speaker's attention some five years ago, about 250,000,000 feet of gas was being wasted daily by burning in the field, and this increased to a peak approaching 600,000,000 feet per day about one year ago. The waste during the latter part of 1931 was between 380,000,000 and 400,000,000 feet per day, and was only that size because of lack of market for the recovered naphtha.

Under present conditions the life of the field developed is very limited, probably less than five years. Twenty years is the minimum that can be considered from the industrial point of view and that is only possible by taking out such gas as can be profitably used.

The average gas production per barrel of naphtha recovered is the usual criterion of quality of a field. In the Turner Valley 136,000 cubic feet of gas is taken out of the ground for every barrel of naphtha. The best well gives a barrel for about 190,000 cubic feet and they go as high as one barrel per 730,000 feet. On the top of this, each barrel of crude naphtha recovered at the separators is weathered to not much more than half a barrel before it is fit for the refinery. And that portion lost in weathering, the so-called "stabilizer gas," is the most valuable gas from the chemical point of view.

The Turner Valley gas is unique in containing an appreciable amount of hydrocarbons lighter than methane, about 12 per cent of ethane, propane and butane besides the lighter liquid hydro-carbons. These are of greater value as chemical raw materials than methane will ever be and possess a greater value as such raw material than as fuel. The reverse is probably true of methane and an important point to bear in mind is the flexibility of chemical industry.

Dr. Boomer discussed three processes, interlinked and dealing with coal or bitumen as well as gas. The first consideration was obviously, can natural gas be used directly, or can an easily made product of natural gas be used as raw material for established industrial processes. The second consideration and most important, was the market for such product. In Alberta at present, the biggest market for any product derivable from natural gas is motor fuel and oil. All the other chemical products that may be related to natural gas have markets insignificant by comparison.

The project which has become the cornerstone was dealt with first, namely, the pyrolysis of Alberta natural gas and the stabilizer gases. By pyrolysis is meant simply a beating of the gas itself in the presence of a catalyst or not. Interest was taken in the yields of liquids, their nature and the resultant gases. By recycling the gas three times the yield could be pushed up to about 100 gallons per 1,000 feet, a 10 per cent increase. This was preliminary work and it is doubtful if anything of commercial application is possible. With Turner Valley gas, the yield is increased enormously. About .75 gallons per 1,000 feet could be obtained on one treatment, .4 gallons of which was light oil and .35 tar. Recycling doubled the yield after a total of four passages. With stabilizer gas, containing a high percentage of hydrocarbons above methane, there is another jump in yields, 3½ to 4 gallons per 1,000 feet is obtained, the light oil fraction running above 2 gallons per 1,000 feet.

Another gas of wide application in industry is water gas—a mixture of CO and H2. It is the source of the bulk of the methanol of commerce, is used in producing the newer solvents and plasticizers as used in lacquer industries. There is a method of preparing it very cheaply from the waste gas of the pyrolysis process and the proportions of CO and H2 are very favourable. Water gas is also the cheapest source of H2 except where hydro-electric power is available at one-tenth of a cent or less.

The treatment of the waste Turner Valley gases is a border line project but would be profitable if the exit gas were assigned a value equal to the cost of the original gas. The treatment of stabilizer gas would be profitable in any event with a minimum daily throughput of three to five million feet. McMurray bitumen was first examined and its possibilities as a source of gasoline and oil examined. That it could be cracked was known, and would yield some 30 per cent as a good gasoline, 20 per cent fuel oil and the rest coke. Hydrogenation processes, while more expensive, would give higher yields and possibly be applicable. It is commonly accepted that cheap hydrogen is the fundamental requirement of such processes.

A year or so ago work was commenced on Alberta coals. Coal was hydrogenated most rapidly, with minimum coke and gas formation and the oils were of the highest grade. A standard procedure was used on all thirteen coals, using in each case petrolatum and tetralin and the same catalyst, M.03.

A point regarding coal hydrogenation that may give it a more promising outlook: it requires hydrogen and impure hydrogen is quite sufficient, which ties it up with natural gas; it requires tetralin or a like substance which again ties it up with natural gas. Tetralin cannot be produced under five cents a pound usually which makes its use under normal circumstances impossible. However the pyrolysis tar already referred to, which lacks a big market, contains 35 per cent naphthalene and the rest consists of close relatives of naphthalene. Pyrolysis tar has been used in place of tetralin and it is equally satisfactory. Its use makes the process of coal hydrogenation in conjunction with a pyrolysis project a very possible thing. The pyrolysis tar would normally be hydrogenated separately and a quantity of gasoline recovered. The rendered heavy hydrogenated products of an aromatic character would then be used as a coal medium.

At the conclusion of the address, G. R. Elliott moved a hearty vote of thanks to the speaker for his most interesting and instructive address.

The Lethbridge Branch of The Engineering Institute of Canada held its regular dinner meeting Saturday evening, February 20th, at the Marquis hotel.

L. R. Brereton, A.M.E.I.C., metallurgist at the Manitoba Rolling Mills, Calgary, was the speaker and took as his subject "The Manufacture of Steel Products," with special reference to the heat treatment of steel, and illustrated both by motion pictures and lantern slides.

Preceding the address N. Marshall, M.E.I.C., announced the result of balloting for chairman for the ensuing year which resulted in the election of W. Meldrum, A.M.E.I.C., to this position. The announcement was received with great applause and the new chairman in a few words suitably thanked the members.

The meeting opened with the usual dinner at 6.30 followed by a short period of community singing led by W. Meldrum, A.M.E.I.C.

The orchestra under the direction of George Brown was again in attendance entertaining with a splendid programme of music.

The guest artist of the evening was Mrs. Roy, who presented two splendid vocal numbers. Mrs. Roy was assisted at the piano by Mrs. George Brown.

The Manufacture of Steel Products

The solution theory of carbon in iron, Mr. Brereton said in opening his address, is the basis of heat treatment of steel. He then went on to a discussion of the freezing of various alloys and their eutectic solution illustrating his remarks by a slide showing the freezing curve of lead and tin alloys. These eutectic solutions freeze in tiny crystals arranged in parallel bands.

Next he showed a curve illustrating the freezing of certain carbon and iron alloys. One of the effects of carbon in iron is that it tends to retard any changes in the iron.

Mr. Brereton followed this with a discussion as to the differences in Alpha, Beta and Gamma iron.

If steel is cooled quickly there is not so much time for structural changes to take place in the material. The steel becomes too rigid to permit changes to take place and when that happens an unnatural condition sets up internal stress. The fact that these changes may be controlled is the basis of all heat tieatment.

An important characteristic of steel is that of grain size. When austenite is cooling the crystals grow in size and that is detrimental to the steel as they produce large cleavage planes weakening the metal very materially. This can be rectified by reheating above the critical temperatures thus normalizing the grain structure.

From this he went on to discuss the effect of alloys on steel. Nickel and manganese he said lower the critical temperatures. Chrome is a hardening alloy and forms a carbide. The higher the carbon content the greater the effect of the chrome. Nickel alloys directly with the iron and the resistance to repeated stress in a nickel steel is very high.

The speaker concluded his address with a discussion as to the manufacture of steel by both the open hearth and electric furnace processes.

At the conclusion of the address, J. A. Jardine moved a hearty vote of thanks to the speaker.

Moncton Branch

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

An important development in the process of the manufacture of steel rails was described in a most interesting manner by C. M. Anson, A.M.E.I.C., assistant to the general manager, Dominion Steel and Coal Corporation, Ltd., Sydney, N.S., in an address delivered before the Branch on January 28th. The meeting was held in the City Hall. G. E. Smith, A.M.E.I.C., chairman of the Branch, presided.

Previous to the main address, a five minute talk was given by T. H. Dickson, A.M.E.I.C., on the electric power supplied by the Minto steam plant. Mr. Dickson emphasized the point that continuity of service is assured the city of Moncton since all ordinary demands for power can be met either by the hydro or by the steam plant.

The Manufacture of Steel Rails

Mr. Anson described the routine processes of steel manufacture up to the point where the steel ingot, about eight and one-half inches square and of sufficient length to roll two rails, is heated to a temperature of 2,000 degrees and passed into the rail mill. Here, it goes through the rolls and is shaped to the section of rail required. Before the development of the MacKie process, the rails were next placed in the open air to cool, it taking approximately three to four hours to come down to a temperature at which they could be handled.

Now, steel contracts in cooling, and it stands to reason that the contraction of the metal on the outside of the head of the rail goes on at a different rate of speed to the contraction of the metal in the centre of the head. Thus internal stresses are set up which occasionally result in the formation in the interior of the rail head of minute cracks, known as shatter cracks. It is claimed that under the pounding of heavy traffic these shatter cracks develop into transverse fissures which finally grow big enough to break the rail. Then comes disaster. The first train passing over it goes off the track.

After thorough investigation and a long series of experiments, Mr. I. C. MacKie, chief metallurgist of the Dominion Steel and Coal Corp., developed a process for the complete elimination of shatter cracks in rail heads. The process consists in slowing-up the cooling of the rails after rolling. Retardation of cooling is not applied at the top temperature, as this would unduly soften the rails. Instead, the rails are allowed to cool quickly to a temperature of 700 degrees. They are then placed in a closed tank and the remainder of the cooling spread over a period of from 24 to 28 hours.

The two Canadian railways are taking great interest in the new development and have placed trial orders.

A hearty vote of thanks was tendered Mr. Anson on motion of F. O. Condon, M.E.I.C., seconded by L. H. Robinson, M.E.I.C. A vote of thanks moved by B. E. Bayne, A.M.E.I.C., seconded by J. R. Freeman, M.E.I.C., was also accorded Mr. Dickson.

Cement and Concrete Lectures

Through the courtesy of the Canada Cement Co. Ltd., Montreal, a series of nine lectures on cement and concrete was delivered before the branch during the week commencing February 22nd, by J. M. Portugais, A.M.E.I.C., technical engineer of the company. Mr. Portugais was assisted by Mr. B. S. Boyd, assistant chief chemist, who made tests and gave practical demonstrations.

Through the kind co-operation of Mr. W. U. Appleton, General Manager, Atlantic Region, Canadian National Railways, five of the lectures were given in the afternoon in the general offices of the Railway. The remaining four lectures were delivered in the evening, in the City Hall, and were open to the public.

The Care of Surveying Instruments

A very instructive address was delivered on March 8th before student members of The Institute at Mount Allison University, Sackville, N.B., by J. G. MacKinnon, B.Sc., A.M.E.I.C. Gordon D. Wagner, S.E.I.C., presided. Mr. MacKinnon spoke on the handling and care of surveying instruments. Valuable and practical advice was given on accuracy of measurements, time-saving methods and the protection from injury of the delicate parts of instruments used by the engineer.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.
F. V. Dowd, A.M.E.I.C., Branch News Editor.

The weekly meeting of the Montreal Branch of The Institute was held on February 18th, 1932, Lieut.-Colonel Daniel Hillman, D.S.O., M.E.I.C., presiding. The speaker of the evening was Mr. Allistair Fraser, K.C., assistant general counsel to the Canadian National Railways, and his address dealt with Railway Law.

Railway Law

After explaining how the engineer and the lawyer work together and require each other's services on all large undertakings, Mr. Fraser stated that for the railway lawyer, the railway law means the Railway Act. In any railway project the engineer was first consulted, then the lawyer, who required the engineer to tell him what powers were needed to ensure the efficient construction and subsequent maintenance of the road.

The Dominion Railway Act was then explained, as dealing with approximately 2,000 subjects; of its 460 sections only four grant any powers to the railway, while the remaining 456 impose restrictions.

The speaker sketched the powers and duties of the Board of Railway Commissioners, and remarked that sections 162 to 165 of the Railway Act were the only sections granting general powers providing for the temporary diversion of streams, highways, etc., and the expropriation of the necessary property for the construction of the line.

All tolls are subject to the provisions of the Act and to the regulations of the Board of Railway Commissioners; it is also forbidden for a railway to cross or run along any existing highway before having obtained the consent of the Board of Railway Commissioners.

Passing to the problem of preventing accidents at grade crossings, Mr. Fraser gave the approximate mileage of steam railways in the Dominion of Canada as 42,000 miles and stated that on those lines there exist some 31,000 level highway crossings. The average cost of eliminating each of the above crossings was given as $35,000, thus an expenditure of over $1,000,000,000 would be needed to eliminate all of them.

In 1929, 1,294 persons were killed in Canada in all classes of motor vehicle accidents, but only 102 fatalities, or 8 per cent of the total, happened at railway grade crossings. It would be unreasonable to expend a billion dollars to save these, without an additional expenditure of twelve times this amount to deal with the remaining 92 per cent. Such expenditure would take about one half of the total national wealth of the country. All grade crossing accidents could be avoided if motorists would exercise ordinary caution before attempting to cross railway tracks.

A hearty vote of thanks was tendered the speaker on the motion of Major Harold N. Gzowski, A.M.E.I.C., seconded by Geo. R. MacLeod, M.E.I.C.

Seaboard Power Plant

At the weekly meeting of the Montreal Branch of The Institute held on February 25th, 1932, R. E. MacAfee, M.E.I.C., presided over a well-attended meeting, and after a few remarks introduced the speaker, K. H. Marsh, M.E.I.C., chief engineer of the Dominion Steel and Coal Corporation, Ltd., who made a special effort to come to Montreal to deliver this lecture.

The Seaboard Power Plant, Mr. Marsh explained, was the newest of four inter-connected plants of the Dominion Steel and Coal Corporation, having been constructed during the nine months prior to June 1930.

The equipment consists of two 922 h.p. steam boilers, fired with 1,100 B.t.u. pulverized refuse coal; the working pressure was 450 pounds and they were the first boilers in Canada to have all four walls water cooled.

At the close of the paper an exceptionally interesting discussion took place.

J. T. Farmer, M.E.I.C., tendered the vote of thanks, which was seconded by Mr. MacAfee.

Technical Science of the Ancients

Another special dinner was held by the Montreal Branch of The Institute at the Windsor hotel, prior to the weekly meeting held at The Institute Headquarters on March 3rd, 1932.

The dinner was very well attended, and at the head table were the speaker, Professor W. P. Wilgar, M.E.I.C., Dean Ernest Brown, M.E.I.C., chairman of the evening, P. E. Jarmin, A.M.E.I.C., R. E. MacAfee, M.E.I.C., J. H. Hunter, M.E.I.C., and W. C. Adams, M.E.I.C. There were also present several out of town members.

Professor Wilgar gave a very instructive and interesting lecture to a full house. The speaker referred to the present age being called the Age of Technical Science and if by this it is implied that it was reserved for our age to create these sciences or to develop them to a high standard, the implication was entirely wrong.

Technical science had its ebb and flow. The Middle Ages were an example of extreme low tide, when restrictions and regulations imposed by the system of Guilds prescribed the hours of work, the number of skilled workmen as well as the type of materials that might be used. The present represents one of the great flood tides.

It was left for the present age to realize in its own great advance the remarkable skill of its professional ancestors, who in their widsom and forethought, preserved throughout the centuries the stories of civilization that otherwise would have been completely lost.

Lantern slides were shown of various examples of ancient arts.

The speaker terminated by mentioning that the position occupied by the engineer of the present day was a long up-hill fight from the middle ages, when progress was looked upon with suspicion. The ancient engineer was different, genius was given a free rein, he was listened to with respect and consulted with the mightiest rulers.

The vote of thanks was tendered the speaker by J. H. Hunter, M.E.I.C., who said that the remarkable talk was something that we could all learn a lesson from. Dean Brown seconded with a few remarks, and a very pleasant evening had been spent by all those present from the general applause.

On March 10th, 1932, the Montreal Branch of The Institute held their regular weekly meeting under the chairmanship of F. S. B. Heward, A.M.E.I.C., at which C. J. Desbaillets, M.E.I.C., chief engineer of the Montreal Water Board, read a very interesting paper on "Reinforced Concrete Watermains."

Reinforced Concrete Watermains

Mr. Desbaillets' paper was the outcome of the connecting of the Montreal Water system reservoir on Pine avenue with the Cote des Neiges reservoir recently acquired from the Montreal Water and Power Company, the latter company having been purchased by the city of Montreal several years ago.

It was explained that the city of Montreal sought the strongest pipe obtainable; one that would not burst and would also resist corrosion and electrolysis. All these points were to be found in a reinforced concrete pipe of special design and make.

The pipes were 34 inches in diameter and 16 feet long, consisting of a welded steel sheet with a reinforced concrete lining, centrifugally spun on the inside and another heavily reinforced concrete covering placed on the outside by vibration.

The steel shell and spiral reinforcing both used in tension were designed to work under normal tension stresses of 11,500 pounds per square inch.

The inside lining was 3,500-pound concrete, the mix being one part cement, one and three-quarter parts sand and one and one-quarter parts of stone.

Aggregates:	Sand Fineness Modulus	3 to 3.3
	Stone " "	5.5 to 6

Stone is one-quarter inch and the maximum size shall pass a three-eighths-inch sieve.

The outer concrete cover was of the same mix as the lining but the water cement ratio was selected to give a 4,500-pound cement at twenty-eight days.

The speaker remarked that pit sand with coarse particles was used in preference to others, as this gave the best results. Regarding the spinning of the shell, a speed of 1,500 feet per minute was used to start placing the concrete and this was gradually raised to 2,500 to 3,000 feet per minute.

The pipe was designed for 135 pounds working pressure and during a test 640 pounds pressure was applied to a length of pipe without being able to destroy it.

After the presentation of the paper, a most interesting discussion took place. A vote of thanks was proposed by P. E. Jarman, A.M.E.I.C.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

A dinner meeting of the Niagara Peninsula Branch was held on January 21st, 1932, at the Welland hotel at St. Catharines, Ont., with an attendance of forty persons.

The speaker of the evening was R. A. Fairbairn, A.M.E.I.C., building and equipment engineer for the Bell Telephone Company of Canada, western area. Mr. Fairbairn was assisted by Mr. G. O. Burwash, local equipment engineer. The subject of the address was "The Dial Telephone System."

The Dial Telephone System

Mr. Fairbairn first gave a brief historical outline of the growth and development of the telephone and telegraph systems and then talked on various engineering and financial phases of the subject and their relation one to the other.

Mr. Fairbairn started by outlining the fundamental problem of the Telephone Company, namely getting two people in communication with each other as quickly and cheaply as possible. He started with the case of two subscribers and developed the problem from this simple fundamental to the equipment encountered in a large multi-office city. This covered a brief description of magneto switchboards, common battery switchboards, single office areas and multi office areas.

The theory of 'trunk efficiency' was discussed at some length. A trunk may be defined as one of the communication channels between two central offices in the same exchange area and trunk efficiency is the percentage of the total time during the busy hour that the trunks can be in use to give a pre-determined grade of service. In most telephone engineering, trunks are provided on a sufficiently liberal basis so that not more than one call in one hundred will be delayed. Small groups of trunks are less efficient than large groups. As an example Mr. Fairbairn compared a party line with a group of seventy-five trunks between two central offices. An average party line is in use approximately five minutes out of the busy hour and yet each party believes the other subscriber is using the line continuously. In the case of the inter-office trunk group, each trunk can be in used for approximately forty-five minutes in a busy hour and still have less than one call in one hundred delayed. Furthermore, the delay is so short in most cases that it is very questionable whether the subscriber appreciates the fact that there has been trouble in obtaining an idle trunk.

It was then shown how the theory of trunk efficiency was used in telephone engineering in manual offices. Every operator has access to every trunk in order to obtain the economies of large trunk groups. In a very large city such as New York, even this arrangement does not provide sufficient economy in trunk plant and it is sometimes desirable to establish a tandem centre. This tandem centre is a telephone office which is used only for switching inter-office calls so that instead of providing trunks in every office in the city to every other office, they are provided only from every office to the tandem centre. In this way the number of trunk groups is decreased, the size of each is increased and therefore, more efficient use is made of the conductors. As an example, it was stated that if every office in Toronto was provided with trunks to Hamilton, the size of each group would vary from two to eight and a total of thirty-nine trunks would be required. However, by concentrating all this traffic in one channel by means of a tandem office, only twelve trunks between Toronto and Hamilton are required.

There are two types of dial systems in use: the panel type used in the larger cities in the United States and the step-by-step type used in the smaller American cities and in Canada. The step-by-step system is also used in a large number of other countries.

It was shown that both these systems were built around the theory of trunking and that a large amount of ingenuity had been employed to use large trunk groups and, therefore, to keep the necessary amount of equipment at a minimum. The panel system is designed for use where tandem operation can be justified and the step-by-step system where adequate efficiency can be obtained by employing direct trunks between various offices. The step-by-step system was described in considerable detail. The operation of the various pieces of equipment was exceedingly interesting but still more interesting was the method in which economies were effected in all parts of the system by employing large trunk groups. The technical features were illustrated by lantern slides and by the use of a demonstration set (supplied by the Hamilton-Niagara division of the Telephone Company). The demonstration equipment consisted of a two-position manually operated switchboard and a miniature dial central office. This equipment showed the method of handling calls on a manual basis and on a dial basis as well as indicating how calls are handled between manual and dial offices.

Mr. Fairbairn concluded his talk with a description of certain miscellaneous equipment such as the dial system 'A' Board. This is a switchboard which is used to assist subscribers who have difficulty in making calls, in completing toll calls to nearby points and in giving information in connection with changed or disconnected numbers. A very brief but interesting description was given of the equipment required in connection with coin boxes. This equipment is almost human in that it will return coins in case the called number is busy or does not answer or in case the call is for information or repair clerk and will only collect the coin on a call to another subscriber when the called telephone is answered.

At the close of the talk there was considerable discussion and the the following are some of the points which were discussed:—

It takes approximately nine to ten months to engineer a dial office and probably eighteen months to manufacture and install the equipment all ready for the change over. However, when everything is ready the change from manual to dial would require only a few minutes. The rapidity with which a large city is converted to dial operation is largely a financial problem and in general only the older manual offices are abandoned and dial equipment is installed to replace these and to care for the growth being experienced.

In answer to a question whether or not many telephone operators were discharged due to the putting in of dial systems, it was stated that the operators in telephone exchanges had to be replaced frequently owing to getting married and other causes and that in normal times the annual loss in operators keeps pace with the elimination of the manual offices.

In answer to a question regarding television or seeing the person one is talking to, it was stated that such equipment has been demonstrated by the American Telephone and Telegraph Company but that the equipment is complicated and very expensive and for this reason it does not appear that it will become popular at the present state of the art.

Chairman W. Jackson, M.E.I.C., on behalf of the meeting, extended to Mr. Fairbairn and his assistants a hearty vote of thanks.

Ottawa Branch

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

Engineering and High Pressure Chemistry

G. S. Whitby, Ph.D., LL.D., F.R.S.C., Director of the Division of Chemistry, National Research Laboratories at Ottawa, was the speaker at the noon luncheon of The Institute at the Chateau Laurier on February 18. C. McL. Pitts, A.M.E.I.C., chairman of the local Branch, presided and, in addition to the speaker and himself, the head table guests included J. A. Wilson A.M.E.I.C., J. A. Ewart, A.M.E.I.C., Samuel Bray, M.E.I.C., Noulan Cauchon, A.M.E.I.C., R. A. Gilmour, C. V. Caesar, S. J. Hambly, G. J. Desbarats, C.M.G., M.E.I.C., L. L. Bolton, M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., and John McLeish, M.E.I.C. Many members of the Ottawa branch of the Canadian Institute of Chemistry were guests at the luncheon and were made welcome by the chairman in his opening remarks.

As an aid in carrying out chemical reactions, the use of high pressures of from 3,000 to 15,000 pounds per square inch combined with high temperatures such as 1,000 degrees F., has been made possible by the development of alloy steels containing various proportions of nickel, chromium and vanadium, stated Dr. Whitby at the commencement of his address. The industries resulting from this method of carrying out chemical reactions have played a very important part in the production of explosives and fertilizers, and have undergone great development, particularly in the past four or five years.

The first large scale pressure process was the manufacture of ammonia from the nitrogen of the air and hydrogen. This was successfully developed in Germany in 1913 and came into prominence during the War. But for it Germany would have been unable to make enough nitric acid for explosive manufacture, as her previous source of nitrogen supply—saltpetre from Chile—was cut off.

Since the War synthetic ammonia has been chiefly used for the manufacture of fertilizers. High pressure ammonia plants have been rapidly built in all parts of the world, the world's productive capacity of nitrogen fertilizers being now equivalent to 20,000,000 tons of sulphate of ammonia.

In Canada two synthetic ammonia plants have come into operation in the past eighteen months, one at Sandwich, Ontario, and the other at Trail, B.C. These plants are marvels of both chemical and engineering skill.

There is room in Canada for the further utilization of fertilizers, particularly in the western provinces. Vast amounts of these fertilizers may be obtained by the utilization of the sulphur dioxide that has hitherto been a waste product of the Consolidated Mining and Smelting Company. Trials in this connection were carried out in 1930 and the results of the experiments showed that the application of fifty pounds of such fertilizer per acre provides needed plant food in the early part of the season resulting in an early maturity and better yields.

The next largest achievement in industrial high pressure chemistry was the production of methyl alcohol. This was started in 1925 and now runs to tens of millions of gallons per year. As a consequence, the price of this liquid has been greatly reduced, this method of production threatening to replace the previous method of hardwood distillation. The Canadian hardwood distillation industry has suffered on account of this competition, particularly in its export business.

Other products, the manufacture of which has been undertaken by high pressure reactions during the past three or four years, are urea used as a fertilizer for tobacco and other crops, carbolic acid used in the manufacture of bakelite, aniline used for dyes, and several others. High pressure treatment with hydrogen is capable of turning coal to liquid fuel and, as recently shown, crude petroleum completely into gasoline. A new plant in the United States, using this method, has a capacity of 5,000 barrels of gasoline a day. The possibilities along these lines will become of greater importance as the oil resources of the world diminish.

This field of industrial chemistry holds further immense possibilities. Canada has not contributed very greatly in the way of original research contributions to it, and the speaker stated in conclusion that a well-equipped high pressure laboratory should be established in this country so that research could be carried on commensurate with what is being done in other countries.

Improvements in Field Gun Manufacture

The further perfection of field gun manufacture as a result of experimental research together with advances in economy of construction, particularly in the United States, were foretold in an address by Lieut.-Colonel N. O. Carr, General Staff Officer, Artillery, of the Ottawa National Defence Headquarters, at a luncheon address at the Chateau Laurier on March 3rd, 1932, before the local Branch of The Engineering Institute of Canada. The meeting was presided over by the local chairman, C. McL. Pitts, A.M.E.I.C., the head table guests including in addition: Colonel A. F. Duguid, A.M.E.I.C., Colonel W. G. Beeman; G. J. Desbarats, M.E.I.C., Major-General A. H. Bell, Brigadier A. C. Caldwell, M.E.I.C., Colonel H. H. Matthews, Colonel J. L. H. Bogart, A.M.E.I.C., and Group Captain E. W. Stedman, M.E.I.C.

By the use of lantern slides the development and trend of manufacture were traced from the introduction of cannon into England about 600 years ago to the present day. This development and trend have been entirely associated with the progress of science in the fields of explosives and metals.

Up to the middle of the 19th century guns were produced in one piece, either from wrought iron or bronze. This gave way to cast-iron and steel, and from 1880 onwards to steel alone. During all these years, apart from any other feature of design, the pendulum has swung from breech loaders to muzzle loaders and back many times, the final and lasting return to breech loaders coming about late in the 19th century.

The present design of all steel weapon has a gun barrel consisting of a number of tubes shrunk one upon another. Since the inner barrel is already in a state of compression, this allows the suddenly-induced tensile stress resulting from the explosion of a charge to be taken care of without rupture.

Lieut.-Colonel Carr at this point went into a detailed description of the methods of production in use at the present time. The great number of heat and annealing treatments required, the highly skilled labour necessary, and the extreme care and accuracy that must be exercised throughout all stages of the work were emphasized in this description.

The number of tubes used in the built-up gun of today is tending to decrease, due to the use of better steel and an initial treatment to which the tubes are subjected, known as "auto-frettage." In fact, in some guns of lighter nature a single tube alone is used, known as the "mono-bloc" gun.

A recent and novel departure also is the adoption in guns of more than one tube of what is termed a "loose liner." In this case the innermost tube is made so as to be readily removed and replaced in the field, thus effecting a very substantial reduction in maintenance charges.

Centrifugal casting as a process has been in existence for over a century, stated the speaker, although it has not been brought to anything like perfection until recent times. Some authorities claim that a steel tube can now be produced by the centrifugal method of casting, which in every way is equal in strength, if not stronger, than a similar tube produced by forging. There is much difference of opinion upon this point but experiments in this regard are being vigorously prosecuted in the States with steels of varying composition. There is no evidence that England as yet contemplates abandoning the old forging method of production.

Visit to Aeronautical Laboratories

Under the auspices of the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, with which is incorporated the Ottawa section of the Royal Aeronautical Society, the members of The Institute were given a demonstration on the evening of March 11th, 1932, of some of the equipment of the Aeronautical Laboratories of the National Research Council.

Through the kind permission of Dr. H. M. Tory, president of the Council, the workings of the wind tunnel, water channel and engine dynamometer equipment were explained and demonstrated to those present.

J. H. Parkin, M.E.I.C., of the Research Council, chairman of the Aeronautical Section, was chairman of the meeting, and after a brief descriptive address, those present were conducted throughout the various offices and buildings of the laboratories.

Peterborough Branch

W. F. Auld, Jr.E.I.C., Secretary.
A. R. Jones, Jr.E.I.C., Branch News Editor.

With Chairman A. B. Gates, A.M.E.I.C., presiding, and eighty-eight members and guests in attendance, the February 25th meeting was given over to a talk by Mr. E. Chapman, Director of Engineering Research for Lukenweld, Incorporated of Coatesville, Pennsylvania. The subject was of sufficient interest to attract visitors from Orillia, Kingston, Lakefield, Oshawa, Toronto and Montreal.

Electric Welding

Mr. Chapman in his talk assumed a knowledge of the methods of welding and proceeded to deal with the requirements of the materials used and the necessary qualities of the finished products. He dealt particularly with machine parts as differentiated from structural steel. He contended that the chief criterion for these parts was their fatigue resistance and not the elastic limit under stress. He went on to show how the unit stresses at the critical points may be cut down using welded materials and thus improved designs obtained. These points were very well illustrated with slides of punch press, rolling mill, crane Diesel engine, and many other machine parts.

Mr. Chapman emphasized very strongly the fact that, in welding, we are working with a material which is predictable, so that there is a great challenge to engineers in its development.

At the conclusion of his paper Mr. Chapman answered a number of questions, mostly regarding the methods used in obtaining the welds which had been seen. He emphasized the importance of annealing all the completed parts so as to secure a homogeneous stress free structure.

The vote of thanks was moved by Mr. E. Long of Orillia, and was very heartily seconded by the gathering.

The next meeting of the Branch will be held March 10th and will be addressed by Mr. A. Kalin of the Woodward Governor Company. The speaker will be describing cast parts to a large extent, so the members are promised the other side of the cast versus welded steel controversy.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. G. Clark, S.E.I.C., Branch News Editor.

A joint meeting of the Saint John Branch of The Engineering Institute of Canada and the Association of Professional Engineers of the Province of New Brunswick was held at the Admiral Beatty hotel on January 25, 1932. The annual meeting of the Association of Professional Engineers was held during the afternoon. The public meeting at 8.15 was preceded by a banquet which was well attended. A. A. Turnbull, A.M.E.I.C., vice-chairman of the Branch, presided and the following were present: G. G. Murdoch, M.E.I.C., E. Ronald Evans, A.M.E.I.C., John L. Feeney, Dr. John Stevens, A. R. Crookshank, M.E.I.C., Geoffrey Stead, M.E.I.C., Mr. Justice J. B. M. Baxter; The Hon. Senator W. E. Foster; Thomas Bell, M.P.; Hon. D. A. Stewart, Minister of Public Works, N.B.; H. C. Schofield, President of the Saint John Harbour Commission; J. D. McKenna, President of The Telegraph-Journal and The Evening Times-Globe; Hon. L. P. D. Tilley, Minister of Lands and Mines, N.B.; Mayor W. W. White; Hon. E. A. Reilly, Chairman of the New Brunswick Electric Power Commission; A. A. Dysart, Leader of the Opposition in the N.B. Legislature; J. D. Palmer and F. J. Robidoux, members of the N.B. Electric Power Commission; A. L. Foster, President of the Saint John Board of Trade; O. J. Fraser, General Manager of the New Brunswick Telephone Company, Limited, and F. M. Sclanders, Secretary of the Saint John Board of Trade.

Engineering Developments in Northern Manitoba

The speaker at the evening meeting was C. H. Wright, M.E.I.C., of Halifax, District Manager of the Canadian General Electric Company. Mr. Wright's subject was "Engineering Developments in Northern Manitoba." The address was illustrated with maps, charts, and pictures of the district.

Historical references were given to show that the original settlers of western Canada entered the country via Hudson Bay. The growth of Manitoba was traced from its foundation in 1870 with a population of 12,000 to the present time with a population of 700,000. Winnipeg during this period has grown from a population of 240 to more than 222,000. The speaker made use of a chart, showing the distribution of water power in the Dominion, to show the large supply in this district. The aggregate water power of the Nelson and Churchill rivers is comparable with the Niagara and Saguenay in the East, and the Nelson river has the second largest watershed in Canada, being only surpassed by the McKenzie. Attention was also called to the vast mineral wealth of the province.

The first charter for the Hudson Bay Railway was obtained by Hugh Sutherland just after the Canadian Pacific Railway was being pushed west from Winnipeg. The distance from Le Pas to Churchill is 510 miles. In 1918 the grade was completed to Nelson, 424 miles, and steel was laid to Kettle Rapids, 322 miles from Le Pas. After the war it was proposed to abandon this development and continue shipping grain via Fort William or Vancouver, but due to the efforts of the Progressive Party it was revived in 1926. In 1927 the Palmer report changed the terminus from Nelson to Churchill, and during the winters of 1927 and 1928 work continued so that on March 29, 1929, steel entered the townsite of Churchill. The country through which the railroad passes was described and difficulties of construction pointed out by the speaker. The total cost of the undertaking was given as slightly more than fifty-six million dollars.

Churchill was described as having a fine harbour, six and one-half miles long and two and one-half miles wide, equipped at present with a grain elevator of 2,500,000 bushel capacity, which may be increased later to 10,000,000 bushels. No town has yet been erected at Churchill, although the townsite has been laid out, this being the property of the Manitoba government. Due to the absence of employment as well as lack of fuel and food in the district, the present population of Churchill is about 50. It is thought that construction of harbour facilities and coal handling plant will be resumed this spring. The period of possible navigation through Hudson straits was given as being from July 15th to October 15th. The distance from Churchill to Liverpool is about the same as from Montreal, roughly 3,000 miles. Thus shipping grain by this route would save the long rail haul from Regina to Montreal.

The disadvantages of the port were given as the impossibility of handling a given year's wheat crop via Churchill the same year due to the early closing to traffic, the lack of a return cargo for ships carrying grain, and the lack of possible traffic for the railroad due to its passing through a barren country unsuited to agriculture. These features were given as being adverse to the project becoming a profitable venture, as was also the lack of support at present from the western provinces.

At the close of the address an opportunity was given for discussion and a unanimous vote of thanks was passed and tendered Mr. Wright for his excellent paper.

Saskatchewan Branch

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

The regular meeting of the Saskatchewan Branch of the Engineering Institute of Canada was held in the Hotel Champlain on Friday evening, February 26th, being preceded by a dinner at which fifty-six guests were present.

Immediately after the dinner the chairman, with a few appropriate remarks, welcomed the guests of the evening in the persons of the Honourable J. F. Bryant and the representative members of the Technical Society of Agriculturists.

Drought and Soil Drifting in Saskatchewan

The meeting was then favoured with two songs by J. D. B. Ellis, after which the chairman introduced the speaker of the evening, T. C. Main, A.M.E.I.C., his subject being "Drought and Soil Drifting in Saskatchewan." Mr. Main's paper was enthusiastically received and in the discussion which followed, lead by P. C. Perry, A.M.E.I.C., and J. W. D. Farrell, A.M.E.I.C., many points of interest were brought out. Mr. Perry dealt with the paper from both an academic and practical viewpoint, while Mr. Farrell confined his remarks very largely to the effect of drought on civic water supplies.

C. H. Taggart, A.M.E.I.C., one of the guests of the evening, then dealt with the subject from the point of view of the agriculturist, following which the Honourable J. F. Bryant, chairman of the Saskatchewan Drought Commission, spoke on the subject, dealing with it from world wide as well as an historical viewpoint. In concluding his remarks Mr. Bryant stated his belief in the necessity for an extended meteorological service in western Canada.

J. N. de Stein, M.E.I.C., contributed to the discussion of the evening, confining his remarks largely to the field of engineering.

In replying to the previous speakers, Mr. Main emphasized the necessity for water conservation, stating that in time we would be obliged to use water from the Saskatchewan river.

H. S. Carpenter, M.E.I.C., congratulated Mr. Main on the excellence of his paper, moving a hearty vote of thanks, which was seconded by D. A. Smith, A.M.E.I.C., and carried unanimously.

It was then moved by J. J. White, A.M.E.I.C., seconded by A. P. Linton, A.M.E.I.C.:

> "That the Saskatchewan Branch of the Engineering Institute of Canada heartily endorses the petition sent to the Honourable, The Minister of Marine and Fisheries by the members attending the Meteorological Conference in Winnipeg on November 5th and 6th, 1931, that more stations recording meteorological data be established in Western Canada and that a greater variety of data be recorded.
>
> It is pointed out that members of the Engineering profession are called on to assist in the solution of national problems of an engineering nature and that satisfactory solutions for these problems are, to a great extent, dependent on accurate meteorological data covering a long period of years.
>
> Further, that a copy of this resolution be forwarded to the Honourable The Minister of Marine and Fisheries."

On discussion, this resolution passed unanimously.

Victoria Branch

I. C. Barltrop, A.M.E.I.C., Secretary-Treasurer.
Kenneth Reid, Jr.E.I.C., Branch News Editor.

A crowded meeting of members and friends assembled on February 15th, 1932, at the Y.W.C.A. rooms, under the Branch chairmanship of Major H. L. Swan, M.E.I.C., to hear papers by F. W. Knewstubb, A.M.E.I.C., R. C. Farrow, R.P.E., and S. H. Frame, A.M.E.I.C., of the Provincial Water Rights Branch, on "Investigation of High Head Hydraulic Power Sites in B.C."

Investigation of High Head Hydraulic Power Sites in B.C.

Viewing the situation in the light of developments in long distance transmission, the requirements of fisheries conservation, the limitations imposed on several potentially large power sites by railways and highways; the requirements of special industries using large amounts of power; and facilities for transport during construction and operation of such industrial plants, it was stated the Comptroller of Water Rights, Major J. C. MacDonald, M.E.I.C., had decided on the investigation of the large capacity high head powers available by diversions through the Coast Range of important feeders of Fraser river. Such feeders have large lakes at their headwaters, and the upper ends of these lakes reach in several cases very close to the summits of the Coast Range passes, and west of the latter the drop to the deep valleys, in which flow coastward streams at low elevations, is very rapid. A few miles of conduit would concentrate much of the fall now spread over several hundred miles of stream course to the sea via Fraser river. Part of these conduits might be flume or pipe line along hillside, but in these localities, subject to severe climatic conditions, rock-slides, snow-slides and glaciers, such construction would not be thought of and tunnels are indicated to the penstock head.

Chilko-Homathko Project

What is designated as the "Chilko-Homathko" project was first described. The Chilko-Taseko lake system has a watershed and lake areas of about 1,600 square miles and 83 square miles respectively, and a run-off estimated at 3,400 c.f.s. from short-period gaugings—correlated to Bridge river with adjacent watershed and a continuous gauge record of 16 years.*

From Chilko lake, the western and larger lake—elevation 3,845 feet—there are two main alternatives, one to Tatlayoko lake with a head of 1,050 feet; using that lake as a balancing reservoir the waters would be re-used on Homathko river, combined with the waters of that stream, at five sites under heads varying from 250 to 635 feet, the total head from Chilko lake, considered usable, being 2,870 feet; the gross horse power is estimated at 1,350,000.

The alternate scheme has two variants: the first or "A" route presumes an 8.9-mile tunnel and a head of 2,420 feet, the waters being re-used ultimately through a 6-mile tunnel with a head of 635 feet at the Southgate Forks.

The "B" variant has the same objective with its intake at the head of Franklyn Arm. The first section has a tunnel length of 12¼ miles and a head of 1,530 feet and the second a tunnel length of 3½ miles and a head of 1,525 feet. The total gross horse power for each of these variants with a total head of 3,055 feet is 1,140,000, divided, for each section, in proportion to head.

Taseko lake (elevation 4,400 feet) with a water yield of probably 40 to 45 per cent of the total, would require storage and diversion works consisting of dam and 10.9 miles of tunnel and flume to bring its supply to Chilko lake.

Nechako Lakes Diversions

The scheme known as No. 2 would draw from Eutsuk lake, with which would be combined Whitesail, Tetachuck, and Pondosy lakes. The total watershed is about 1,770 square miles, lake area 166 square miles and run-off 3,500 c.f.s. from one year's gaugings and that a year of low run-off. There are two alternative diversion routes to Kimsquit river which enters tidewater at the head of Dean channel. The first is from the head of Pondosy lake, thence via Gable Pass and the west side of Salahagen gorge to the mountain side flanking Kimsquit river. Length of tunnel about 9¾ miles with access points—shaft or adit—about two miles apart. For access points at one-mile intervals the length would be increased ½- to ¾-mile. Penstock is about 5,000 feet long, head 2,090 feet, and gross horse power estimated 805,000. Distance of power house from tidewater 21 miles.

The alternative line would be from the head of Eutsuk lake via Smaby pass to the mouth of Smaby creek. Total length of tunnel about 9½ miles and access by shaft or adit could be had not over one mile apart without much increase in length of line. Penstock would be about 3,000 feet in length, head approximately 1,760 feet and corresponding gross horse power 675,000. The power house would be about 29 miles from tide-water at Dean channel. Storage in Eutsuk lake would be made available by draw-down without a dam; Tetachuck lake could be utilized by a short reversing cut; and Whitesail lake may be connected partly by a dam to raise its own surface and partly by a cut through the summit of the low connecting portage.

Tahtsa-Kemano Scheme

This contemplates the use of the waters of Tahtsa lake as a first stage; Tahtsa river and Troitsa lake as a second, with Nanika and Kid Price lakes on Morice-Skeena watershed as a third installment.

The total watershed and lake areas are about 860 and 32 square miles respectively and estimated run-off 2,900 c.f.s. The power diversion tunnel—about 9¾ miles long—would have its intake at the westerly end of Tahtsa lake, taking thence a westerly and south-westerly direction to the mountain side overlooking Kemano river, with a penstock 1¾ miles long connecting to a power house near that stream at a point about 9 miles from tidewater, the total head being about 2,550 feet and corresponding gross horse power 810,000.

Though transmission to inland points would be possible in at least two of the projects described, they are considered as essentially of the type suitable for manufacturing or reduction plants requiring large blocks of cheap power.

For a number of interior streams with inland winter conditions, the average proportion of run-off is 85 per cent during seven open months, the remaining 15 per cent in the five winter months, that the three diversions suggested would take off about 4½ per cent of the watershed of Fraser river (to Hope) but about 9½ per cent of its flow.

Transport conditions were dealt with. Planes have not been used; owing to the lack of landing places on the coast side, they would not have cut out that most unpopular of sports "back-packing."

Tribute was paid to topographical work of B.C. Land Surveyors, R. B. Bishop, F. Butterfield, J. Davidson and F. C. Swannell, which had made the operations of the Water Branch much easier.

Profiles of much longer tunnel diversions for smaller powers in Japan and Scotland were shown by a wall diagram and a large number of slides were also shown.

The total developed water power to date in British Columbia was stated as being 623,912 h.p. Comparing this figure with the estimated undeveloped power of the above schemes it is evident that this vast amount of reserve power would be amply sufficient to serve the needs of British Columbia for many years to come.

A hearty vote of thanks, proposed by O. W. Smith, M.E.I.C., was tendered the members of the Provincial Water Rights Branch for their very interesting and instructive lecture.

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*For a paper by E. E. Carpenter, M.E.I.C., on Bridge River Power Project, see Engineering Journal for July, 1928.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.

Report of Regular Meeting, February 4th, 1932

There were 54 members and visitors present, according to the register.

The minutes of the previous meeting were read and confirmed.

A letter from the General Secretary was read relative to the possibility of the General Meeting for 1933 being held in Winnipeg.

An amendment to a motion which had carried in the last Executive committee meeting was read before the Branch, the amendment being worded:—

"In view of the fact that Branch dues are paid by only a portion of the Branch membership, that the collection of Branch dues be discontinued and in order to meet the resulting reduction of income, that the usual grant of $200 to the annual joint supper-dance be reduced to $100, with a view to the supper-dance becoming self-supporting in future years and that the Entertainment committee be advised that this step is taken, and that the honorarium of the Secretary be reduced to $100 per annum."

Moved by N. M. Hall, M.E.I.C., seconded by J. W. Porter, M.E.I.C., that the Branch support the Executive committee in its action in carrying the foregoing amendment. Carried.

Scrutineers for the ballot for the election of officers of the Branch were then appointed to report at the annual meeting to be held on February 18, 1932, the appointees being Messrs. H. L. Briggs, A.M.E.I.C., and J. T. Rose, A.M.E.I.C.

Field Tests of Generators

The Chairman then introduced the speaker of the evening, J. P. Fraser, A.M.E.I.C., electrical engineer of the Northwestern Power Company, Limited, who gave an address under the title of "Field Tests of 32,500 k.v.a. Generators at Seven Sisters."

At the close of the address discussion took place, among those taking part being Messrs. Robinson, N. M. Hall, M.E.I.C., E. V. Caton, M.E.I.C., J. W. Sanger, A.M.E.I.C., W. Schoeni, Jr.E.I.C. (Toronto Branch), H. L. Briggs, A.M.E.I.C., and J. T. Rose, A.M.E.I.C.

H. Klempner, S.E.I.C., then arose to a point of privilege and requested that the Branch make a resolution to be presented to the principal employers of engineering assistance, to the effect that preference should be given to engineering students and new graduates of the Engineering Department of the University, when men were being engaged for survey parties and similar work of an engineering nature.

This matter was referred to the Executive committee and the meeting adjourned.

Report of Annual Meeting, February 18th, 1932

There were 72 members and visitors present according to the register. After calling the meeting to order chairman Chas. T. Barnes, A.M.E.I.C., announced that all business would be held over until after the speakers had finished. Mr. Barnes then introduced Mr. James C. Aitken of the Anthes Foundry Company who delivered an excellent address under the title of "Explosives."

Mr. Aitken described in detail the various processes followed in the manufacture of picric acid, which is the basis of many of the high explosives.

Picric acid has been known for about three hundred years and until comparatively recently was very limited in its use.

The French, American and Italian governments in late years have used it extensively as an explosive for military purposes.

At the close of the paper the speaker answered several questions asked by the members, and the chairman called upon Messrs. D. S. Binnington and E. Able who entertained the members with a very clever burlesque dealing with the handling of high explosives. The experiments performed by Messrs. Binnington and Able were very interesting and somewhat spectacular.

After the audience had sufficiently recovered from the laughter that had prevailed during the burlesque the meeting was opened for the business of the Branch.

The minutes of last annual meeting were read and confirmed.

Reports of Committees were then received.

The report of the Students Prize committee was presented by E. V. Caton, M.E.I.C., who moved its adoption. This was seconded by E. P. Fetherstonhaugh, M.E.I.C., and carried.

This report showed that prizes had been awarded as follows:—

Civil Engineering Section:

1st Prize, $25.00, to Rudolph Willms, fourth year Civil Engineering, the University of Manitoba, for a paper entitled "A Modern Elevator."

2nd Prize, $15.00, to E. R. Love, S.E.I.C., second year Civil Engineering, University of Manitoba, for a paper entitled "Some Observations on the Development of Slave Falls."

Electrical Section:

1st Prize, $25.00, to Lawrence M. Howe, second year Electrical Engineering, University of Manitoba, for a paper entitled "Sound Recording."

2nd Prize, $15.00, to Herbert A Park, third year Electrical Engineering, University of Manitoba, for a paper entitled "High Tension Steel Tower Line Erection."

In moving the adoption of the report Mr. Caton stated that a number of excellent papers had been submitted and that the task of the Committee in selecting the prize winners had been no easy one.

The report of the Library and Publications Committee was presented by J. F. Cunningham, Affil.E.I.C. who moved its adoption. This was seconded by G. S. Roxburgh, A.M.E.I.C. and carried.

Mr. Cunningham was gratified with the reception that had been given the "Tabloid" during the period of its publication.

The Auditors' report was read by the Secretary and its adoption was moved and seconded by the Auditors, R. H. Andrews, A.M.E.I.C., and H. L. Briggs, A.M.E.I.C.

The Auditors recommended that the decision to discontinue the collection of Branch dues be not applied to the case of Branch Affiliates who in the opinion of the Auditors should continue to contribute to Branch funds at the rate of $3.00 per annum.

The report of the Scrutineers on the Ballot for the election of Branch Officers for the year 1932 was presented by H. L. Briggs, A.M.E.I.C., who moved its adoption. This was seconded by J. P. Fraser, A.M.E.I.C., and carried.

This report showed those elected to office to be:—

Chairman: T. C. Main, A.M.E.I.C.; Nominees for Councillor: W. P. Brereton, M.E.I.C., F. G. Goodspeed, M.E.I.C.; Secretary-Treasurer: E. W. M. James, A.M.E.I.C.; Executive Committee: E. V. Caton, M.E.I.C., C. H. Fox, M.E.I.C., A. J. Taunton, A.M.E.I.C.; Chairman Nominating Committee: N. M. Hall, M.E.I.C.; Chairman Library and Publication Committee: J. F. Cunningham, Affil.E.I.C., Auditors, A. W. Fossness, M.E.I.C., H. M. White, A.M.E.I.C.; Chairman Legislation and Public Affairs Committee: W. M. Scott, M.E.I.C.; Chairman Advisory Committee: E. P. Fetherstonhaugh, M.E.I.C.; Chairman Remuneration Committee: C. A. Clendening, A.M.E.I.C.; Chairman Students Prize Committee: E. P. Fetherstonhaugh, M.E.I.C.; Chairman Programme Committee: L. M. Hovey, A.M.E.I.C.; Chairman Research and Investigation Committee: R. W. Moffatt, A.M.E.I.C.

The Chairman read the report of the Executive committee and asked T. C. Main, A.M.E.I.C., to assume the chair.

In moving the adoption of the report of the Executive committee as read by the chairman, D. A. Ross, M.E.I.C., included a hearty vote of thanks to the retiring chairman and retiring members of the Committee. This was heartily accorded and the retiring chairman Chas. T. Barnes, A.M.E.I.C., took the opportunity to thank the retiring members of the committee and the chairmen and members of the several committees who had co-operated so ably in conducting the affairs of the Branch to the conclusion of a very satisfactory year.

Mr. Barnes' remarks were greeted with much applause.

Mr. Main then addressed the meeting and stated that it is his hope that the Branch will this year give due consideration to the question of the engineers taking their proper place in public life and that it will give of its energies to the solution of many of the economic problems which mark the present time.

A letter from the General Secretary was read containing the suggestion that a General Professional Meeting might be held in Winnipeg in the spring or summer of 1933. The Branch referred the matter to the incoming Executive committee for consideration and suitable reply.

Moved by J. W. Porter, M.E.I.C., seconded by Chas. T. Barnes, A.M.E.I.C., that authority to sign cheques and conduct the banking business of the Branch be conferred on the Chairman and Secretary-Treasurer.

The thanks of the Branch were expressed to the speaker and entertainers of the evening.

The meeting adjourned at 11.20 p.m.

Preliminary Notice

of Applications for Admission and for Transfer

March 21st, 1932

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, 1932.

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

BEAMENT—GEORGE EDWIN, of Toronto, Ont., Born at Ottawa, Ont., April 12th, 1908; Educ., Grad., R.M.C., 1929. B.A.Sc. (M.E.), Univ. of Toronto, 1931; 1930 (summer), shopwork, Babcock-Wilcox & Goldie-McCulloch, Galt, Ont.; 1931 (summer), design and dfting, Waterous, Limited, Brantford, Ont.; at present, Student-at-Law, Osgoode Hall, Toronto, articled to Beament & Beament, Ottawa, Ont.

References: R. W. Angus, C. H. Mitchell, R. S. Smart, E. A. Allcut, E. J. C. Schmidlin, L. R. Grant, C. A. Waterous.

FLAHERTY—BENJAMIN GUY, of Montreal, Que., Born at Leavenworth, Kansas, July 3rd, 1885; Educ., B.S. in E.E., 1909, E.E., 1916, Univ. of Washington, Seattle; 1908, meter dept., Everett Ry. Lt. & Power Co.; 1909, meter dept., Seattle Tacoma Power Co.; 1909-10, city electrn., Cle Elum, Wash., for North Western Improvement Co.; 1910-12, mine electrn., N.W.I. Co., Roslyn, Wash.; 1912-13, lineman and substation constrn., Stone & Webster; 1913-14, local operating agent, Sumner, Wash., 1914-16, gen. operating agent, and 1916-18, gen. foreman, southern dist., Puget Sound Traction Light & Power Co.; 1918-20, elect'l. engr., Pacific Coast Coal Co.; 1920-23, elect'l. and hydraulic engr., Allan Cunningham Co., Seattle, Wash.; 1923-24, chief electrn., W. and E. Callahan Constrn. Co., Marysville, Calif.; 1924-26, elect'l. and hydraulic engr., Puget Sound Bridge & Dredging Co.; 1926-29, elect'l. engr., The Dredging Cont. Ltd., Quebec; 1929-31, chief engr., General Dredging Contractors, Ltd., Montreal; at present, chief engr., Consolidated Marine Companies Ltd., Montreal, Que.

References: R. DeL. French, P. S. Gregory, S. Hermans, C. K. McLeod, W. Lambert, E. H. James.

FLINTOFF—ALLAN FREDRICK, of 17 Second St., Chatham, Ont., Born at Oshawa, Ont., Nov. 15th, 1903; Educ., four years, 1924-28, Univ. of Toronto; 1926 (summer), City of Oshawa, engrg. dept.; 1928-30, instr'man., and 1930 to date, asst. res. engr., Dept. of Highways, Ontario, Chatham, Ont.

References: W. B. Dunbar, C. K. S. Macdonell, A. A. Smith, R. M. Smith, G. A. McCubbin.

MACDONALD—WALTER ELWOOD, of 21 Fourth Ave., Ottawa, Ont., Born at Ottawa, May 20th, 1893; Educ., 1906-11, Ottawa Collegiate Institute. Special study to Scranton School on hydraulics and municipal engrg.; 1911-12, asst. on hydro-electric surveys; 1912, dftsman., leveller and jr. asst. on waste water pitometer surveys; 1913-14, supt. of constrn. of new water mains and dams, on design high pressure system; 1914, asst. to R. S. and W. S. Lea on fire stream tests of water distribution systems; 1915, supt. on constrn. of pumping station and installn. 12 m. gal. elec. pump, Queen St. Station; 1915-16, asst. engr. on extensions and improvements to City of Ottawa distrib. system; 1916-18, associated with firm of J. B. McRae, consltg. engr., on design and constrn. of new pumping station; Jan. 1916, asst. engr. in charge of all city pumping stations; aqueducts, intakes, and sterilization apparatus; Aug. 1916, appointed mech. engr. of water works dept. Appointed to position of water works engr. for the city of Ottawa. Work included mtce. of water works system; constrn. of new water mains and services; installn. of new water meters; design and constrn. of high pressure fire system; installn. of new fire hydrants; new re-distribution system; constrn. of overland pipe system; design and erection of new low lift pumping station. Directly responsible and in profess. charge of design and constrn. of new City of Ottawa 35 m. gal. rapid sand purification plant. July 1931 appointed City Water Works Engineer, City of Ottawa, Ontario.

References: J. E. N. Cauchon, A. F. Macallum, W. Gore, N. B. MacRostie, W. Storrie, G. J. Desbarats, F. H. Peters, J. McLeish, C. M. Pitts.

McCULLOCH—JOHN ALEXANDER, of 105 Quinn Blvd., Longueuil, Que., Born at Beadnell, England, July 31st, 1892; Educ., Armstrong College, Newcastle-on-Tyne, 1907-09, night classes; 1908-10, ap'ticeship, Emerson Walker & Thompson, Engrs., Gateshead-on-Tyne; 1910-12, with Sir Wm. Angus Sanderson & Co., Automotive Engrs., Newcastle-on-Tyne; 1912-14, shop dftsman. and setter out, George & Jobling, Automotive Engrs., Newcastle-on-Tyne; 1914-15, in charge of works and vehicle designer, McHardy & Elliott, Automotive Engrs., Edinburgh, Scotland; 1915-16, jigs, etc., Sir W. G. Armstrong Whitworth & Co., Aircraft Constructors; 1916-19, war service; 1919-21, private business, automotive and general engrs., Leeds, England; 1921-22, Blackburn Aeroplane & Motor Co., England; 1922-26, aircraft inspector to works supt., A. V. Roe & Co., England, aircraft mfrs.; 1926-28, in charge aircraft supply section, Sitka Spruce Lumber Co., Vancouver, B.C.; 1928 (Mar.-Dec.), chief inspr., 1928-30, works manager in control of aircraft division, Canadian Vickers, Limited; June 1930 to date, J. A. McCulloch & Co., Montreal, aircraft insprs., adjustors and appraisers for aircraft, automobile fire and general, and aeronautical consultant.

References: J. S. Hall, E. W. Stedman, A. Ferrier, W. G. Hunt, R. Ramsay, G Agar, O. E. Leger.

PINEAU—MAURICE E., of 1036 Gouin Blvd. East, Montreal, Que., Born at St. Medard, France, March 6th, 1902; Educ., 1924-27, Montreal Technical School, Diploma, 1927; course in heating and ventilating engrg., American School, Chicago; 1927-29, with Crane Limited, Montreal, design of heating systems and boiler plants for office bldgs., etc. Research work in design and testing of radiators and boilers; June 1929 to date, designing dftsman in heating and ventilating engrg., McDougall & Friedman, Consltg. Engrs., Montreal, Que.

References: G. K. McDougall, F. J. Friedman, L. A. Amos, T. E. McGrail, C. P. Creighton.

ROBINSON—DENIS OWEN, of Toronto, Ont., Born at Stapleford, Notts., England, July 6th, 1901; Educ., B.Sc. (Civil), Queen's Univ., 1923; 1920-21 (summers), inspr., pavements and sewers; 1922 (summer), supervn. of design and constrn. pavements and sewers, St. Thomas, Ont.; 1923 (May-Nov.), labour foreman, Mich. Central R.R. yard constrn., at St. Thomas, for Dominion Constrn. Co.; 1923-24, engr. in charge, design and constrn., sewage disposal plant, St. Thomas, Ont.; 1924-25, 1925-26 (sessions), demonstrator in physics, Queen's Univ.; 1925 (May-Oct.), designing engr., gen. munic. engrg., Detroit, Mich.; 1926 (May-Nov.), design and field engr., Detroit City Gas Co.; Nov. 1926-Jan. 1927, design and field engrg., City of Pontiac, Mich.; Jan. 1927-July 1928, supt. in charge, Schaefer-Thompson Co., Paving Contractors, Pontiac, Mich.; 1928-30, supt. in charge, White Constrn. Co., Gen. Contractors, Chicago, Ill.; Feb. 1930 to date, sales engr., Canada Cement Company, Toronto, Ont.

References: H. S. Van Scoyoc, J. M. Breen, A. G. Fleming, W. C. Miller, W. P. Wilgar.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BALL—SPENCER, of Halifax, N.S., Born at Liverpool, England, June 30th, 1890; Educ., B.Sc. (Civil), Univ. of Sask., 1916; 1913, mtce. of way, C.P.R.; 1915, research work, Univ. of Sask.; 1916-19, overseas, Lieut., R.G.A.; 1919-20, design of steel and reinforced concrete structures, 1920-22, design and checking of steel structures, gen. hydraulic design, computations, economy studies and hydraulic investigation, 1924-25, backwater studies, Niagara River, and report, 1926-28, hydraulic design and investigation, reports, investigations, etc., for the H.E.P.C. of Ontario, Toronto; 1922-23, gen. sewer design, reports and plans, 1923-24, investigation and design of sewerage schemes, hydraulic problems, studies of assessment, City of Toronto, sewer section; 1928 to date, asst. professor of civil engineering, Nova Scotia Technical College, Halifax, N. S. (*S. 1915, Jr. 1920.*)

References: T. H. Hogg, J. J. Traill, H. G. Acres, F. R. Faulkner, O. Holden, G. H. Burchill.

CUSHING—RICHMOND HERSEY, of Fraserdale, Ont., Born at Houlton, Maine, Aug. 13th, 1898; Educ., 1914-16, applied science course, Acadia Univ.; 1915 (4 mos.), in land surveyor's employ; 1916 (4 mos.), with G. G. Murdoch, M.E.I.C.; 1917 (9 mos.), dfting., mfg. plant, T. McAvity & Sons; 1918-20, not engaged in engrg. work, but studying practical civil engrg.; 1921, instr'man. and 1922-23, asst. to H. A. Ryan, constrn. engr. on St. John-Moncton transmission line, N.B. Electric Power Commn.; 1923, asst. to G. P. Rigby, constrn. engr., on Musquash reconstrn.; 1924-26, instr'man. and in charge of transit party, St. John River flowage surveys, Grand Falls, N.B.; 1926, asst. to constrn. engr. on constrn. of 1½ miles of spur line at Grand Falls; 1926-28, asst. to constrn. engr. on power house and tunnel, Grand Falls, N.B.; 1929, asst. to constrn. engr. on Grand Falls power house and Green River development for town on Edmundston, N.B.; 1930, in charge of survey party for American Telephone Co., on line from St. Stephen, N.B., to Sydney Mines, N.S.; Feb. 1931 to date, asst. to concrete engr., at Abitibi Canyon development, Dominion Construction Company, Fraserdale, Ont. (*Jr. 1916.*)

References: A. C. D. Blanchard, G. H. Lowry, T. V. McCarthy, G. Mitchell, R. L. Hearn, P. C. Kirkpatrick, A. A. McLaren, S. R. Weston.

DION—JOSEPH EDGAR, of 467 Mount Stephen Ave., Westmount, Que., Born at Ottawa, Ont., May 6th, 1899; Educ., B.Sc. (Mech.), McGill Univ., 1926; 1919-20, asst. to chem. engr., British America Nickle Corpn.; 1920 (July-Sept.), quant. chem. analyst, Dominion Govt., Customs Labs.; 1922 (summer), charge survey party, highway relocation, Dept. Public Highways, Ontario; Oct. 1922-Dec. 1923, dfting and design on hydraulic turbines, Dominion Engrg. Works, Ltd.; 1923-24, asst. to constrn. supt., Texas Constrn. Co.; 1925 (summer), cadet. engr., trans. dept., Pennsylvania Power & Light Co.; 1926-29, with the Montreal Engineering Company, as follows: 1926-27, estimating, design, reconnaissance and surveys for power projects; 1927-29, in charge of constrn. for the Bolivia Power Co., La Paz, Bolivia, S.A. In charge of re-organization and operation of engrg. dept., Bolivia Power Co. and investigation of power sites; Jan. 1929 to Feb. 1932, prelim. surveys and asst. to res. engr. in charge of Chat Falls development. (*S. 1922, Jr. 1927.*)

References: H. L. Trotter, D. Stairs, J. T. Farmer, J. H. McLaren, J. Dick, S W. B. Black, N. Malloch.

JOHNS—CHARLES DOUGHLAS, of 47 Lincoln Road, Walkerville, Ont., Born at Marmora, Ont., July 13th, 1898; Educ., 1921-23, 2 years, applied science, Queen's Univ.; 1915-16, dftsman., British Chemical Co., Trenton; 1916-17, dftsman., Quaker Oats Co., Peterborough; 1917-21, dftsman., designer, field engr., on grain elevators, flour mills, etc., McFarlane, Pratt, Hanley, Ltd., Midland, Ont.; 1922 (summer), designer on grain elevators, Fegles Constrn. Co., Fort William, Ont.; 1923-24 (summers), estimator, field engr., asst. supt., John V. Gray Constrn. Co., Toronto, Ont.; 1924-26, estimator, engr., Walbridge Aldinger Co., Detroit, Mich.; 1926-28, engr. in charge of constrn., for same company, foundations, warehouses, factories, office bldgs., etc.; 1928 to date, branch manager, John V. Gray Construction Co. Ltd., Windsor, Ont., gen. bldg. constrn., (*Jr. 1924.*)

References: F. S. Milligan, A. H. Aldinger, R. J. Fuller, L. M. Allan, A. J. M. Bowman, M. E. Brian, R. A. Spencer.

RINFRET—GUY RAOUL, of Montreal, Que., Born at Dawson City, Y.T., June 3rd, 1901; Educ., B.Sc., McGill Univ., 1925; 1922-23 (summers), Quebec Streams Commission; With the Shawinigan Water & Power Company as follows: 1918-20, chainman and rodman, 1926 (May-Aug.), office and field engrg., Shaw. Falls, 1927 (Oct.-Nov.), reconn. trip to N. St. Maurice Watersbed; With the Power Engineering Co. as follows: 1926 (Sept.-Nov.), i/c survey party on Mattawin River; 1926-27, office engr. re above at Shaw. Falls; 1927, Mar.-June, estimates, Montreal office, July-Aug., i/c reconn., Upper Mattawin River, Sept.. i/c survey party on Peribonka River; 1927-28, estimates, Montreal office; 1930 (Jan.-Apr.), res. engr. on Toro Storage Dam. Mattawin River; With the Shawinigan Engineering Company, Ltd., as follows: 1920-21, leveller on tower bases, and instr'man.; May 1923, and summers 1924-25, instr'man.; May 1928 to Dec. 1929, asst. to supt. on surveys of power dev'mt. sites, Upper St. Maurice River; 1930 (May-July), asst. to gen. supt. on prelim. constrn. work of Rapide Blanc Dev'mt., at La Tuque; Aug. 1930 to Dec. 1931, res. engr. on Rapide Blanc Dev'mt.; Jan. 1932 to date, in Montreal office on estimates, etc. (*S. 1924, Jr. 1927.*)

References: S. Svenningson, C. R. Lindsey, J. A. McCrory, C. Luscombe, H. Dessaulles, O. O. Lefebvre.

TOUPIN—VALERIEN, of 2186 Souvenir Ave., Montreal, Que., Born at Montreal, Jan. 25th, 1899; Educ., B.A.Sc., C.E., Ecole Polytech., Montreal 1925; 1924, (summer), Dominion Bridge Co.; 1925-27, lab. for testing materials, City of Montreal; 1927 to date, with St. George Construction Co. Ltd. (formerly St. George & Gauvreau, Ltd.), Montreal, Que. (*S. 1925, Jr. 1928.*)

References: J. E. Blanchard, A. Frigon, C. A. Gelinas, J. E. Heroux, L. Laferme, J. A. Lalonde, W. E. Lauriault, C. J. Leblanc, A. E. Patterson, H. L. St. George, A. Ste Marie.

FOR TRANSFER FROM THE CLASS OF STUDENT

BROWNELL—HAROLD ROSS, of 215 Chestnut St., Winnipeg, Man., Born at Truro, N.S., Aug. 28th, 1903; Educ., B.Sc., McGill Univ., 1929; 1921, chainman and rodman, dam and reservoir constrn., C.N.R.; 1925-26 (winter), instr'man., Carter-Halls-Aldinger Co. Ltd.; 1926-27 (winter), estimating, Oliver Iron Mining Co., Minnesota, U.S.A.; 1929 (summer), in charge of layout of steam lines, ducts and tunnels, Canadian Engineering & Construction Co. Ltd.; March 1930 to date, sales service engr., Bailey Meter Co. Ltd., Winnipeg, Man. (*S. 1927.*)

References: A. R. Roberts, T. Kipp, Jr., N. M. Hall, T. C. Main, W. G. Chace.

BURNSIDE—ROBERT JOHN, of Toronto, Ont., Born at Bannockburn, Ont., Oct. 30th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1927; 1925-26 (summers), Instr'man., Northern Development Br. of Ont. Govt.; 1927 to date, res. engr., with James. Proctor & Redfern, Ltd., Toronto, 1927-30, Forest Hill, sewers and pavements, and 1930-32, Almonte, waterworks and sewers. (*S. 1927.*)

References: E. M. Proctor, C. R. Young, W. B. Dunbar, W. B. Redfern, W. D. Proctor, C. H. Mitchell.

STEWART—LESLIE BAXTER, of Shawinigan Falls, Que., Born at Antigonish, N.S., July 21st, 1903; Educ., B.Sc. (St. Francis Xavier Coll.), 1923, B.Sc. (Elec.), McGill Univ., 1927; 1923-25, foreman on reinforcing steel, timekpr., etc., with N.S. Power Commn. on hydro-electric constrn. at Sheet Harbour, N.S.; 1925 (5 mos), timekpr. on bldg. constrn. with Parsons-Ed Co., at Antigonish, N.S.; 1927-29, student ap'tice, and 1929 to date, elect'l. tester, in charge of testing of elect'l. equipment at 250,000 h.p. hydro-electric generating station, Shawinigan Water & Power Company. Shawinigan Falls, Que. (*S. 1925.*)

References: H. J. Ward, H. Dessaulles, A. N. Budden, C. V. Christie, E. Brown.

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Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

MECHANICAL ENGINEER, Jr.E.I.C. Univ. Toronto '22. A.A.S.M.E. Diversified experience, one year teaching, three years Canadian Westinghouse Co., past four years in charge of mechanical laboratory of leading manufacturer in U.S.A. Sound technical knowledge and good organizing and executive ability. Wishes to return to Canada. Position with industrial or commercial laboratory. Apply to Box No. 138-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. At present employed. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

DRAUGHTSMAN, experienced in design steam and ventilating plants, boiler layouts, hoisting and other machinery, and structural engineering. Good references. Present location Montreal. For interview apply Box No. 329-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing or sales organization. Apply to Box No. 334-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available February 1st. Qualified Captain in military engineering. Apply to Box No. 377-W.

FILTER PLANT ENGINEER, B.Sc. (Honours Civil Engineering and Hydraulics), recently resident engineer on filter plant construction, finally in charge of operation, desires similar position. Experience of control of chemical treatment and knowledge of water analysis, running testing and adjustment of waterworks equipment. Can do laboratory work. Apply to Box No. 395-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and movable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.A.Sc. and C.E., A.M.E.I.C., age 29, married experience over the last nine and a half years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations of hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial, available at once. Apply to Box No. 477-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc. '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.G., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in mining, pulp and paper industries, seeks association with manufacturer as designer and sales engineer. Holds some patents on machinery for trade. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes one year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door substation construction, as assistant engineer. Also geological survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931, N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once. for Canada or tropics. Apply to Box No, 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; student's test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsiblity or taking charge of technical work for small concern. Apply to Box No. 669-W.

Situations Wanted

CIVIL ENGINEER, graduate University of New Brunswick '31, in C.E. Experience consists of three seasons on a survey party. Available October 1st. Desires permanent position. Willing to go anywhere. Apply to Box No. 672-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

RADIO ENGINEER. Graduate McGill Applied Science '30. Experience includes the cesign, development and production of broadcast receivers, as well as general radio laboratory practice. Apply to Box No. 680-W.

ELECTRICAL ENGINEER, graduated 1914, desires position with engineering firm or electric utility. Experience in design and layout of power houses and sub-stations, including automatic and supervisory control equipment; design of switchboards and switching equipment; manufacturing, testing, erection and operating of electrical apparatus of all kinds. Anywhere in Canada. Permanent position preferred. Apply to Box No. 681-W.

OPERATING ENGINEER, A.M.E.I.C. Operating superintendent or assistant. Age 44, married. Twenty years experience in industrial manufacturing, steel mills, power plants and quarrying operations, both large and small. Very successful with labour problems, cost accounting, etc. Will take any position with view to betterment. Available immediately in any location. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsiblity. Above can be verified by best of references. Available on short notice. Apply to Box No. 692-W.

ELECTRICAL ENGINEER, B.Sc. '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

ELECTRICAL ENGINEER, B.A.Sc., graduate '28. Test experience D.C. motor and generator design, and industrial electric heating design experience. Single. Location immaterial. Apply to Box No. 709-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draftsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply Box No. 713-W.

Situations Wanted

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experienced in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (University of Alberta, '31), S.E.I.C., single, age 24. Experience consists of lumber manufacturing, chainman on subdivision survey, transitman on railway maintenance and assistant on highway right-of-way surveys. Available immediately for position anywhere. Apply to Box No. 724-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E., (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc. (Univ. of Man. '31), age 22. Experience includes two months surveying and two summers draughting maps and treated timber bridges with highway department. Interested in manufacture of electrical equipment, water power engineering, radio and telephone, highway engineering. Available on one month's notice. Apply to Box No. 747-W.

MINING ENGINEER, university graduate '30. Experienced in surveying, mapping, assaying, examination of prospects, diamond drilling and a season on Dominion Geological Survey. Employed at present but available on short notice. Apply to Box No. 748-W.

Situations Wanted

SALES ENGINEER, B.Sc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available shortly. Apply to Box No. 749-W.

CIVIL ENGINEER, M.A. (Cantab.), A.M.Inst.C.E., A.M.E.I.C. Age 27. Unmarried. Three years experience on hydro-electric construction, tunnels, dams, penstocks, etc., geodetic and general surveying. Three years experience on design of hydro-electric structures and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 751-W.

CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

CIVIL ENGINEER, M.Sc., R.P.E., (Sask.), D. and S.L.S. Age 28. Available May 15th to September 15th. Will consider any offer for above period. Ten years experience in highway, drainage and railroad engineering; surveying of all types; sewerage and waterworks design; sales and newspaper work. Owns a car and has a thorough knowledge of prairie provinces. Apply to Box No. 760-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate '23, A.M.E.I.C., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.) Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box 770-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monumental and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

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Engineering Education in Canada

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Note: The Past-Presidents' Prize for 1931 was awarded to this essay which is now published by direction of Council.

The method of discussion of Engineering Education in Canada to be followed in this paper consists, first of all, in a brief review of engineering and of education in their general aspects and secondly, in a somewhat more extended presentation of some thoughts arising from the simple act of placing these two words together.

It is clear that any discussion of the technicalities of engineering education, of the details of curricula, of entrance standards, of pedagogical method and the like, does not lie within the competence of the layman in educational affairs. These questions are, in the main, properly left to educators, to those whose business or profession it is. Their study and experience eminently fit them to make the wisest possible decisions on matters pertaining both to the method and content of engineering study in the universities.

On the other hand, it is equally the prerogative of the layman, provided he be an engineer, or employer of engineers, to pass in review the educational requirements of the profession. It is even more than a privilege, it is almost a duty for any engineer who has given thought to the matter, to express his ideal of the equipment to be provided by the engineering college. The educators must realize clearly the mark at which to draw their bow. It should aid them in formulating their plans if active participants in engineering set down, with as much clarity as lies in them, their concept of educational needs.

Where the writer has departed from this division of authority and strayed into the fields of the educator, he can only plead that ideas, possibly originating from the immature mental processes of youth, have nevertheless clung steadfastly in the intervening years and will not be dislodged.

In addition, from his own thinking and experience, the engineer may give voice to his ideas concerning education as it applies to graduates. Education should be only well begun when a student completes his university course and the young graduate will find that some of the most difficult things he has to learn and assimilate, even in a technical sense, still lie before him.

ENGINEERING

It might be worth while to repeat here a definition of engineering offered several years ago by a well known engineer. He said, "Engineering is the science and art of directing applications of the science of mechanics in the economic utilization of the forces and materials of nature." It is not necessary to enlarge on this definition; the ideas embodied in it are familiar to all and it is repeated only to give point and focus to thought.

This statement of the field of engineering is an excellent one; but even in the few years that have elapsed since it was written, a new phase of thinking and action is demanding consideration. This is the idea of the social functioning of engineering. Such an idea is implicit in engineering and the profession has been derelict in its duty in not giving this matter the amount of thoughtful attention that is in keeping with its value. Engineers cannot forever ignore the social implications of their calling and continue to hold their high place in the public confidence.

The engineer has been blamed for technological unemployment because he has devised machines as a substitute for human labour. No blame can rightly be attached to the inventor or discoverer as such. The world owes far too much to them to restrict or hamper their work in any fashion whatsoever. The blame does attach to those who, introducing new machines and discoveries into the economic life, ignore the results of their own accomplishments, and in so doing, fail in their social responsibility of effecting the inevitable adjustments in the personnel of industry.

As an instance of the magnitude and complexity of these problems it is estimated that, for the automobile industry of the United States as a whole, sixty-six men out of every hundred have been replaced by machines during the past sixteen years; in the manufacture of razor blades, one man now produces as many razor blades in the same time as five hundred men in 1913; in the lumber industry, one man used to saw 100 feet of lumber a day, now, with the aid of machines, he can saw 10,000 feet of lumber in a single day. From 1899 to 1919, a period of twenty years, the production of the average wage earner increased 11 per cent; but from 1919 to 1929, only ten years, production per worker increased 53 per cent. In the last eight years, machinery in farming, manufacturing, railroading and mining has eliminated two million, three hundred thousand workers. Again these figures apply only to the United States but a similar development is taking place and will continue to take place in Canada; it behooves us to profit from the experience of others and not permit, as far as is possible, similar difficulties to occur in the development of our own country. This gain in productivity resulted mainly from improvements in equipment, organization and management rather than to increased efficiency of manual labour. Such a truly extraordinary showing is due, in no small part, to the work of the engineer.

In the past, the engineer has proceeded on his way, absorbed in the technicalities of his profession, with an almost childlike naïveté and ingenuousness, little recking of the trail of human problems and difficulties he has left behind him. Either he must call a halt to this blind journey or somebody else will do it for him. The human suffering caused by increasing technological unemployment and the appalling loss of productivity are a challenge to industry. Insofar as the engineer is a directing force in industry, he must accept this challenge.

It is of the very essence of all well-regulated human activity that it be directed toward adding to the happiness and general prosperity of mankind. By the term general prosperity, spiritual and mental well-being are included as well as the material comforts. This is the criterion of all endeavour. Engineering must be consciously paralleled with it or be futile. It is now generally recognized that an unchangeable law governs every event in the world of nature—particularly those series of events that are usually thought of as scientific. This order in nature, however, is not limited to any one sphere. It pervades the entire realm of human relationships just as it does all other fields. Sentiment alone is not sufficient in regulating human conduct and human relations. It must be guided and directed by knowledge. As yet our knowledge in this field is meagre, but it can be augmented only by the same use of imagination, observation and deduction, in short, by the use of the scientific method, that has opened to mankind his other stores of knowledge.

To keep these human ends in view should be a constant endeavour. This is a much more difficult task when dealing with steel and concrete than when direct relationships with men and women are the normal activity. This fact, however, must not be allowed to obscure the issue. Many engineers have deplored the apparent lack of esteem in which the profession is held by the public, and the failure of the profession to be represented on bodies charged with the investigation of questions of public interest and welfare. Perhaps engineering fares no worse in this respect than other scientific professions. Absorption in scientific and technical matters has left, in the lives of many engineers, neither room for a study of the problems of polity in the state nor interest in questions of human welfare. On the other hand, government, whether municipal or state, is directly concerned with these matters. It may be readily imagined that its leaders will be more than anxious to appoint engineers on public commissions just as soon as they raise their noses from their blue-prints and figures and survey occasionally the world of men and women about them.

In a social order in which the applications of science to the production of goods are continually increasing and in a society dominated by the desire for material wealth, the engineer must continue to play an increasingly important part. This is particularly true since competent observers declare that there are discernible as yet no signs of any change in this secular urge. Industry chooses its administrators wherever it can find them. Other things being equal, the administrator with a scientific training has been found best fitted to its needs and at present many of them are drawn from the ranks of engineers. It is a logical source and it is a logical development for the engineering profession. Of course it is quite true that a man trained in engineering is not necessarily a good administrator but, on the other hand, experience has shown that there is nothing in the administrative faculty which cannot be acquired by engineers of high talent. Whether some engineers cannot acquire this faculty, or have not been taught it, or simply have not taken the trouble to learn it, is another matter altogether.

New recuits to the profession should be given the opportunity through training to meet these new developments in thought and practice, and engineering education in the universities must be oriented to fill this very great need.

Education

If, as we turn our attention to education, we were to ask ourselves what it is we require of and expect from education, we should probably receive a large variety of replies. Without a doubt, all would agree that education must be directed toward providing the means of obtaining a livelihood. It is impossible to lead "the good life" without an adequate source from which to draw the necessities of civilized life. The time when a leisured class, dependent upon property, were the only ones who could pursue the quest of learning has long departed. Today the tables are reversed. To obtain a livelihood, we must be educated. Knowledge, and the ability to use it in the general scheme of production and distribution of goods, is required of all, even though in varying degree.

In addition, education would not be complete if it did not give us some apprehension of the true principles of behaviour. However much of a truism it may be, the fact remains that men are social; the fundamental satisfaction of their beings demands that they work together, play together, share ideas together, in a word, live together. The happiness of the individual is measured entirely by the degree to which he approximates in his daily living the basic requirements of human conduct. This is not merely a question of morals, *per se*, in which a code of behaviour, developed either by society or by the individual himself, must be maintained, but the consummation of a scientific basis of human living in its individual and social aspects. This basis was discovered and enunciated long ago. It may be found tucked away in the sacred literature of all religions. What is new, and this is a point on which many have gone astray, is its changing form of application with each generation. Principles such as these may not be apprehended in their entirety by the intellect alone. Understanding of them comes little by little as they are incorporated into the daily acts of living. It is this that makes life so difficult. For not only has each new generation to discover the principles for itself but it has to find out also how to apply them to its own particular social and economic environment.

From the university graduate, an interest in general ideas is expected. As new ideas are presented, he should analyse and examine them from all possible angles and accomplish some degree of understanding before accepting or rejecting them. If he throws them into fresh combinations according to the pattern of his own mental experience, he thereby prevents them from becoming dead. In education, mental apathy, caused by the placid reception of ideas, is, above all things, to be avoided. The imaginative handling of ideas is creative; it is only accomplished by the most rigorous discipline in the mental life. General ideas, thus handled by an active mind, give meaning and coherence to the flow of otherwise disconnected events that make up the round of daily experience. It is like finding the place for a piece in a jig-saw puzzle. The ferment that comes with the apprehension of some broad generalization with its vistas of unifying implications is like a glorious mental drunkenness. As new ideas are apprehended and tested, our understanding of life in its entirety is deepened and wisdom creeps upon us.

Education is a process of self-development. It does not consist of the accumulation of information—that may or may not be a by-product. As one writer has expressed this truth, "A merely well-informed man is the most useless bore on God's earth." A truly educated man is one who has acquired the art of utilizing knowledge. He knows where to find the information he requires and how to sort it out. He has trained himself to perceive quickly what is relevant and what irrelevant. Finally he can evaluate his discoveries and assemble his conclusions with the argument for each finding set forth logically and pleasingly. This art can be stimulated and directed from the outside but the real spade work must be done by the individual himself. An old saying has it that "Education is what is left when you have forgotten everything you have learnt."

Engineering Education

Engineering education may be taken, and should be taken, to mean the education of students in engineering colleges and the education of practising graduates. Education never ceases so long as the mind is active. We would not be loyal to our profession nor truly shoulder the responsibilities of our vocation if we did not, with all the means available, actively and forcefully continue and extend the educational process begun in the engineering colleges. More important even than this is the effect on the individual of the continuing educational process. The old fallacy that nothing new could be learned after the age of thirty has been thrown into the discard. One of the most interesting and hopeful of present day movements is the rapid adoption and extension of adult education resulting from the spread of this new truth. The growth of university extension courses in recent years is amazing. Far from the mind ceasing to develop before the early thirties have passed, we know that it may continue to mature, gaining in power and shedding richness on the inner experience of the individual throughout the full span of life.

First of all in the training of engineering students comes a knowledge of the science of mechanics. Then, hand in hand, comes the study of applied physics and chemistry and the properties and mechanics of materials. Following these, the student will go on to the theory of structures and machines, combining with them sufficient work in the laboratory to illustrate the major principles and sufficient draughting to ensure a reasonable facility in the art of preparing and reading plans. Concurrently with these subjects, enough work in mathematics must be undertaken so that it may be used as a tool in the development of the studies outlined. These studies form the technical basis of the engineer's mental equipment. Their importance is fundamental and primary. Without an adequate knowledge of them no man may rightly bear the title of engineer. True engineering always contains an economic element. In other words, all engineering projects must not only be technically sound, but also economically justifiable. It has always been part of engineering training to lay stress on the best technical solution devisable for any particular problem. In a practical world, however, we must always cut our cloth to suit our pocket. Consequently, true engineering consists in providing, not always the best possible, but the best that can be obtained for the money that is available. In their interest in technical studies, both professor and student are apt to overlook the fact that there are such things as dollars and cents. The graduate, in practice, very soon learns that everything he does has to be examined through the economic microscope.

As the years pass after graduation, the engineer gradually discovers that he has not only to devise structures, sound from a technical viewpoint, for the smallest possible amount of money, but also to examine them from their revenue producing aspect, with all that that entails of an intimate knowledge of markets, corporation and company financing, operating methods and the like. There have been and will continue to be many projects, both small and large, in which the major features belong to the field of engineering. Consequently it is not only appropriate but extremely desirable that engineers should fill the leading consultative positions during the promotional stages of these projects, and the leading executive positions relating directly to its constructional features and similar managerial positions when the project is actively functioning. If he is really competent in this field, an engineer may sometimes prove to be a very desirable and necessary brake to an over-enthusiastic financier or promoter. When such a project is commercially unsound and bankruptcy ensues, the engineer or engineers concerned rightly share in the general obloquy.

For the reasons outlined above, as well as for his own individual protection, and that of the profession at large, it behooves the engineer to have a somewhat more than cursory knowledge of certain phases of economics, business and finance. With a mastery of these matters in his possession, he is then in the enviable, and at the same time extremely responsible, position of being able to make his actions conform to his wisest thought, confident that his thinking rests upon a sure foundation.

It may be accepted as a fact that engineering colleges have had many years of experience in the teaching of technical subjects such as mechanics, both pure and applied, physics, chemistry, etc., and that the cumulative experience gained has in a measurable degree perfected the art as it relates to these subjects. Consequently, one outside of academic life may not with propriety offer any detailed suggestions concerning this matter. This is not true in like degree of courses in economics, finance, etc., which, in most colleges, have been introduced only in recent years. Moreover, work in the former subjects is an extension and prolongation of studies already undertaken in public and high schools. Hence their general atmosphere and thought technique have already been acquired, in some measure, by the students. This thought orientation (with its accompanying new vocabulary) is perhaps the greatest difficulty to be overcome in the mastery of a new realm of knowledge. For example, general economic forces are initiated by the physical needs and desires of human beings and differ radically in their nature and manner of action from mechanical forces. They require other types of analyses for their apprehension and resolution. Consequently, it would seem advisable, especially if the courses are to have any value, that instruction should be initiated early in the college period—certainly not later than the second year, and that it be continued at least over two or more years. It is a well known psychological fact that the mind takes time to digest knowledge and especially to form new thought patterns. The sudden clarity of thought that is experienced when a subject is renewed after the summer vacation, accompanied as it often is by an increased interest, is a fact of common observation.

In a previous section, the implications of engineering as they affect the social order and the professional responsibility of engineers to society have been stressed and a few phases of these questions have been indicated. The writer believes that these matters will attract considerable attention from engineers and from society in the future and that they are rightly to be considered of very great importance. It is only proper and just that the profession should take the lead as this inquiry develops. Obviously, this means organized training of a type that the majority of engineers now practising have never received and equally obviously it is the place of the engineering colleges to initiate such training for their students and for the professional societies to continue and extend it among graduate engineers. It is clear also that students will never become imbued with a sense of professional social responsibility unless the faculty itself is pervaded by this sentiment; also that to instil this sense among the student body will require a rare skill indeed. Active aid in the form of a symposium of lectures from engineers whose work has brought them into a direct relation with representative social groups would be one suggestion to further this idea. It is equally clear that no engineer, as such, can obtain an adequate sense of his responsibility to society unless he has a very definite conception of the social implications of his calling. Immediately the attempt is made to consider the nature and range of these implications, the enormous field of knowledge to be covered to assure an exhaustive discussion becomes apparent. Economics and sociology must both contribute an important share. Here is a new and excellent field for specialized study and an opportunity to make an extremely useful contribution to the sum of human knowledge. There are at least two methods of approach to this question. One would be by the institution of scholarships for study on one or more phases of the general problem of the effect of engineering activity on the social and economic life of the nation. The other would be by the inclusion of discussions of this general theme in the more advanced courses on economics and finance given in the engineering colleges. That is, in the opinion of the writer, instruction in these courses for engineers might include, for example, such topics as the effect that changing methods of transportation have on the buying habits of people, the economic consequences of the introduction of new engineering materials or new uses for old ones, etc., etc., as well as such subjects as the principles of amortization or the theory of supply and demand. In other words, the writer believes that every engineer should be given an opportunity to obtain a comprehensive view of that interlocking of scientific, economic and social endeavour which is at the heart of our present-day civilization. Such studies have far more than an academic interest. Rightly presented to active and inquiring minds, they will produce an expansion in outlook that will lead to an interested consideration of the development and progress of Canada, both as a national entity and as an increasingly important unit in the commonwealth of nations. With such training and knowledge at their command, engineers can step into the van of the onward march of civilization, keeping stride and pace with the very leaders themselves. This is the birthright of their profession.

Of equal importance with the study of science, mathematics, economics and finance in the education of an engineer is the study of the means by which ideas may be transferred from one person to another. When the practice of engineering was simpler and more empirical in its nature, the transference of ideas could be accomplished, in the main, by the use of imagery. Mental images of structures and machines could be built up and transferred to the drawing board. For the simplest cases, even the use of the drawing could be dispensed with. Imagery has of necessity become elaborated and formalized into the highly efficient art of modern draughtsmanship; as long as we deal with materials, it will constitute the main vehicle whereby the ideas of the designer may be understood by the constructor.

However, as engineering developed and broadened its scope to include in a much larger measure the realm of abstract ideas and the building up of argument, imagery became an ineffective vehicle and recourse was made to language. It is interesting to note here that doctors and engineers, dealing mainly with substance, are notably deficient in their ability to use language effectively, whereas lawyers, clergymen and teachers, whose work is almost solely with argument and abstract ideas, are usually very proficient both in writing and talking. This comparison has further significance when we remember that doctors, today, are realizing, as they have never done before, that the human body is not only an organization of chemical units, functioning according to the laws of chemistry, but has an additional element which we may term, for lack of a better word, spiritual. This latter element can most readily be influenced by certain ideas conveyed by speech. So we find that doctors now talk to their patients in an endeavour to normalize their mental life, as well as prescribing for them in the accustomed manner.

Language has been termed the vitamins of education, that is, it is something that makes assimilable the subject matter of the various studies undertaken. As such, its inclusion in all courses is an absolute necessity. Perhaps, more than any other subject, language requires that its pursuit be attended by enjoyment. One might hazard a guess that this is due to its closeness to human living. Our speech and writing are almost integral parts of us, and their quality is fashioned by the emotional life within us. Through language, as it comes to us in the writings or speech of masters of the art, we may experience types of beauty not found elsewhere.

Activity in language is needed if progress is to be made. We must be able to use it readily and with precision. With precision particularly, because it is the vehicle of thought; slovenly and inept phrasing dulls the edge of our understanding and appreciation. Without language, without the ability to communicate our thoughts, desires and emotions, our spirits would shrivel into nothingness. Experience has taught us all how difficult it is to say exactly what we mean. We write or say something that seems to us to be perfectly clear and possible of but one interpretation, yet to another person what we have said has a widely divergent meaning. Accurate expression can only come with much study and practice. The study of language, with its concomitant reading, is not without its rewards. Verbalization inevitably produces clarity of ideas. As the cobwebs are cleared from our mind, our language reflects with sharper outlines the image of our thought. In turn, additional clarity is gained, and the reciprocal impulses thus set up cause our understanding to grow and deepen.

For engineers, who have to deal mainly with things, but who have to live in a world of men and women, reading may offer vicarious experience. In other words, if we read the proper books, we can live, in imagination, with a vast army of other people of diverse types and kinds. We can live with them and understand them, too, as it is rarely given us to live and understand in the actual world. Our experience of people may be multiplied enormously and deep appreciation gained of human motives and aspirations. And what greater gain can any other study afford? It is gain not only to us as persons but also to us as engineers. The development of a social consciousness in engineering is causing us to relate more definitely and with greater awareness our professional work to the needs of human kind. The more we know of human nature, the better we can fill our particular niche in the scheme of things.

It has been advocated in some quarters that a study of history, philosophy, psychology, ethics, etc., and even the humanities should be included in the engineering curriculum with the idea of "liberalizing" the course. In fact, the president of one of the large American automobile companies is reported to have said, in part:

> "My own stand in the matter of cultural subjects is very positive. No matter what he takes up, a man's success depends upon his salesmanship. This being true, it is most important that he acquire the poise and polish that general culture gives him, in order that he may make the finest impression of himself and his ideas."

Alas for cultural subjects and education if this be the only use to which they are to be put!

One of the most distinguished of present day writers has said, "Culture is activity of thought, and receptiveness to beauty and humane feeling." This paper has been prepared in the belief that a study of the subjects advocated therein, undertaken in the spirit and manner outlined, will result, if it be possible at all, in producing graduates whose feet will be firmly set on the path of culture in the sense of the latter quotation.

The same writer has also enunciated two educational commandments—"Teach few subjects" and "What you teach, teach thoroughly."

The method of teaching is, at least, equally as important as the subject matter being taught. In fact, there are many who would pre-empt first place for quality of pedagogical skill. It is a matter of common knowledge that the high reputation acquired by any university has not been gained mainly by an excellent and well balanced curriculum, but by the high calibre of its faculty. It is their skill in guiding the development of the minds of the students that has placed the name of their university high on the list. Perhaps the universities have been right in not requiring special training in pedagogy for its staff, placing reliance, instead, in selection based on the results of experience. The art of teaching is a venerable one but the science of pedagogy is still in its cradle. However, a great deal of directly useful research in this science has been accomplished and numerous additions are being vigorously prosecuted. Much material, therefore, is now available for assisting members of the teaching profession in the acquisition of that, at present, rare ability to impart knowledge in a stimulating and vitalizing fashion. It seems a strange anomaly that a college, admittedly concerned wholly with training others in the applications of science, should omit from the preparation it requires of its own staff, any scientific training in the work it calls upon them to perform. We, who set great store by education and by efficiency in all our undertakings, neglect, thereby, a great opportunity to increase the effectiveness of one of the most vital functions of the modern state.

In actual practice, after graduation, there is much to be gained from the perusal of technical books and current technical literature. They are valuable in keeping abreast of new developments in thought and technique and often give considerable aid and assurance in dealing with specific problems. Not lightly do we acquire the ability to quickly and thoroughly incorporate the story of another's thinking and experience, misted as it often is by a foreign phraseology and a strange symbolism, into our own mental make-up. Such a process might well be begun at university while the mind is (or should be) still elastic, by a somewhat drastic remodelling of the time-table in which the number of lecture periods would be considerably decreased and the number of study periods correspondingly increased. There is really no adequate reason why vigorously minded and competent men should undergo the drudgery of repeating in lectures, year after year, the same formulae and explanations. It is no wonder that lectures have been dubbed "dry," for lecturing in this fashion is a soul-destroying and devitalizing experience. The joy of the real teacher results from stimulating other minds into activity and from the interchange of that subtle something that is created by fresh ideas perceived imaginatively by an active mind. There is no joy in handing out information to be copied in a note-book. A "talkie" reel, with appropriate diagrams and monologue, could be made to accomplish the same result much more efficiently. The printing-press, though in existence for centuries, is strangely ignored by our universities, to the detriment of both professor and student, thereby wasting much valuable time. Even the ancient art of Socrates is no longer "comme il faut"!

How much more valuable it would be for the students if they were forced to dig information from one or more of the many excellent text books available on each particular subject and to attend occasional lectures at which note-books would be excluded and in which the aim of the lecturer would be, not to dispense new facts or demonstrations, but to synthesize, co-ordinate, weigh and make significant the material previously studied. Recent advances in the profession or science, insofar as they could rightly be included, would also be legitimate themes of discourse. Students would thus become more self-reliant and would learn to see the various parts, as well as the whole of each subject, in a co-ordinated relationship, the one with the other—a result almost impossible of achievement when all attention is, of necessity, riveted on the stenographic-like procedure of note-taking. Another result would be a shifting of the responsibility for learning from the shoulders of the professors to those of the students, where it rightly belongs.

How much more valuable for the faculty, too, such a plan would be. Not only would it provide more stimulating and enjoyable work, but there would result the releasing of many hours to be filled with more wholesome and worth while pursuits. Probably some of these gained hours might well be employed as consultation periods. That is, each professor might set apart definite time in which he might be found at his office and the students given every encouragement to come and talk over, in a friendly way, the particular problems that each is bound to encounter. This would provide an opportunity to initiate that desirable personal relationship between faculty and students which can be so productive of inspiration, enthusiasm for and delight in a subject, and guidance in the art of clear and cogent thinking. In addition, such a regimen of instruction and guidance would be self-selective, and the final examination paper would truly reflect the initiative, energy, ambition and mentality of the individual student, instead of the sterile result of thirty-six hours of intensive memory work on a season's notes.

It would seem to be very definitely in the interests of both staff and students if as many members of the faculty as desired were encouraged actively to practice engineering, as far as time permitted, or to carry on research. There are several reasons for this. First of all because of its effect on the professors themselves. Continual contact with immature minds leaves a very definite mark on any person—a mark of a type that is not altogether wholesome or desirable. Not for nothing have the innumerable jokes and tales about teachers' oddities been set in circulation. Professional or research work would react against this tendency toward an inclination of the mind and would expand it and keep it stable. Moreover, it would provide a very necessary contact with reality. Unless we make use of our knowledge, dry-rot will inevitably ensue. This seems to be a fundamental law of our nature and we ignore it at our peril. By reason of his vocation, the member of a teaching faculty is somewhat restricted in the types of professional work in which he may engage, and accordingly every encouragement and facility to this end should be forthcoming.

The well-being of the faculty is mirrored in the student body. Any gain that the former may achieve is reflected in increased esteem on the part of the latter. The entire process is invigorated—for the professor because his mind is freed by a more harmonious relationship, and for the student through the growth of a willing and eager receptivity.

On graduation, the professor-subject-student rhythm in education is exchanged for a problem-worker rhythm. In the main, engineering practice consists of the solution of a series of specific problems. These may or may not have any relationship in their sequence as presented. Lack of relationship in sequence is immaterial, however, provided that the totality of problems is grouped in one of the major branches of the profession. This is obviously necessary for the purpose of specialization. The practical nature of engineering indicates how the technical side of the engineer's education may be continued. Any specific problem carries with it its own enthusiasm and interest. Hence, with this emotional aid as a driving force, opportunity should be made to study all that can be found about the particular phase under investigation within the time available. If such a procedure is consistently and intelligently carried out, excellent results are bound to ensue.

Empiricism, too, plays an important part in engineering practice. Each person can contribute but a small portion to the common fund of practical results. But the common fund is available to all in the technical literature and from this source we can add to our particular bit in the measure we desire. By taking advantage of our interest, as it is generated by our work, to enlarge our fund of knowledge and then apply it to the matter in hand, we are able greatly to expand our own experience, and consequently our usefulness. It does not matter if only a small portion of knowledge so gained can be directly applied to the immediate problem. The really important thing is the sifting and examining of the matter read, in the light of our previous experience and as it relates to the work in hand. In so doing, new ideas, at the very beginning, are prevented from becoming inert and fresh knowledge from forming a junk heap.

Current technical literature and meetings of engineering societies, at which papers are presented, both offer new knowledge and bring fresh developments in the art. They contribute matter of real worth to graduate education. Without them it would be difficult for most engineers to keep pace with progress in the profession. Nor is the social aspect of engineering gatherings to be ignored. When opportunity for wide and varied social intercourse is limited, as it is in most engineering fields, then it is advisable to take advantage of every occasion that is presented. Perhaps it would not be amiss if the arrangements for more meetings could be so ordered that the amenities of friendly conversation were facilitated. The art of talking easily and interestingly, whether in a small group or before a large audience, is well worth cultivating. It is one of the hallmarks of an educated person.

The engineering colleges of Canada were not fashioned in their present form "ab initio." They represent the rapid growth of technical education, one of the new children in the school of learning. Their development has taken place in response to pressure from the youth of Canada, eager to equip itself for the adventure of life. They bear the marks of that pressure. Now that this period of development and stress is waning, it would be fitting for the engineering colleges to ponder seriously on the nature and quality of technical education in relation to the varying ability of students who present themselves for its discipline and in relation both to their function as training schools for the engineering profession and their status as units in the universities of Canada. As a basis for thinking, the suggestion is offered that training in engineering and its allied pursuits falls into three divisions—each roughly representative of the type of ability possessed by students in it, and the length of time which, for various reasons, they are prepared to devote to continuous, organized study. The first of these divisions would include those students whose mental and manual characteristics are heavily weighted in the direction of physical activity and who do not take kindly to much figuring or in whom the broad sweep of general ideas finds no welcoming lodgment. Such students are eminently fitted to fill the majority of positions that fall under such titles as surveyor, draughtsman, plant engineer, etc. It is submitted that for most of these students there is much time that must necessarily be considered as wasted in the ordinary four year university course. It was not designed for them; the training for such students might more properly be undertaken in a two year course at an advanced technical school. Much valuable time might thereby be saved, instruction more in keeping with requirements given, and the universities freed to devote time and energy to their proper function. The second grouping includes those students whose aptitudes especially fit them for the majority of the more strictly engineering positions and for whom the present courses in engineering colleges, modified slightly as the result of the absence of students coming under the first division, and presented with due regard to their status as being of university grade, would form an adequate and excellent preparation. The third division represents the confluence of two minor streams in the national life, streams, however, which will grow larger as the years roll by. Both of these have been briefly discussed, from a somewhat different viewpoint, in previous paragraphs. For the present purpose they may be described as demands for engineers with a broader and more liberal education than is now offered by the engineering colleges and for workers in those border-line fields that require specialized training both in engineering and in some other branch of study. For these students, the writer suggests a combined course in Arts and Engineering extending over six or seven years. Such a course would have the very successful precedent of a similar one in Arts and Medicine. For example, besides his work in engineering, a student taking this proposed course might study for his Arts degree, work in law, or pure science, or economics and finance. The very decided humanitarian trend in the development of social thought on the North American continent has resulted in more attention being paid to the various needs of people designated by such terms as sub-normal and under-privileged than those of average abilities receive. The latter are probably looked after fairly well. Society, however, gives the relatively few people of great ability and of unusual and valuable combinations of intellectual qualities almost no opportunities other than those which they have in common with everyone else. On the other hand, it is to these people that society owes most of the gains that it has made and on them depends for leadership. A combined course in Arts and Engineering would help materially in filling this lack in the educational opportunities provided for engineering students of exceptional ability. In addition to this, the inclusion in the ranks of engineers of men who have undergone successfully this far-reaching educational discipline would cause a rise in the general esteem in which the profession is held and the regard of educated men and women to be greatly increased.

There remains one matter to be treated under this section. It is of supreme importance, yet the observations are so obvious that but a few sentences are needed to state them. This matter relates to the question of salaries received by the staff of the engineering colleges. Clearly, they must be in keeping with the exceptionally high grade of ability that is required, and of the same standard as the remuneration received by practising engineers of like attainments. Through their contact with undergraduates, the members of the staff exert an unequalled influence upon the entire profession. Love of work and devotion to the cause of education should not be the only attractions drawing men into the ranks of engineering educators. It is only just that their services be fully rewarded. The joy that they find in their labour is but the privilege and perquisite of all good workmen and must not be assumed as part payment in lieu of the only measure which society acknowledges for that purpose, namely, dollars and cents or their economic equivalent. If educators are not paid in accordance with their ability, there will be an inevitable lowering of the general standard of teaching—in spite of the few who must teach because for them it is the only happiness—with all that that means to the detriment of the high standing of the profession at large.

Vocational Guidance Necessary

Vocational guidance for pupils attending secondary schools is now being recognized as necessary in the general national economy and definite schemes for this purpose are being formulated in several of the provinces. The engineering profession could give stimulus and aid to this movement. It would be their share in the solution of this important social problem and they would be more than amply rewarded by an even better standard of ability among the members of the profession than now exists. Very few youths before entering engineering colleges have ever met an engineer face to face, or seen him actively at work, or even have had direct contact with him through his writings. The same is not true of doctors, dentists, clergymen or even lawyers. Most of us have very intimate knowledge of the activities of these professions from our infancy onward. This simple fact constitutes a challenge and an opportunity. For it is axiomatic that no wise decision can be made if adequate knowledge is lacking, and when the problem of choosing one's life work is undertaken, all the assistance and guidance possible should be available. Moving pictures on engineering subjects circulated among the schools; a short and well-illustrated book, outlining each of the major fields of engineering and written by eminent engineers, in every collegiate library; talks on engineering by engineers to high school pupils; these are some of the things that might be undertaken for this purpose and doubtless others would suggest themselves if adequate study were given to the problem. By this means the profession might recruit to itself a greater proportion of those well fitted to be engineers by natural endowments and reduce the number of those who are the proverbial square pegs in round holes, to the very great benefit of everyone concerned.

Extra-Curricular Activity

Undoubtedly the percentage of students who have the opportunity of filling the various student offices is very small and it is neither possible nor desirable to make much change in this respect. The restless currents of student popularity and a sense of the fitness of things in the student body itself will usually apportion the various offices among as many students as possible. These offices provide an opportunity and that is all. In this, of course, they do not differ from other things of a like nature. Any results of value that accrue to the holder of an office are determined by his ability and the effort he makes to do his job well. Exercise of public responsibility, deciding on matters of policy affecting the student body, organization of public functions, experience in active co-operation within a small group working for a common end,—these are some of the benefits to be derived. Rightly conducted such benefits give material aid in arriving at that social consciousness and outlook that forms a very valuable addition to the education of any man.

The degree of participation in physical and general college activity that is wise, will vary with the inclinations and needs of each individual student. Physical fitness is almost a necessity for good living and there is no better time for such training than in the university years. There are usually excellent facilities for games, swimming, track-work, etc., and every student should be encouraged to take full advantage of them. A few simple facts about the care of the body, under varying conditions, should be taught. Also there are usually a sufficiently great variety of societies and organizations connected with the general college life, apart from the curriculum, to provide recreation and stimulus for every student. Not the least valuable result from participation in these two types of activity are the acquaintances and friendships formed with students from other faculties. A wider knowledge of people with different backgrounds and viewpoints is gained giving tolerance and understanding to social relationships.

Practical Work

What is commonly called practical work, that is, direct participation in the building of machines and structures, is a very important, in fact, almost necessary part of the training for engineers. It provides knowledge of the extent, as well as the limitations, of the art as carried out in present day practice. It gives the future designer acquaintance with the various processes that have been developed so that when the time comes for him to lay out his ideas on the draughting board, his design will not only have adequate strength and potentially correct functioning incorporated in it, but will also be so fashioned that it can be built and erected economically and with facility.

In addition, practical work provides for the student that conjunction of theory and practice that has already been stressed in another connection. Engineers, by the very nature of their calling, are likely to be strongly imbued with a creative urge. They want to build things, and it is balm to their souls and stimulation to their brains to have adequate satisfaction for this fundamental craving. Perhaps the lack of this satisfaction is partly responsible for the sterility that so often permeates draughting offices. Far, far too many draughtsmen never see the materialization of the numerous drawings they make, either in the process of building or the completed machine or structure.

To return to our subject, one of the objects of the recently created Technical Service Council is "to aid industry in their technical and scientific employment problems" and in fulfillment of this aim as it relates to students this body has already done extremely valuable work as a liaison agency between industry and the engineering colleges. It has presented to industry the need and worth of giving suitable employment to students and has acted as an employment bureau in the same connection. Thus a contribution of far reaching importance to engineering education has been effected and undoubtedly as the Council gives continued thought to the matter and extends its experience, even greater gains will be forthcoming.

Summary

To sum up, therefore, it may be stated that the education which an engineering student may expect to receive from his college course has a dual aspect. On the one side is a thorough knowledge of the basic scientific principles underlying all fields of engineering endeavour, a fairly comprehensive introduction to economics and finance, a generous discipline in the art of writing and speaking his mother tongue, and if the student is able to choose, as much study in the specialized field that he expects to enter as time will allow. Coupled with this is an opportunity to obtain, at first hand, a comprehensive idea of the methods and conditions under which structures and machines are built and operated. On the other side is the method by which this information is acquired. An imaginative grasp of learning, activity in thought and a real interest in the general ideas underlying the studies undertaken — these may be expected to emerge and flow from an appropriate pedagogical treatment in the hands of a teacher who, himself, possesses these qualities.

Engineering is not an end in itself; it is but a means of accomplishing certain desired results for the progress and welfare of society. The two aspects of education, mentioned above, should be so ordered that this end is made all pervasive and yet unobtrusive like that elusive something, the bouquet of good wine.

Recommendation

The general problem of engineering education does not lend itself to a categorical solution; the factors involved vary with each province and with each particular college. Even if the writer possessed the specialized knowledge of the educator, which he has not, he would find in attempting a specific answer that this almost insurmountable difficulty had to be faced. Differences in public and secondary school training of incoming students, differences in their racial and social backgrounds, differences in their prospects in life; differences in regional natural resources requiring different emphases in courses of study; diverse experiences and capabilities among the various members of the staff; all these factors combined in a different pattern for each college make a specific solution of the general problem the sole concern and specialty of the individual faculty. They, and they alone are in a position to evaluate all the diverse elements enumerated above in their own particular situation with a reasonable assurance that their judgment may be true and their solution wise.

It speaks well for the educational effort of the various engineering colleges in Canada that their graduates are able to undertake the immense engineering problems of this country and to carry them to a successful solution. In so doing, Canadian engineers have won not only the praise of their fellow countrymen, but also the esteem of other nations. Engineering education is the particular problem of the engineering colleges, it is their job and their responsibility and to them the profession looks for an adequate source of recruits. On the other hand the profession and industry are both vitally concerned with the training and preparation that these recruits receive. It is obvious that engineering professors have neither the time nor the opportunity to study, at first hand, the educational requirements of engineers and it is equally obvious that engineers are in no position, both by lack of training and of knowledge, to advise engineering educators what specific things should or should not be done in the colleges. For this reason, it would seem to be a very fruitful and rewarding form of effort if representatives of the various engineering faculties, of the profession and of industry could meet at a round table conference to discuss how each can help the other in this, their mutual problem. How the practical aspects of engineering could be made more real and stimulating to students and the more adequate formulation of the educational needs of engineers for which it is possible to provide during college years are suggested as two of the major themes on which discussion might be initiated.

To provide a means of effecting such a desirable association among the parties concerned, it is strongly urged that an advisory council for engineering education be formed consisting of representation from the engineering colleges, from industry and from the profession. As far as the writer is aware, never before have these three met together in a determined effort to help in the solution of the problems of engineering education as they arise from time to time. The training of personnel is the primary problem of all fields of human endeavour. As someone has remarked, "If you want to find out which is more important, a good man or good tools, just put a bunch of good tools in the hands of a poor workman." Modern education is too extensive a problem to be treated in a purely rational manner by one mind, or even by a group of representative minds; there must be, in addition, a basis of experience, facts and experimentation. It is hoped that the proposed advisory council might form an organization of this nature to guide the further progress of engineering education. In making this suggestion there is no thought that any radical changes in the present methods of education would, necessarily, be either expected or advocated. "First the blade, then the ear, then the full corn in the ear" is the rule in this as in all other fields. Rather the task would be to formulate and to disseminate among all persons concerned, the fundamental principles of engineering education and to assist in applying these principles to meet local and regional needs as they arise. If this were carried out with the same scientific zeal, with the same thoroughness and with the same imagination that has characterized engineering in the past, a very great, almost incalculable, gain is bound to ensue both in the quality of life for individual engineers because of the greater freedom which their educational discipline would give them, and, through industry and professional life, to the nation as a whole, because of the interspersion throughout the latter of a group of men whose training will have been well begun in science, economics and finance and in the art of logical and imaginative thinking, well-fitted thereby to enter the field of directing their specialized knowledge in the production of goods and services to meet the needs of the men and women of Canada.

Cyanamid and Its Derivatives

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SUMMARY.—The plant of the American Cyanamid Company at Niagara Falls, Ontario, is one of the largest metallurgical plants operating in Canada, or in fact in the British Empire. The cyanamide method of fixation of nitrogen is one that has certain advantages which have caused the rapid development of this plant.

The paper describes the equipment and general method of operation in the production of calcium carbide, cyanamide and cyanide.

There was exported from the Dominion of Canada in 1929 195,000 tons of calcium cyanamide valued at $5,500,000. This was the largest export of any chemical produced in Canada and serves to show the importance of the industry.

This material was produced at the plant of the American Cyanamid Company at Niagara Falls, Ontario. Built in 1909, the original plant had a production capacity of 5,000 tons of cyanamid per year. In twenty-one years this production has grown to a capacity of 355,000 tons equivalent to 75,000 tons of contained nitrogen.

The cyanamide process was discovered in the year 1898. In this year Sir William Crooks, a famous British scientist, predicted that unless a new supply of nitrogen was discovered or new methods evolved for the manufacture of nitrogen in a form that would be available as plant food, it would not be many years before the world would face a serious food shortage. At the time when this statement was made two German chemists, Frank and Caro, were experimenting in a laboratory in Italy in an attempt to make barium cyanide. They were not successful in making barium cyanide, but accidentally produced barium cyanamide. This illustrates very well the way in which many great discoveries have come about. Frank and Caro soon learned that cyanamide had very valuable properties and by replacing the element barium with calcium made the process to manufacture calcium cyanamide commercially feasible. It was not until eight years later, however, or in 1906 that the first plant was built. This had an annual capacity of only 500 tons. The world production has grown from 500 tons in 1906 to 1,350,000 in 1930.

The first material required for the manufacture of calcium cyanamide is limestone and the Ontario plant secures its supply from a quarry owned and operated by the company at Beachville, Ontario. This stone is noted for its extremely high calcium content and its uniformity, the analysis being approximately as follows:—

Silica and oxides..........	1.00 per cent.
Calcium carbonate........	98.00 " "
Magnesium carbonate.....	1.00 " "

The production of high calcium stone from the Beachville district is sufficiently valuable to warrant the deposit being considered one of the valuable non-metallic mineral

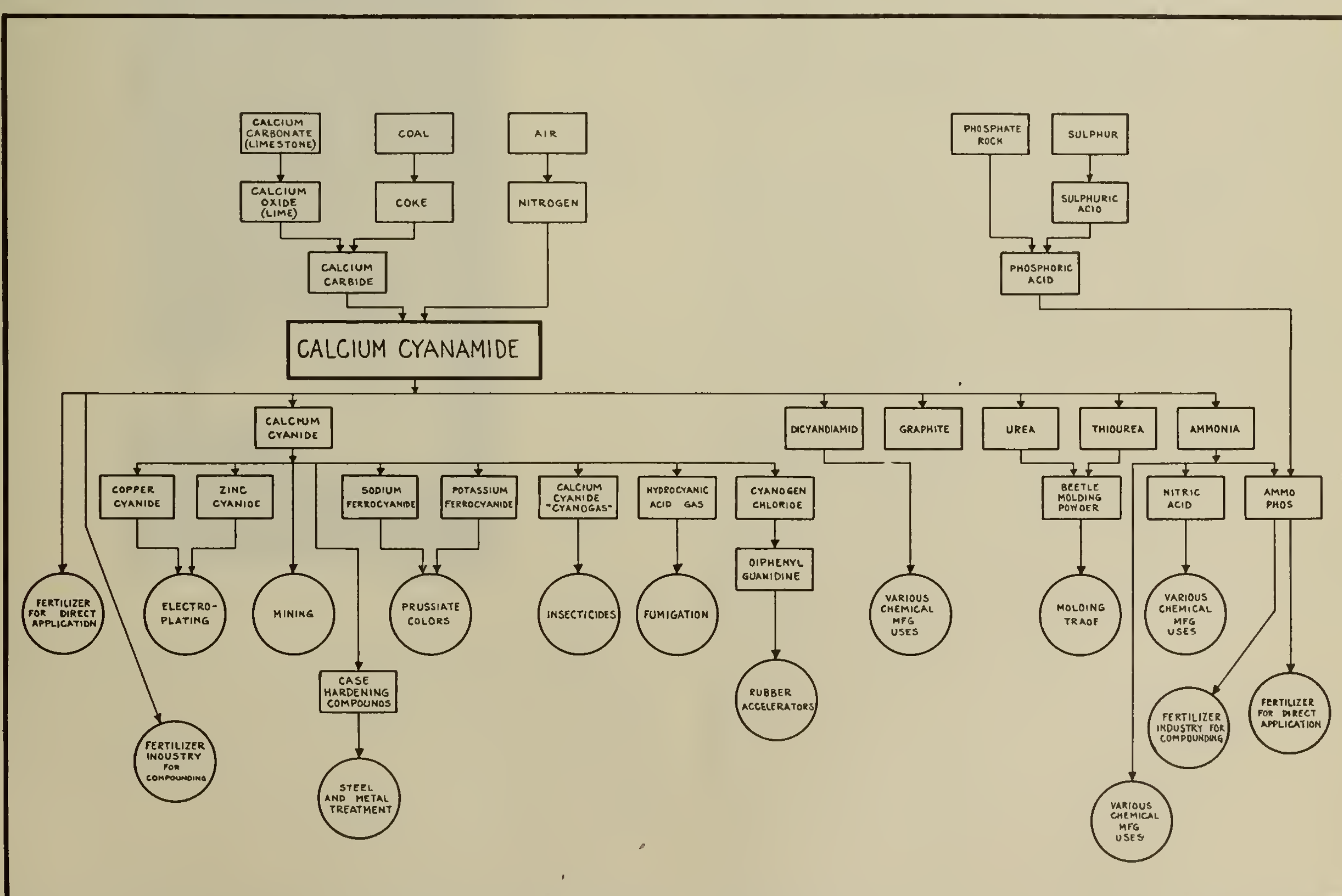

Fig. 1.—Calcium Cyanamide and Its Uses.

deposits in Canada. The stone after being blasted out and crushed to size in a modern plant is shipped to Niagara Falls. The screenings and small stone produced at Beachville, not suitable for cyanamid manufacture, are dried, screened and pulverized in a by-product plant and sold for many purposes. This material has found a fairly good market as a soil corrective for agricultural purposes, as a

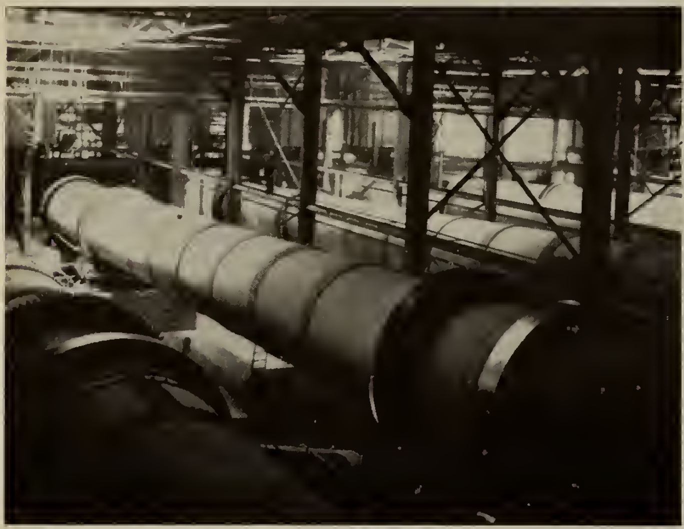

Fig. 2—General View of Rotary Lime Kilns taken from Intake End.

mineral filler in various industries and as a mineral ingredient to furnish the necessary calcium in stock and poultry food.

After the limestone arrives at Niagara Falls it is passed through a track hopper elevating and conveying system and is distributed to large steel bins from which it is fed to any of the seven rotary kilns. These rotary kilns are similar to those used in the manufacture of portland cement and measure 8 feet in diameter by 125 feet long and are illustrated in Fig. 2.

Each kiln has a capacity of 100 tons per 24-hour day. The drive requires 27 h.p. per kiln; they are operated at one-half revolution per minute through a bevel-gear drive. The pitch of the kiln is 5 feet in the total length of 125. Four workmen per shift care for all of the kiln department operations, but several workmen on the day shift care for unloading of the limestone and filling of the feed bins. The stone as charged averages 98 per cent calcium carbonate; it is burned to about 1 or 2 per cent carbonate with a fuel ratio in the kiln of three tons of lime to one ton of coal. Bituminous slack coal for firing the kilns is reduced in size first in a roll-type crusher and secondly in aero pulverizers. During the process of pulverizing, the coal is partially dried by utilizing waste heat given off by the hot lime as it leaves the kilns. A hood, 3 feet by 6 feet, has been suspended above the conveyor which carries the lime from the kilns to the coolers, and the heated air is drawn through a pipe extending from the hood to the pulverizer and circulated through the pulverized coal. This same air is used for blowing coal into the kilns to effect the burning of the limestone. The powdered coal, burned in an air blast, maintains a maximum temperature of 2,200 to 2,500 degrees F., without material injury to the brick kiln lining.

The engineers ascribe their ability to obtain constantly a lime of unusually good quality to their means of controlling the temperature of the kilns. For years the temperature was controlled by radiation pyrometers on the firing ends of the kilns which indicated temperature in the firing sections of the kilns. But it was found that the temperature of the gases leaving the kilns bears a closer relation to the calcining operation; and therefore that if the temperature in the upper part of the kiln was kept constant, the quality of the lime would be more nearly uniform. Therefore, a thermocouple was placed in the connection between the kiln and stack, and the kiln is operated to hold the temperature of the stack gases at approximately 1,100 degrees F.

The seven kilns are served by a single Peck conveyor below the spouts at the discharge ends, which is composed of overlapping steel buckets so arranged as to carry the hot lime with a minimum breakage. This conveyor feeds three rotary coolers designed by the company's engineers for a minimum of abrasive action during the cooling. These coolers are 8 feet in diameter and open at both ends. The longitudinal steel plates which attach the inner cylinder and the outside shell divide the cooler into six compartments so that the hot material entering the coolers is segregated in the smaller compartments, resulting in less fall and less breakage of the lime. By means of the air circulating through the inner cylinder and the water spraying over the outer, the temperature of the lime is reduced from about 1,000 degrees to 300 degrees F. On leaving the cooler the lime is conveyed to a bin in the storage room adjacent to the carbide furnaces.

Coke, the other important raw material, is reduced in crushers to the maximum size of one inch. From the crushers it passes to the pulverized-coal-fired dryers. Each dryer is equipped with an Erie City unit pulverizer and a combustion chamber. The temperature of gases entering the dryer is thermostatically controlled by the admission of outside air.

Fig. 3—View of Furnace.

When dried the crushed coke is carried to the raw materials building. Beneath the dried-coke and quicklime bins are scale hoppers from which weighed quantities of materials are delivered to a conveying-mixing belt and elevator by which they are carried to the carbide furnace room, where they are distributed among the furnace-feed bins. The mixed charge is dumped from these through chutes directly into the furnaces.

The carbide-making plant contains eight furnaces; four 4,000-h.p. furnaces each with a capacity of 22 tons of calcium carbide per day were built in 1913; six years later, two 16,000-h.p. furnaces were installed which had a capacity of 98 tons per day each; and in 1928, the capacity of the plant was increased by the installation of two 30,000-h.p. furnaces, each with a capacity of 185 tons. These larger furnaces have greatly increased the efficiency of this department. For every 1,000 h.p. used in the smallest size only 5.5 tons of calcium carbide is produced, as compared with 6.1 tons made in the two large size furnaces with the same power consumption. An additional advantage gained by the use of the larger furnaces is in the labour requirement per unit of product.

The attention of even the casual observer is attracted by the giant electrodes suspended in the furnaces. (Fig. 3.) The oblong assembly of five 20-inch by 22-inch by 100-inch carbons weighs complete with holder about 16 tons; a single set of carbons has a life of seven days. The assembly can be handled with ease, two workmen changing a set of electrodes in fifteen minutes. The lowering of the electrodes into the furnace is continuous and automatic; a special attachment stops them when they have reached the previously determined danger point.

The mixture of lime and coke is fed around the electrodes, from the bins above the furnaces, through swinging spouts. The rate of feeding is adjusted so that the furnaces are kept full at all times, compensating for the discharged carbide. The current passing between the electrodes creates a temperature of approximately 4,000 degrees F. and melts the lime, which combines with the coke, forming calcium carbide and carbon monoxide. The latter burns at the top of the furnace charge to carbon dioxide and escapes.

Furnaces of 4,000 h.p. are tapped at one-half hour intervals, and the others almost continuously. Tap holes are opened by burning with a portable electrode or electric needle, and carbide at 4,000 degrees F. flows into cast iron chill cars of 2,000 pounds capacity. Several cars are pulled on to a truck by a gasoline locomotive, and the truck is moved along beneath the tap hole by a car puller, controlled by a pushbutton. When all cars are filled, the locomotive pulls them out to the cooling shed.

After cooling the cars containing carbide are sent to the crushing and milling department where the carbide is reduced in size to 100 mesh material by means of primary jaw crushers, Symons cone crushers and compeb mills. Mills and elevators and conveyors of the plant are kept flooded with nitrogen gas to eliminate the danger of explosion due to formation of acetylene gas.

In the liquid air department located some distance from the main plant air is brought in and has its carbon dioxide removed by causticizing equipment. It is then compressed in large three-stage compressors to a pressure of approximately 300 pounds per square inch. Between each stage of compression it is cooled and after the final stage of compression it is sent to the liquid air columns which are of the Claude type and in these the air is brought by expansion to a temperature of approximately 371 degrees F. below zero. The nitrogen is distilled off by fractional distillation and by this process the nitrogen gas secured is 99.95 per cent pure. No use is made of the oxygen at present, it being returned to the atmosphere. It is interesting to note that the total requirements of the plant when operating to capacity are approximately 500 tons of air per day. It is calculated that there is sufficient air over one square mile of the earth's surface to furnish the entire nitrogen requirements of the world for about sixteen years. The nitrogen after leaving the liquid air plant is piped to the nitrifying department.

Like most of the other departments, the nitrifying equipment has passed through several stages of modernization. The original ovens installed at Niagara had a capacity of 600 pounds of carbide; those in use now have a capacity of 8,000. It has been found that ovens of this size are most efficiently operated. After being filled with pulverized carbide they are closed, and the nitrogen, piped from the liquid air plant, is turned on. Through an opening in the centre of the cover a carbon rod is inserted and heated to incandescence with the electric circuit. By radiation the surrounding charge of carbide becomes white hot. It absorbs the nitrogen, forming calcium cyanamide and free carbon, and since the reaction is exothermic it con-

Fig. 4—Ovens in which Cyanamide is Made.

tinues until completed. This reaction is represented as follows:

$$\underset{\text{(Calcium Carbide)}}{CaC_2} + \underset{\text{(Nitrogen)}}{N_2} = \underset{\text{(Calcium Cyanamide)}}{CaCN_2} + \underset{\text{(Carbon)}}{C}$$

After the oven is charged and started, no attention is necessary until it is ready to be discharged. The period of nitrification from start of oven to removal of cold finished product, known as lime-nitrogen, is about one day per ton of carbide charged. When the absorption has stopped, the cured cyanamid, which has sintered together, is removed by the crane operator and his assistant, who lift the cover, lower special tongs into the hole in the centre of the pig left by the carbon rod, pick up the pig and transport it to a car at the end of the building. It is then carried to the cooling room, where it remains until ready to be crushed. The ingot of lime-nitrogen, weighing about 6 tons, is broken into several pieces which fall into a hopper and are delivered by a drag conveyor to a Williams hammer mill, which breaks it into two-inch pieces. A second Williams mill completes the crushing. It is then carried by screw conveyors to storage or direct to the hydration plant.

The lime-nitrogen as produced in the cyanamid oven is composed of 25½ per cent nitrogen, or about 70 per cent calcium cyanamide; 12 per cent finely divided graphite, which gives it a slate-gray colour; 18 per cent free lime; and miscellaneous impurities picked up from the coke ash, electrodes and limestone. There remains from one to two per cent of unnitrified carbide.

This product is treated before marketing. For chemical purposes, or if to be used for production of ammonia, a small quantity of water is added as the fine cyanamide passes through a mixing-type screw conveyor, to decompose the remaining traces of carbide. It is then ready to be loaded into 70-ton hopper cars and sent to conversion plants. The product for agricultural purposes, commonly known as cyanamid, is treated differently. It goes through a more elaborate mixing system where both oil and water are added. The water is used to decompose the carbide and to hydrate the major portion of the free lime. Oil is added for the purpose of preventing dustiness, in quantity equal to four per cent by weight of treated product. It is then cooled by passing through a rotary cooling cylinder and sent to bulk storage. It is shipped to the fertilizer manufacturers and the farmers in bags and to chemical manufacturers in 70-ton steel tank cars.

The primary and still very important use for which calcium cyanamide is manufactured is its use as a source of nitrogen in fertilizer mixtures. Nearly all the commercial mixed fertilizers manufactured in Canada and the United States contain cyanamid as one of the sources of nitrogen. A more recent employment of the material in the agricultural field has been for direct application on lands or crops which require large quantities of nitrogen. This latter use is being rapidly extended.

In addition to the above, cyanamid is considered of economic importance as a parent chemical from which may be formed numerous important derivatives which may be described briefly.

By treatment of cyanamid in electric furnaces at Niagara Falls, it is converted into cyanide and a large proportion of the total world's production is here manufactured in this manner. Probably the largest use to which cyanide is put is in the mining industry for the extraction of gold and silver from their ores and for this purpose Canadian cyanide is shipped to South Africa, South America, Mexico, United States, northern Canada and in fact all over the world where gold mines are operating. This cyanide contains approximately 48 per cent to 50 per cent NaCN. Specially prepared, this material is also used as an insecticide and under the name of "Cyanogas" is successfully used as a control for agricultural pests such as gophers, ground hogs, rats, rabbits, ants, etc.

Hydrocyanic gas or HCN is prepared from cyanide by the addition of acid. It is stored and shipped in steel cylinders and used as a disinfectant for fumigating flour mills, factories, ships, warehouses, grain elevators as well as domestic houses.

Some of the older uses of cyanide are still important, namely, as a case hardening material useful in the automobile and machinery trades and also as a chemical used in electro plating. Copper cyanide and zinc cyanide are used mainly for this purpose.

Sodium ferrocyanide and potassium ferrocyanide, known as the prussiates, are also derivatives from cyanamide and these are used to form the basis of a number of colours and pigments.

Cyanogen chloride is a derivative from which is formed the compounds known as the guanidines which have found quite an important use in the modern world for the manufacture of rubber. The two compounds used are diphenylguanidine and di-ortho-tolyl-guanidine.

In turning back to our original cyanamide we find it is frequently used as the source of ammonia. By autoclaving cyanamide ammonia is produced readily and both aqua and anhydrous are produced in this way. By the oxidation of ammonia, nitric acid and the various nitrates are made.

Ammonia gas is used along with phosphoric acid (produced from phosphate rock and sulphuric acid) to produce ammonium phosphate which is a high analysis fertilizer of growing importance. The analysis of "Ammo-Phos 'A' " as it is called is 11 per cent NH_3, 48 per cent P_2O_5. The fact that this fertilizer contains nearly 60 per cent available plant food permits its being shipped to distant points and a large export trade is conducted in this material from the works at New York Harbour where it is made. The graphite, released in the manufacture of ammonium phosphate, originating from cyanamid which contains approximately 12 per cent, is recovered and marketed.

Dicyandiamid, another derivative, is an important material in the manufacture of pharmaceutical chemicals.

Urea and thiourea are also readily formed from cyanamide. By the combination of these ureas with formaldehyde and other readily obtainable materials a moulding powder known as "Beetle" can be produced which may be hot pressed into shapes of a strong resistant character. Non-shatterable tumblers, dishes and lamps, mostly produced in pastel shades with an attractive appearance, are the end products in this case.

The above mentioned uses by no means exhaust the possibilities to which cyanamide can be adapted. This material stands mid-way between the organic and inorganic fields of chemistry; new derivatives are frequently being found, and developed if economically feasible.

Construction Progress at Beauharnois

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Paper presented before the Toronto Branch of The Engineering Institute of Canada, November 27th, 1931.

SUMMARY.—After noting the general plan of the Beauharnois development, the paper discusses the excavation for the power house foundation and tailrace, the sequence of operations in the concrete work in the power house and the method by which the various stages were planned and co-ordinated.

The Beauharnois development of the Beauharnois Power Corporation consists of a power house on the shore of Lake St. Louis, 22 miles above Montreal, and a canal about 15 miles long connecting Lake St. Louis and Lake St. Francis. This canal passes south of the St. Lawrence river and allows the entire fall of the Soulanges section to be developed in one stage. The development takes its name from the county in which it is situated and the Beauharnois Power Corporation has adopted as its crest the coat of arms of the Beauharnois family with different additions representing subsidiary companies.

The canal is 3,000 feet wide and about 15 miles long. The general location follows a low lying section of the country, and for practically the entire length the land is below the present level of Lake St. Francis, the road by Lake St. Francis forming a dyke. It will be noted that a large part of the work of building the canal consists of raising dykes. The present development only contemplates a partial excavation, but it is necessary to complete the dykes. In other words the dykes are just as necessary for partial as for full development.

The raising of the dykes interfered with the existing regime of drainage and transportation, and entailed a number of large remedial works. The natural drainage of a large area lying north of the canal was towards the St. Louis river to the south. It was necessary to dig a drainage ditch paralleling the canal for about 12 miles and flowing into Lake St. Louis at the village of Melocheville. This required the excavation of about 800,000 cubic yards of material, and the construction of a number of bridges and culverts. A section of the St. Louis river lay within the canal area. This required a diversion ditch with 375,000 cubic yards of excavation, also the old feeder ditch to the St. Louis river had to be closed and a new ditch excavated south of the canal.

The development necessitated the construction of three railway diversions aggregating over 11 miles and the company was very fortunate in being able to combine highway bridges with two of the railway crossings. These bridges are all plate girder type on concrete piers, but due to the varied soil conditions encountered, the piers are of various designs. Some were sunk as open caissons to a maximum depth of 54 feet and sealed to the rock by the aid of compressed air, some were constructed in open excavations.

Throughout almost the entire length of the canal the rock lies so low that it is not reached by the excavation. Three types of material are encountered. The surface in most cases is a stiff yellow clay, the depth varying from two feet to 12 feet. Underlying this is a blue marine clay of varying consistency depending on the water content. The lower stratum is boulder clay. The general scheme of building the dykes consists of two pilot dykes built of the yellow clay with a core of blue clay for sealing purposes. Local conditions determined how these dykes had to be built.

Following down the canal from Lake St. Francis for the first three miles the general level of the ground is elevation 148. The dykes are about 14 feet high and were built by small drag lines. The core was pumped in by suction dredge. Some ridges of boulder clay were encountered at varying depths.

The next two miles were through a ridge of boulder clay which showed at the surface. Due to the fact that this material was required for railway approach fills and canal rip-rap it was found to be economic to excavate it with large drag lines loading into cars. This cut was made in the dry, flooded to float the dredge through, and then the 26-inch pump of the dredge was used to pump the cut dry again, thus allowing the dredge to continue below while the drag lines continued widening the initial cut. From the dragline cut to the Canadian National Railways crossing, a distance of nearly three miles, the ground elevation

Fig. 1—Tower Excavator in Operation.

averages 145 and the small drag lines were still able to build the pilot dykes, so the method of procedure was substantially the same as for the first section.

Below the Canadian National Railways the ground is low and the surface layer of yellow clay is thin. It was necessary here to use the tower excavators for building the pilot dykes. These machines are designed to strip the top soil from a wide area, having a working span of 800 feet from head to tail towers. In some sections of this area the

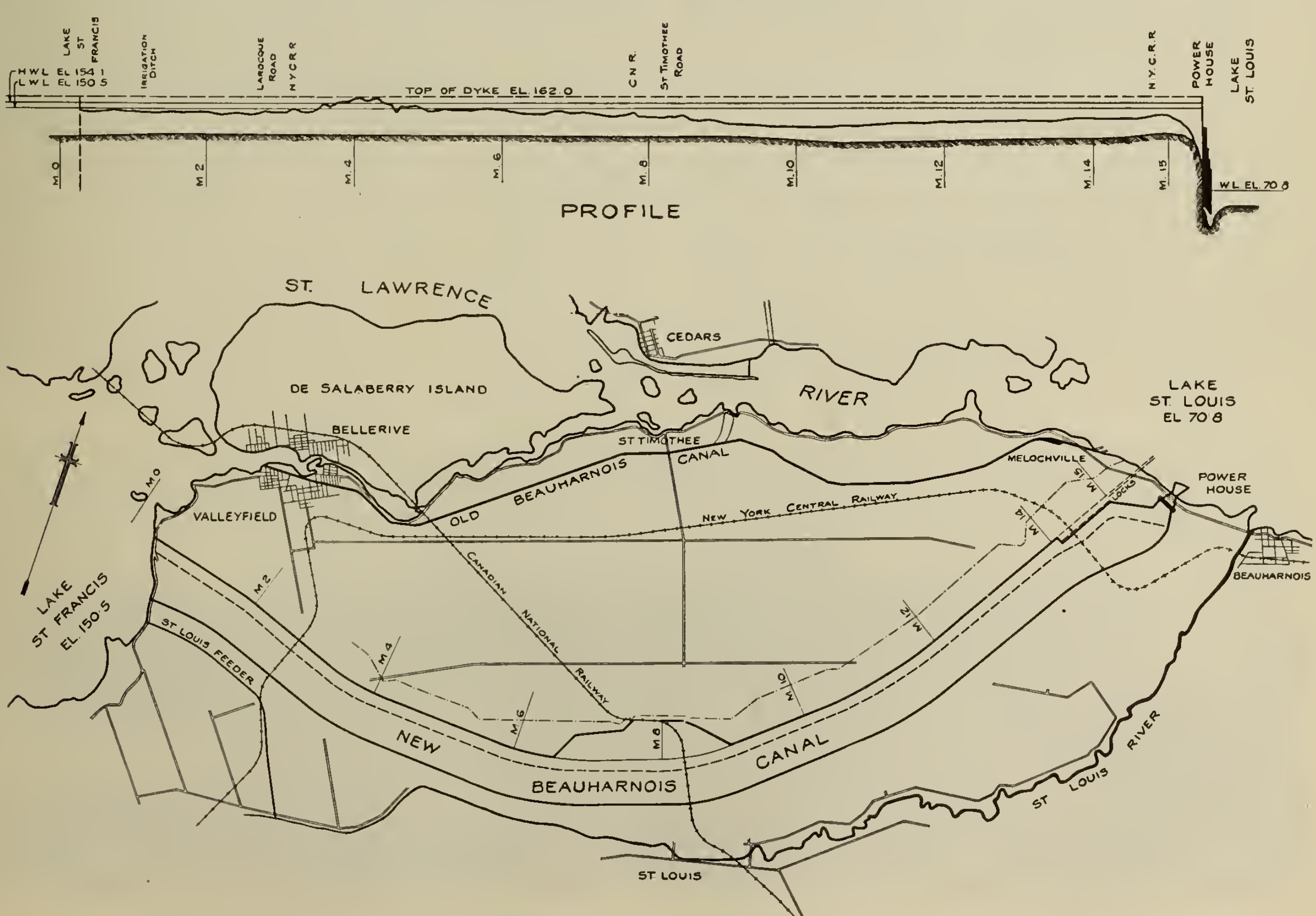

Fig. 2—Plan of Development.

Fig. 3—Excavating for Power House, November 10th, 1930.

impervious core of blue clay is placed by the dredge and in others the tower excavators make another trip along the dyke filling in the core.

The tie-in walls at the power house called for a different type of construction. The ground surface immediately upstream from the bulkhead drops off rapidly from elevation 130 to elevation 93. This increases the height of the dykes. These sections are being built by rolling the clay in thin layers, giving a very dense mass over the full cross section. The south dyke as built now is permanent, so a massive gravity dam closes the gap between contour 130 and the bulkhead. The rolled fill is joined to a cross wall and extends about 1,000 feet upstream. The north dyke tie-in is temporary and will have to be dredged out after future construction takes place. Here there are two reinforced tee walls, with rolled fill between. The walls are narrow and parallel the flow lines of the water in the forebay; so they will not have to be removed. It will only be necessary to dredge out the intermediate fill.

The power house is located about 1,000 feet from the shore of Lake St. Louis and is a little over 1,000 feet long. The east end is the service building with machine shop and storage rooms in the basement equipped with lockers, showers, etc. The first floor has offices and waiting rooms. The second is all office space. The third is an open conduit loft and the top is the control room. Immediately west of the service building are the two 8,000-h.p. service units. These are 60-cycle and have direct connected excitation. Next are four 60-cycle 53,000-h.p. units; then two units are left blank for future installation. Two units are used as sluice tubes, as there are no outside spillways. At the west end there are six more 53,000-h.p. units. These are 25-cycle. All the main units are separately excited. Four extra units of bulkhead were added on the west end to form the tie-in to the north dyke.

The power house foundations and tailrace were excavated in a Potsdam sandstone formation. This is a silica sandstone and is very hard and abrasive. It has well defined horizontal bedding planes and when the rock men became familiar with its action, very little overbreak was experienced. The most serious cases were where it was necessary to go a few inches lower than the natural break; this necessitated removing the full depth of the next stratum which in some cases amounted to several feet. The bulk of the drilling was done by a battery of well drills sinking 6-inch diameter holes, the maximum depth drilled being about 61 feet. This rock was removed by an eight-yard electric shovel and was loaded out at one lift. The benching in the power house area was done by jack hammer drills and the rock removed by skips or back cast by a 1¾-yard shovel into the hole, to be loaded out by the big shovel. The first two shots were in a box cut to let the shovel dig down, these holes were about 42 feet deep at 12 feet centres and were loaded without springing. The second shot had seventy-seven tons dynamite and was quite spectacular. The remainder was open face shooting and was done from holes spaced 15 feet centres.

Fig. 4—Power House, October 12th, 1931.

The section of the tail race which is under water is being drilled by submarine drills on a drill scow and removed by a dipper dredge.

The spoil from the excavation is practically all put through the crushing plant and used for ballast, concrete aggregate and canal rip-rap. The crushing of the rock gives a high sand content, and a large amount of testing was done to determine whether this sand would give good results when used for concrete. This was important because there is no deposit of good sand in the vicinity of the development. The crusher sand has a high percentage of fines, and the first reaction when examining a sample is that it is not a good concrete sand; however, the tests showed that the curves of strength and density were very high. The weight per cubic foot as determined from specimen averages 148.5 pounds.

The crushing plant consists of a 48 by 60 jaw crusher in a pit below track level so arranged that the rock can be dumped directly into a stone filled hopper over the jaw. The material from the crusher is carried up a 17 degree incline on a 42-inch conveyor belt and dropped over a grizzley into 20-inch gyratory crusher also in a pit below track level. In an emergency, rock can be dumped directly into this crusher. The rock then passes up a 30-inch belt conveyor at 19 degrees from here to the screens in the top of the mixer house. There are two 60-inch heavy duty revolving screens which separate the stone into two grades. All passing the 3/8-inch dust jacket goes into the sand bins, and the balance into the rock bins. The natural break of the rock in the two crushing operations does not produce enough sand for concrete requirements so the oversize from the screens is passed through a No. 4 gyratory crusher and returned on a 20-inch belt conveyor to a set of 54-inch by 20-inch sand rolls and returned by the 30-inch belt to the screens.

Fig. 5—Building Concrete Forms on Section of Power House.

The mixing plant consists of two, two-yard tilting weigh mixers with direct motor drive. During operations it was found that considerable vibration was being transmitted to the motor but this was corrected by adopting fibre pinions.

The rock, sand, and cement are delivered to the hoppers by gravity and controlled by manually operated sector gates. The usual bugbear of the cement sticking in the chutes was overcome by mounting two old riveting

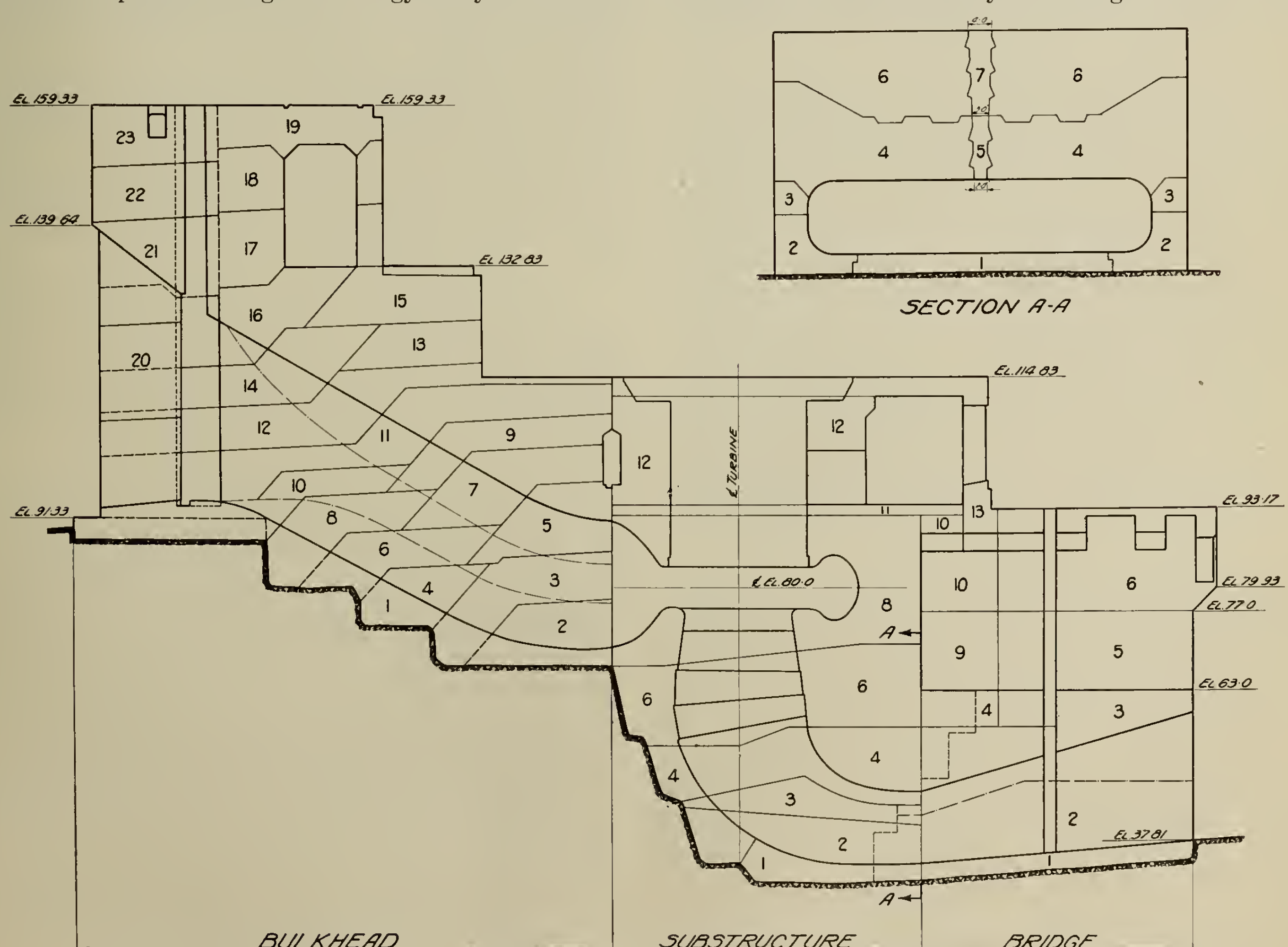

Fig. 6—Sequence of Operations.

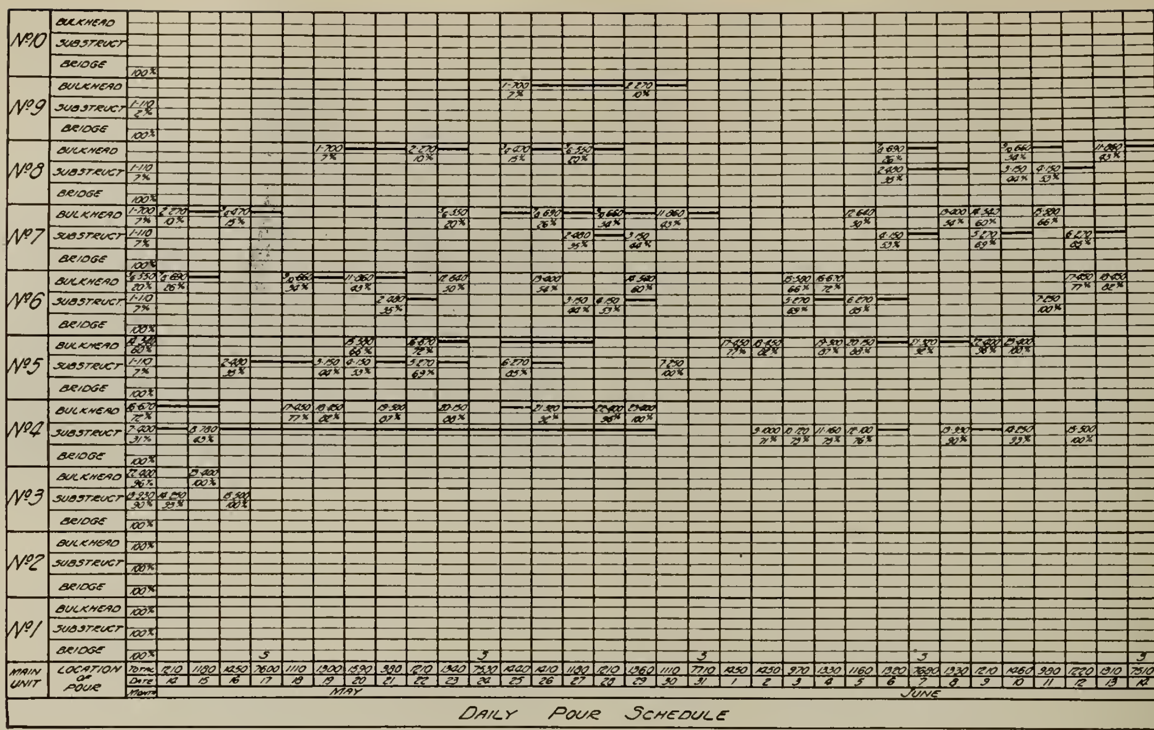

Fig. 7.

hammers on the metal supports of the bins. The valves to these hammers are close to the operators and can be opened whenever the cement is slow in feeding to the hopper. A completely equipped testing laboratory is included and the concrete technician is always in charge of the operation of the mixers.

Cement is delivered in bulk and is manually fed to a 12-inch screw conveyor which delivers it to a 6-inch cement pump. By means of a two-way valve it can be dumped into storage silos or into the bin in the mixer house. The cement stored in the silos can also be fed to the screw conveyor and pumped to the main bin. This system has worked very successfully. Practically the only difficulty experienced in the operation of the crushing and mixing plant was due to the abrasive quality of the rock; 40-pound rails used as grizzley bars would not last a week so sections of cast manganese were secured which are good for about a month.

The design of a 53,000-h.p. unit under the head of 81 feet calls for very large water passages. The percentage of voids in the headworks is 48. This results in a low ratio of concrete to forms. The work that was done in the fall of 1930 showed that if the concrete of the power house was to be completed in the open season of 1931 it would be necessary to give considerable thought to the question of form building, steel setting, etc. The concrete was to be placed by two-yard buckets and derricks. This required heavy forms because the weight of a bucket of concrete, which is about six tons, easily shifts a form if allowed to sway even lightly against it, also, the shock of dumping four tons of material into a form is considerable.

The amount of timber necessary to form the water passages of one main unit was a little over 400,000 feet b.m. so it was decided to build three complete forms in the carpenter shop during the winter arranging the bracing so that the forms could be cut up into convenient size for transporting to the site and re-assembly. It was expected that these forms could be drawn after the unit was poured and used again. In practice it was found that they could be used at least four times.

The first step in the development of the schedule was the preparation of a drawing of the power house cross-section (see Fig. 6), with the intermediate construction joints marked out. The structure divides naturally into three major sections, bulkhead, substructure, and bridge. Each was treated as a separate structure. The intermediate divisions were governed by several conditions. First: The breaks in section such as floor lines, fillets, etc. Second: The elimination of feather edges by crossing all fillets at right angles. Third: A maximum height which could be safely held by the ties was to be used which was set at seven feet. Fourth: As far as possible the quantity was limited to 400 yards for a single boom pour and 800 for a two-boom pour. These conditions of course were not rigidly adhered to, but were used as guides.

The quantity of concrete was computed for each division and tabulated. This table showed the sequence of pours. A conference was held with the power house superintendent and the general foremen who would be responsible for the various operations. Each foreman was instructed to estimate the number of hours he would require to prepare for each pour. This included cleaning the old

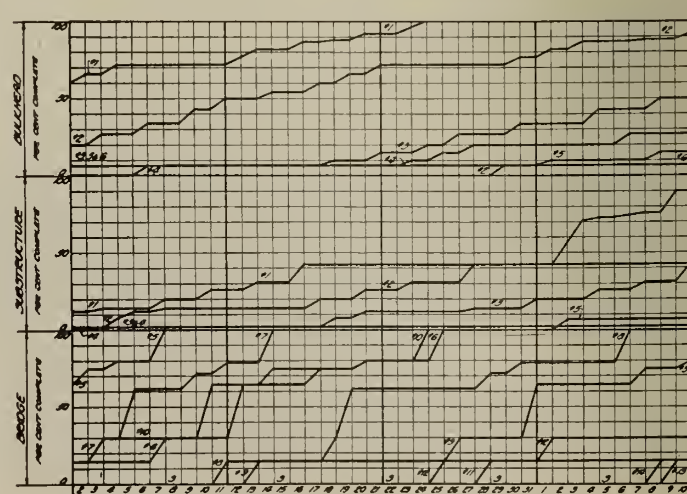

Fig. 8.—Progress Schedule.

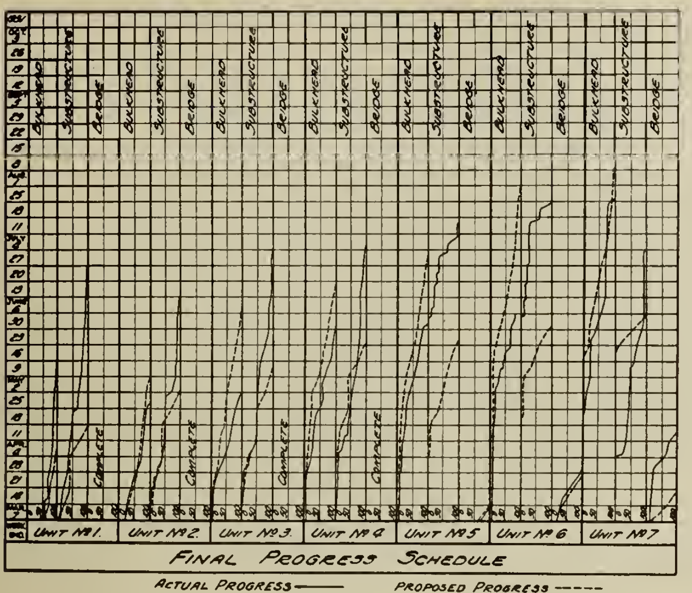

Fig. 9.

surface, erecting forms, setting reinforcing and other embedded steel, placing conduit, etc. This time was summarized and listed as necessary delays. A blank form was then prepared showing each day of the open season as abscissa and each main section of each unit as ordinate (see Fig. 7). Assuming the date of starting in the spring, available pours were plotted by number and yardage against days, aiming at a weekly rate of 8,400 cubic yards. The daily total was also noted, the limiting quantity being 1,600 cubic yards. After each pour was marked, a line was drawn through the following days corresponding to the necessary delays. It will be noted from a study of this sheet that in many cases the days are blank, this indicates that the form is ready but no concrete is available.

These sheets were completed for the entire structure, giving the first estimate of time of completion. It will be noted that the scheduled concrete only includes those sections forming the body of the structure. There were about 50,000 yards of non-scheduled concrete.

The expected possible weekly output was 9,600 cubic yards and the average scheduled was about 7,700 cubic yards leaving 1,900 cubic yards per week of non-scheduled material. Numerous series of pours were tried before a satisfactory one was obtained, keeping in mind the fact that there were only three complete sets of forms. After a series had been completed from the standpoint of forms it was necessary to check against equipment, because many times it was found that one derrick was scheduled to do two jobs at one time.

The next step was to prepare curves for each unit, using time as the abscissa and per cent completed as ordinate. These curves showed very clearly each delay (see Fig. 8) and as in most cases the long delays corresponded with the setting of embedded steel, it served as an ordering guide. For instance 41 per cent completion of the substructure corresponding with the setting of the pit liner and scroll case form, so the dates of delivery of the pit liners were easily determined. In this way the delivery of all the embedded steel and also the structural steel, brick, roofing, etc. was ordered in advance. The impossibility of adhering rigidly to any schedule being realized it was intended to revise these curves each second week but in practice it was found to be unnecessary. Each week the power house superintendent prepared a tabulation of the next week's pours.

During the preparation of the schedule each general foreman was given copies of the curve chart to study and a good many constructive criticisms were received. This gave each man who had responsibility a feeling of cooperation and although some doubts were expressed as to the possibility of keeping to schedule there was not a man who was not ready to work twenty hours a day to keep to it.

This curve although very convenient as far as layout of the work went was not clear when used as a progress record, so a final chart was prepared showing the units plotted as abscissa and time as ordinate (see Fig. 9).

As the work progressed it was found that by keeping the gangs on similar work they became quite expert and were able to increase the output considerably. The best day was 2,310 cubic yards, the best week, 13,250 cubic yards, and the best month, 54,445 cubic yards. The mixing time was 1½ minutes automatically controlled, and there were many days when the average mixer cycle was 2.2 minutes for twenty hours; this meant just 42 seconds per batch to cover charging, dumping, and accidents. The only change made in forms was due to the fact that it was desired to complete the west end of the bulkhead early to allow for work on the north dyke tie-in. This required one extra bulkhead form, also changes in the shape of the sluice tubes made it more economic to build these forms in place.

Many interesting points of construction arose. The concrete over the draught tube immediately up-stream from the centre pier under the bridge section had a span of 57 feet. Some concrete placed earlier had much shorter unsupported spans but had shown shrinkage cracks. It was feared that the long spans would break in the centre, and it was decided to attempt to anneal the mass. This is shown on elevation A-A (see Fig. 6).

Schedule of Delays									
Substructure					Bulkhead				
Main Units Nos 1-4 & 9-14					Main Units Nos 1-6 & 9-18				
Pour No.	Cu Yds	Total Cu Yds	Percent Complete	Delays	Pour No	Cu Yds	Total Cu Yds	Percent Complete	Delays
1	110	110	2	3 Days	1	700	700	7	4 Days
2	480	590	8		2	270	970	10	1 Day
3	230	620	12	1 Day	3	300	1270	13	
4	800	1620	23	3 Days	4	170	1440	15	1 Day
5	20	1640	23	3 "	5	300	1740	18	
6	1330	2970	42	3 "	6	250	1990	20	1 Day
7	30	3000	43	12 "	7	440	2430	25	
8	2000	5000	71		8	250	2680	27	1 Day
9	120	5120	73		9	460	3140	32	
10	160	5280	75		10	200	3340	34	1 Day
11	100	5380	78	1 Day	11	860	4200	43	
12	930	6310	90	1 "	12	640	4840	50	
13	250	6560	93		13	400	5240	54	
14	500	7060	100		14	520	5780	60	
Bridge					15	590	6360	66	
Main Units Nos 1-6 & 9-14					16	670	7030	72	
Pour No	Cu Yds	Total Cu Yds	Percent Complete	Delays	17	450	7480	77	
1	400	400	15	5 Days	18	450	7930	82	
2	380	780	30		19	500	8430	87	
3	900	1680	63	3 Days	20	150	8580	88	1 Day
4	350	2030	75	1 Day	21	320	8900	92	1 Day
5	150	2180	80	2 Days	22	400	9300	96	
6	500	2650	100		23	400	9700	100	

Fig. 10.

A key box as shown No. 5 was set and section 4 poured. These were allowed to set for 72 hours. The key box was then taken out and the key filled with well-rammed dry concrete; this was allowed 72 hours to set and the process repeated for sections 6 and 7. After stripping out the draught tube form no cracks were found, so the desired result seems to have been achieved.

The equipment was all large and in a number of cases transportation to the site was a problem. The main gates were 27 feet by 33 feet and weighed forty tons each. In the shop they were assembled flat and special equipment was designed to turn them over. After they had been completed they were stocked under a heavy crane in a slip at the Canadian Vickers yards.

A lifting beam with two cross beams was designed to pick the gate up at four points and a cradle was built which could be run out into deep water. A gate was placed on the cradle and the Montreal harbour crane took it from there and placed it on a large steel barge. In the meantime another gate was being placed on the cradle. Six gates made a load and they were towed through the Lachine canal and across Lake St. Louis to the company's dock.

A fifty-ton derrick was erected on the dock which transferred the gates to flat cars, to be taken to the power house. So far the gates had always been handled flat but it was necessary to up-end them in order to lower them into the checks. This required the construction of a second lifting beam with outstanding connections so that it would turn as the gate was lifted.

The turbine parts were all transported by rail, so it was necessary to design the pieces to accommodate rail clearances. The runners are delivered in six pieces. The band, when loaded on a well type flat car, cleared the ties by three inches, and had three inches clearance under the bridges. The shaft and runner weigh about one hundred and forty-four tons and can be handled by one of the power house cranes. The rotor however weighs three hundred and sixty tons and it is necessary to link the two cranes together and use an equalizer beam to make this lift.

The development is owned by the Beauharnois Power Corporation and the design is in the hands of a board of consulting engineers composed of Dr. T. H. Hogg, M.E.I.C., W. S. Lee, M.E.I.C., and F. B. Brown, M.E.I.C. The executives in charge of this construction are F. H. Cothran, M.E.I.C., vice-president and general manager, in direct charge; D. F. Noyes, M.E.I.C., general superintendent; M. V. Sauer, M.E.I.C., hydraulic engineer; B. K. Boulton, A.M.E.I.C., electrical engineer; R. G. Watson, A.M.E.I.C., mechanical engineer; J. A. Knight, M.E.I.C., designing engineer, and Messrs. P. H. Morgan and A. O. Hawes, assistant superintendents.

Reconstruction of Wharf at Kaslo, B.C.

P. E. Doncaster, M.E.I.C.,
District Engineer, Department of Public Works, Canada, Nelson, B.C.

Paper presented before the Vancouver Branch of The Engineering Institute of Canada, in November, 1931.

SUMMARY.—The author discussed in some detail the various questions as to cost and durability which had to be decided in settling the type of construction to be employed in rebuilding a timber wharf at Kaslo, B.C. The construction methods adopted took into account the economic durability of this timber structure and some data as to costs are included.

The town of Kaslo, beautifully situated on the westerly shore of Kootenay Lake, and at the easterly end of the entrant valley to the famed Slocan mining area, has had a varied and picturesque existence. Its natural setting, beauty of environment, and outlook over the mountains flanking Kootenay Lake early fixed it as a commercial and residential centre for West Kootenay mining activities. In common with these latter, its fortunes and importance have fluctuated widely since the boom days of the nineties. With a population at that time of upwards of four thousand persons, and attendant twenty-two hotels, with auxiliary capacious dance halls and bars, it has experienced recurrent depressions and revivals in fortune coincident with those of the silver and lead mines of the Slocan. Its 1931 population is approximately six hundred persons.

At the moment the Slocan has just passed through a very substantial and extensive development of its mineral reserves, abruptly curtailed but not terminated by the world-wide slump in the prices of the metals it produces. It is not beside the mark, however, to state confidently that the recent development of mining prospects and mines in the area has demonstrated the existence of large bodies of ore which, with the return of stable metal prices, will swing the Slocan back to a position of sustained prosperity beyond any of those which have preceded it. In this prosperity and business Kaslo will, as heretofore, share a goodly proportion.

Apart from attractive residential features the town possesses a natural sheltered harbour second to none in the interior waters of British Columbia. It is the easterly terminal of the Canadian Pacific Railway branch running through the heart of the Slocan and on to its westerly terminus at Nakusp, on the Arrow Lakes. While the bulk of heavy shipments of ore will continue to be shipped out through Slocan Lake and thence on to smelter at Trail, Kaslo's terminal facilities, both rail and water, must always remain a factor of some prominence in the transport of supplies, machinery and equipment consigned to the mines.

When the question of reconstruction or replacement of the public wharf in the harbour came up for consideration in 1929, the ebb of the preceding years' activities had started, and before plans were far advanced it was definitely established that the amount and value of traffic over it would for a period be curtailed to a fraction of that formerly handled. Under the circumstances the question of justifiable expenditure became an immediate factor to be dealt with. The minimum dimensions of the structure were definitely fixed by the annual range of the lake levels, the depressed railway track alongside, and the freight handling conditions necessary for even occasional heavy units of machinery, etc.

These considerations also pretty well defined the general design and structural features which could not, with safety, be reduced in the interest of first cost. The proposal was reduced at this point to the short and long term cost elements.

Experience with the old wharf, built in 1913-14, placed the life of an untreated Douglas fir structure at sixteen or seventeen years, with interim repairs costs to superstructure over this period of $5,700.

It was estimated a new wharf, of similar untreated timbers and construction, would cost in 1930 approximately $22,900, or 85 cents per superficial foot, and a second replacement seventeen years hence would likely be $26,000, due allowance being made for anticipated higher labour and timber costs at that time. A wharf built of creosoted timbers, to the details noted hereafter, and with an asphaltic surfacing, was estimated to cost $41,000. The actual cost, inclusive of all items, was slightly under $39,700, or about $1.47 per superficial foot.

All of the foregoing factors taken into consideration, and basing the life of the treated timber structure at the conservative life of thirty-four years, it was decided by the Department of Public Works that the higher first cost was justified, and provision was made accordingly.

In the initial comparative short and long term costs argument the figure of 5 per cent compounded over a period of seventeen years was used. The relative costs argument is presented as an appendix to this report.

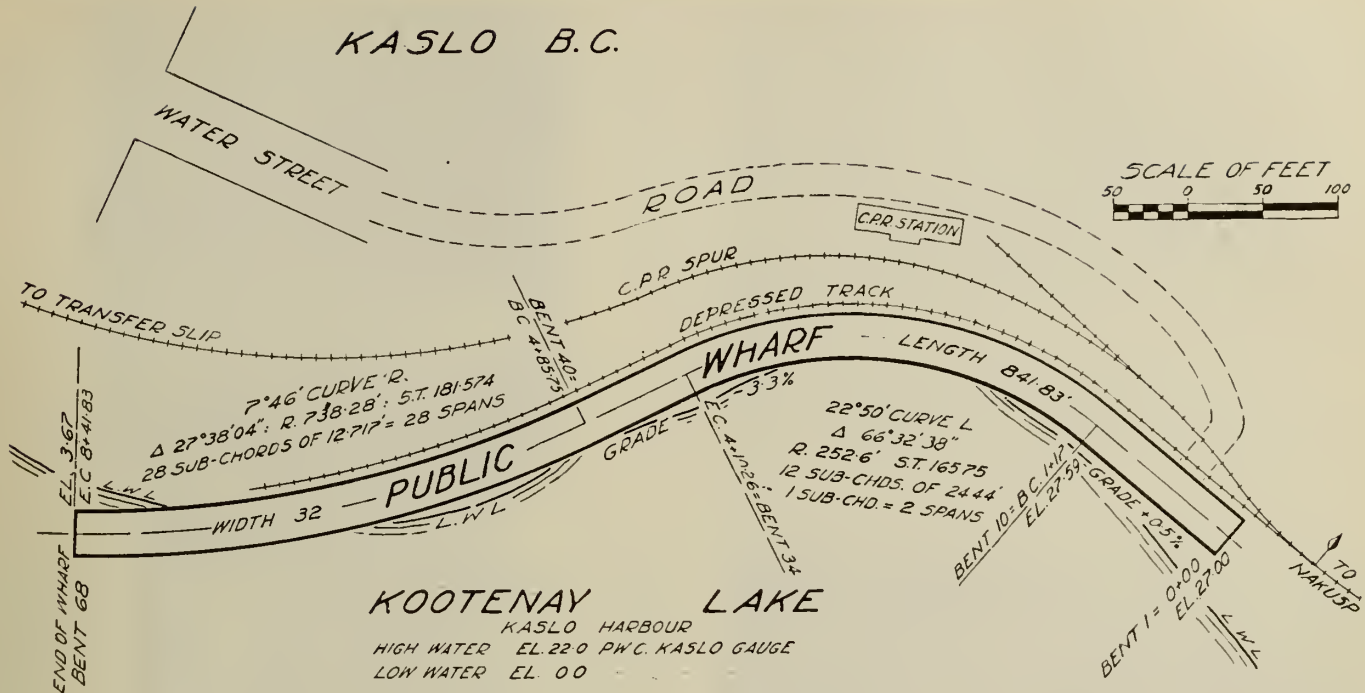

Fig. 1—Plan of Wharf at Kaslo, B.C.

While the structure, as built, embodies no marked departures from practice for structures of this class and type, except possibly the treatment of the bearing piles at cut-off, it is probably the first time that all of these have been incorporated in one structure. It is felt that a descriptive account of its design and construction may serve a useful purpose for reference and record.

As all calculations were based on the new wharf serving at least its expected life, with a minimum of repairs or maintenance costs, every detail having a bearing on this

Fig. 2—Pile Top Heat Retainer.

was scrutinized before adoption. It should be noted here that the length of life of any wharf in the interior of British Columbia is determined by its ability to withstand the combined actions of trapped moisture and fungi growths. Standard designs have proven amply strong and stable enough for the loads and traffic they were to serve, and deterioration from these causes lags behind the more active and destructive actions noted.

Piling

This item gave cause for considerable thought and reliance on past experience. The logical piling for a creosoted timber superstructure would be plant creosoted piles given at least a ten-pound treatment of creosote, or, failing this, a field treatment of immersion in hot creosote. Both proposals were rejected, however, for the following reasons. First cost of plant treated piles, 10-pound treatment—68¼ cents per lineal foot on the work, as against 16½ cents for untreated piles, and representing a difference of $5,615 for the lineal feet concerned. The field treatment, besides being uncertain in results and relatively costly, calls for dry, seasoned wood and no low temperature weather during or just after treatment. Both these essentials were absent or uncertain. It should also be noted that whereas the basis of payment for untreated piles was per foot actually remaining in the work, that for treated piles must have been for footage put in the driver leads.

The final decision was to use untreated, green cut piling, given special treatment at the top ends only. Close examination by boring, etc. disclosed that the piling in the old wharf was in remarkably sound condition except for the top 18 or 20 inches and around the drift bolt, in some cases only at the ground line. (See log of piles in appendix.)

Piles were green cut mountain fir, well impregnated with frost on arrival on the work. After being driven and cut off to exact elevations the bearing piles were given the following treatment for the top 30 inches of their length. Frost and a considerable amount of sap ring moisture were drawn out by heating, to a cherry red, cast iron dump car wheels of 14-inch diameter in a coke salamander. These were set on the pile tops and at once covered with a specially constructed asbestos lined sheet iron cover which resembles an inverted ash can. This effectively dried out the upper portion of the pile to a degree where it would readily absorb two coats of heated creosote. Before the creosote was applied, the upper 30 inches was liberally incised with a specially designed incising tool to ensure under-skin penetration of the oil. When the creosote had penetrated to refusal the cut-off end was coated with three coats of Asbestoline compound, a layer of burlap being inserted between the first and second and the second and third layers, the edges being well tacked down some eight inches from the top. The Asbestoline cushion affords a moisture-proof coating between pile and cap and is of a consistency which heals readily around the drift bolt and should retain its moisture-proof qualities for the life of the structure. To further protect the cut-off surface of pile, an 18-inch square, 16-gauge, Keystone iron plate was placed between pile and cap; with the edges turned down, offering additional protection against trapped moisture.

While the foregoing treatment takes all reasonable care of the top section of the piles, the remainder to ground line should subsequently receive field treatment of heated creosote.

It is being recommended that after two years' seasoning and the piling is in condition to readily absorb it, a field treatment of creosote be applied by brush or pressure gun, preferably the latter. On expiration of another ten or twelve years, a further application of creosote may be indicated.

Beyond the careful setting of all pile positions by instrument, no serious trouble was encountered in the piling work, though heavy boulder and gravel drift conditions on the site indicated that much of it could be expected in a case where prebored and preframed caps were to be set accurately on the bent piles. In a few cases hand excavation and light blasting of the ground was resorted to to get a pile in correct alignment.

Creosoted Timber

Inasmuch as the preframed, incised and creosoted timber was estimated to cost $105 per thousand in the work as against $48 per thousand for untreated timber, the grade specified was higher than usual for this class of work, i.e. "Select Common," except for caps, waling, and chocks, which latter were "No. 1 Common or Better." The specifications were drawn up for rigid inspection, and it was stressed that, irrespective of accepted or mill grading rules, each stick would be accepted or culled at mill on the basis of its suitability for the position and use it would occupy in the work. Coast fir was specified, and hemlock was specifically barred, since in some gradings this is allowed by the grading rules. Timber was inspected at mill, at creosoting plant, and on the job; the result being that no sticks had to be rejected on the work.

Fig. 3—Pile Incising Tools.

Fig. 4—Pile Incised before Field Treatment.

On delivery at the creosoting plant, and before being treated, every timber in the structure was framed, bored, and fitted to the relative position it was to occupy in the completed work. The treatment selected was the Ten Pound Empty Cell process, the oils being five pounds of best grade crude and five pounds of No. 1 creosote per cubic foot of timber. The standard specifications covering creosoting were used, special provision being made for the seasoning under vacuum in the oil; this to be prolonged as much as possible, consistent with latest practice, and for the temperature at no time to exceed 200 degrees F.

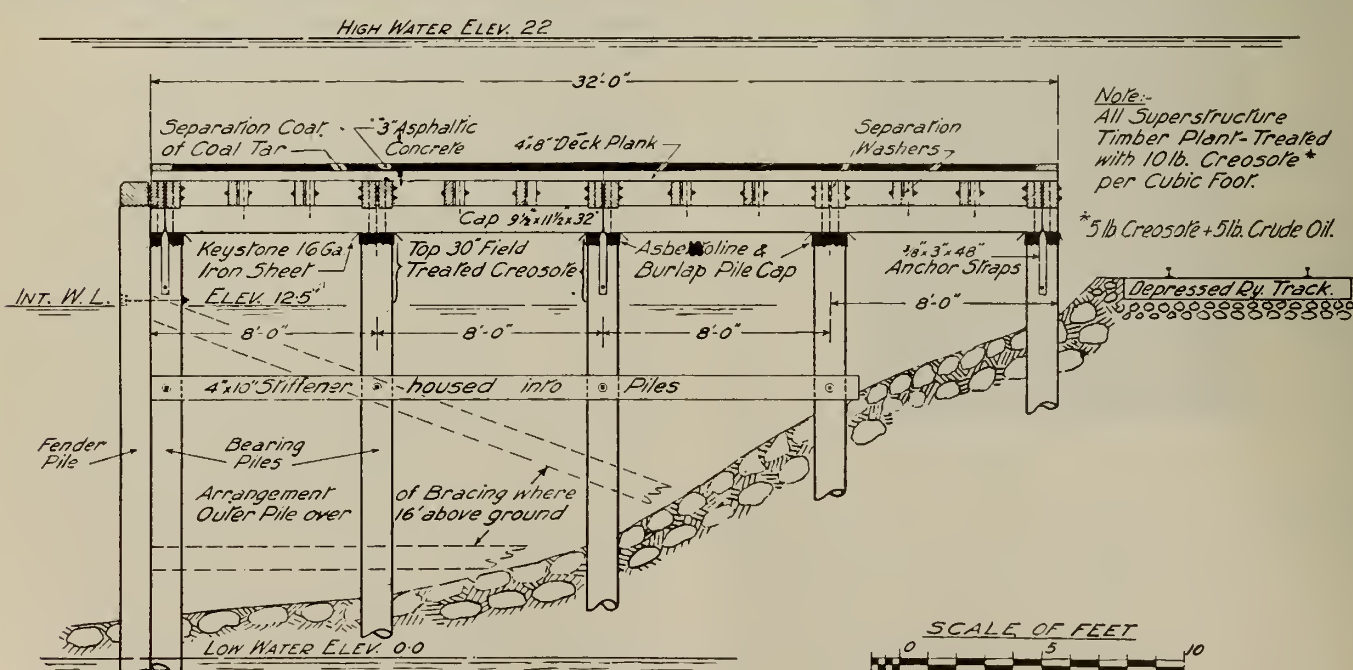

Fig. 5—Typical Section of Wharf on 7 degree 46 minute Curve.

The excellence of the preframing and preboring work was attested by the final assembly. Although the timbers were ordinary mill run cut, and sized as to depth only, no recutting to fit at joints or contacts was necessary, and no holes had to be rebored. When it is considered that the built up stringer members were designed to be bent to the radius of a 7-degree 46-minute curve and on vertical slopes of 0.5 per cent and 3.3 per cent, it would seem to be amply demonstrated that the creosoting treatment not only does not affect the dimensions of the timber, but that careful preframing and boring can be carried out successfully with rough sawn and undressed timbers. The total increment or creep in the 842-foot length of structure assembly was taken care of by cutting off the ends of three stringers, the cuts being ½ inch, ½ inch, and ⅜ inch respectively, or less than 1½ inches in all. These cuts were well within the creosote penetration of the end grains, and liberal field coats of hot creosote on these ensured a penetration equal to or beyond the original depth. In all three cases the increment was on the concave side of the wharf. All drift bolt holes were prebored to the same diameter and the screw bolt holes to ⅛ inch greater than the bolts they were to receive. All built up stringer members were bent in pairs to arc on the framing grounds before being bored, and each timber was match marked at the same time. This experience suggests that drift bolt holes would best be bored to 1/16 inch less than bolt.

Fig. 6—Pile Shoes.

In assembly all curve stringers were drawn to arc, and in no case was there evidence of splitting or failure of the surface fibres, a result which had been predetermined by tests at the creosoting works in advance of the designing.

To ensure there being no trapped moisture between timber members of the wharf, all close up longitudinal contacts were eliminated by the fixed position of the nearby members or by threading separation or packer washers on the bolts fastening the timbers together.

Traffic Surface

This item received considerable attention before the final adoption of the four-inch creosoted plank, overlaid with a 3-inch cut-back asphalt concrete slab. By adopting this decking it was possible to carry out the original intention to have no raw or untreated surfaces or holes in the superstructure. Planks for curves were cut to correct shape and size and all planks were bored to receive ship spikes before being creosoted.

The asphaltic concrete surface, 3 inches deep at curbing and crowned to 3½ inches at centre, was laid on a separation coat of coal tar applied in liberal quantity with brushes on the plank decking. The concrete was cold mix type, known to the trade as "Kreomix," a gasoline cut-back asphalt put through a cement mixer with crushed aggregate. All aggregate was carefully screened under close supervision to ensure a constant fineness modulus of 6.5 to 6.8. In mixing, a small proportion of plaster of paris was used to absorb moisture in the aggregate. After the surfacing had been laid and rolled, the joints between timber curbs and it were swedged back and a rich grout of asphalt and sand was hand poured along them to ensure a

Fig. 7—Completed Wharf, 1931.

Details of Quantities and Costs of Major Items in Kaslo, B.C. Public Wharf Reconstruction

Public Works Canada—Nelson, B.C. District Office

MATERIAL	QUANTITIES—COSTS				Actual Unit Costs to Contractor	REMARKS
	Estimated		As Built			
	Quantity	Cost	Quantity	Cost		
Piling, in place...........	16,060 lin. ft.	$ 0.60	14,200 lin. ft.	$ 0.58	$0.165 on site	Treating of pile top included in these unit prices.
Creosoted Timber, in place.	225.5 M.	105.00	225.5 M.	90.00	66.50 at site	Includes Incising, Preframing, and Creosoting—(see note).
Untreated Timber........	2.0 M.	48.00	1.92 M.	45.00	31.00 at site	$31.00 includes Frt.—(see note).
Iron, Bolts, etc...........	21,575 lbs.	0.15	21,340 lbs.	0.12	—	—
Asphaltic Concrete........	2,880 sq. yds.	1.00	3,392 sq. yds.	1.10	1.30 sq. yd.	Surfacing 3 inches thick.
Plus Minor Items.........	—	—	—	—	—	—

Notes

Cost to Contractor of Treated Timbers includes:—Timber f.o.b. Creosoting Plant $17.00 (depressed market), plus Preframing and Preboring $5.50 M., plus Incising $2.00 M., plus Creosoting (10 lb. Empty Cell) $28.00 M., plus Freight $14.00 M.; or a total of $66.50 per M., ready to assemble on site.

Untreated Timber Cost of $31.00 M. includes:—Timber at Mill $17.00 M., plus Freight $14.00 M.

Rates of Wages to be paid, as set out in Contract, were:—piledriver engineer $1.12½ per hour; carpenters 81¼ cents per hour; labourers 50 cents per hour.

The Special Treatment of Pile Tops, including treating, incising, Asbestoline, burlap, Keystone iron, etc. was not closely segregated as to cost, but it approximated $2.90 per pile.

plastic and healing contact. Test cylinders of mix and appearance both indicate a good dense mix was obtained, but the contractor was required to guarantee the work for twelve months from completion.

As a discussion of the economic features may be of interest, an argument is presented as an appendix, herewith, also a detailed schedule of costs, etc., sheet is added as a matter of record.

It is considered that the work, incorporating a combination of features seldom present in one wharf structure, has been carried to a very satisfactory completion, and it is confidently expected that it will have a minimum life of not less than forty years, with light repairs and maintenance costs in the interval as compared with untreated timber structures. This statement, however, is subject to the condition that the bearing and fender piles be field creosoted from ground line up, in 1933 and again about 1940. Failing these subsequent treatments there will undoubtedly occur a deterioration of the piles which would affect the strength and full life of the whole structure.

Such success as has attended the execution of the work, and the ultimate long life which is expected of it, may be summarized as due to: The use of the higher grades of timber, closely inspected; extreme care in layout and detail plans for preframing and boring, and unabated vigilance in the inspection and supervision of the work once it was in hand. No peavies or pointed timber handling tools were allowed on the work, all timbers being handled by high line and rope slings.

As an additional item of interest and record there is attached herewith as an appendix a résumé of the log of the condition of the piles of the demolished wharf as found when they were cut off at ground line. It will be noted that except for the top section, subject to drift bolt rot, and a few cases of ground line sap wood rot, the piles were in very good condition after seventeen years in the work.

In the design details and in subsequent watchful checks on the work, the Department is indebted largely to the painstaking efforts of the assistant engineers concerned and the junior-engineer inspector on the job.

APPENDIX

Log of Condition of Kaslo Wharf Piling, Driven in 1913-14, as Found on Demolition of Structure in 1931

Of a total of 372 bearing and fender piles examined there were found:—

(1) 14 piles more or less rotted from ground line to top. These were short piles next to some cribbing work along the depressed track of the railway siding and almost every condition favourable to fungi growth, etc. was present.

(2) 310 piles, all of the bearing piles, had a rot ring around the drift bolt. The rot varied from a diameter of 3 inches to 5 inches, and extended down 24 inches, or some 6 inches below the tip of the drift bolt. Except for the drift bolt rot, the cut-off surfaces of the bearing piles were in almost every case in a fairly sound condition, the few exceptions being cedar piles or fir of open or wide growth rings.

(3) Over that portion of the wharf in which the bottoms of piles were below the intermediate stage of lake levels and above the low water stage, the sap ring of all piles, averaging 1¼ inches in depth, was found to have rotted to an extent apparently varying with that of alternate wetting and drying they had been subjected to. This rot extended generally from 12 inches above to 18 inches below the ground line. 102 piles were found defective at this point, but the heart wood was still sound and good for many more years service.

(4) In all cases, except as in (1) above, the piles were found to be sound and free from signs of rot below the drift bolt rot and the ground line rot referred to in (3) above.

Economic Argument as to Comparative Costs of an Uncreosoted and a Creosoted Timer Wharf at Kaslo, British Columbia

Argument No. 1

1. Uncreosoted Timber Wharf:	
Estimated cost—$22,900.00. Estimated life—17 years.	
Annual Sinking Fund Payment required to repay $22,900.00 at end of 17 years, with Interest compounded at 5 per cent	$ 886.23
Annual Simple Interest at 5 per cent on $22,900	1,145.00
Annual Payments	$ 2,031.23
Long Term Cost over 17 years	$ 34,530.91
2. Creosoted Timber and Asphaltic Surfaced Wharf, as constructed:	
Actual cost—$39,700.00. Estimated life—40 years, but payments funded over 17 years.	
Annual Sinking Fund Payment required to repay $39,700.00 at end of 17 years, with interest compounded at 5 per cent	$ 1,536.39
Annual Simple Interest at 5 per cent on $39,700.00	1,985.00
Annual Payments	$ 3,521.39
Long Term Cost over 17 years	$ 59,863.63
Difference in Long Term Costs	$ 25,332.72
3. Long Term Cost of two untreated wharves, with combined estimated life of 34 years, plus allowance of $1,000.00 for demolition of first wharf	$ 70,062.00

The situation at the end of the 17-year period is that in (1) the wharf has served its life and would be ready for replacement, whereas in (2) the treated timber wharf has still a life of twenty-three years or more ahead of it.

Should a second untreated wharf be built at the expiration of 17 years, the combined cost for a total life of 34 years would be:—

($34,530.91 × 2) plus $1,000 demolition cost: $70,061.82,

or, $10,198.19 more than the 40-year life of the treated wharf.

From the nature of the different constructions, the maintenance and repairs costs of the better structure must be lower than for the cheaper one, and, as our inspector remarked: "In the meantime Kaslo enjoys the advantages of 'Packard' instead of 'Ford' quality terminal accommodation."

Economic Argument as to Comparative Ultimate Costs of an Uncreosoted and a Creosoted Timber Wharf at Kaslo, British Columbia

(As submitted by representative of a Wood Preserving Company)

Argument No. 2

1. *Uncreosoted Timber Wharf:*	
Estimated life	17 years
Estimated cost of first wharf	$ 22,900.00
Compound interest at 5 per cent per annum on $22,900.00 for 40 years	138,316.00
Maintenance cost on first wharf	5,700.00
Compound interest at 5 per cent per annum on $5,700.00 for average of 31½ years	20,816.00
Estimated cost of demolishing the first wharf at end of 17 years	1,000.00
Compound interest at 5 per cent per annum on $1.000.00 for 23 years	2,072.00
Estimated cost of building second wharf at end of 17 years	26,000.00
Compound interest at 5 per cent per annum on $26,000.00 for 23 years	53,872.00
Maintenance charges on second wharf	5,700.00
Compound interest at 5 per cent per annum on $5,700.00 for average of 14½ years	5,871.00
Estimated cost of demolishing the second wharf at end of 34 years	1,000.00
Compound interest at 5 per cent per annum on $1,000.00 for 6 years	340.00
Estimated cost of building third wharf at end of 34 years $26,000.00; use 6/17 of $26,000.00 as only 6 years of its 17 years life is utilized	9,176.00
Compound interest at 5 per cent per annum on $9,176.00 for 6 years	3,120.00
Maintenance charges on the third wharf, 6/17 of $5,700.00	2,000.00
Compound interest at 5 per cent per annum on $2,000.00 for an average of 3 years	316.00
Ultimate Cost at the End of 40 Years	$298,399.00

2. *Creosoted Timber and Asphaltic Surfaced Wharf, as constructed:*

Estimated life		40 year
Actual cost	$ 39,700.00	
Less cost of paving	3,731.00	
		$ 35,969.00
Compound interest at 5 per cent per annum on $35,969.00 for 40 years		217,253.00
New asphalt wearing surface at end of 20 years, 3,392 sq. yds. at $1.10		3,731.00
Compound interest at 5 per cent per annum on $3,731.00 for 20 years		6,167.00
Ultimate Cost at End of 40 Years		$263,120.00
Saving in ultimate cost by using the creosoted timber structure		$ 35,279.00

So the building of the creosoted timber wharf was certainly justified and wise.

Discussion on Argument No. 2 (Mr. Greene's Method of Comparative Cost of Treated and Untreated Wharves for Kaslo, B.C.)

With reference to the second paragraph of Mr. Greene's letter, in which he states that the original cost of asphalt paving should not be included in considering the cost of the treated wharf, but allows for its replacement at the end of twenty years:

If the asphaltic surface (or some other wearing surface for the same purpose and with the same advantages) had not been incorporated in the original treated structure, the creosoted timber decking would have very rapidly lost the value of its protective treatment, due to traffic abrasion, and consequently the normal rotting of the deck would be in evidence soon after. Any replacements necessary would result in opening up nail holes in the treated stringers and joists and so damaging their protection.

Apart from the resulting damage to the supporting members, the cost of maintenance of the treated deck would be considerably greater than for that of the untreated type, since creosoted planks would have to be shipped in from the coast, at less than carload rates, and greater care would be required in lifting the defective planks in the original deck and in placing the new ones.

In view of the foregoing, the original cost of the asphaltic surfacing should, in my opinion, be included in the first cost of the treated structure, and then the cost of replacement dealt with at the end of 20 years, as shown by Mr. Greene.

Then the ultimate cost of the treated wharf, as given by Mr. Greene, would have to be increased by an amount representing the original cost of the surfacing with compound interest at 5 per cent for 40 years:—

Mr. Greene's value for ultimate cost of treated wharf at end of 40 years	$263,120.00
Cost of original asphalt surface	3,731.00
Compound interest at 5 per cent for 40 years on $3,731.00	22,535.00
Actual Ultimate Cost of Treated Wharf at End of 40 Years	$289,386.00
Ultimate cost of untreated structures at end of 40 years (Mr. Greene)	$298.399.00
Saving in ultimate cost by using the creosoted structure	$ 9,013.00
As Against:— Mr. Greene, by omitting the first cost of the asphalt surface, shows the saving in ultimate cost as	$ 35,279.00

Economic Argument as to Comparative Costs of an Uncreosoted and a Creosoted Timber Wharf at Kaslo, British Columbia

Argument No. 3

Annual sinking fund payment required to repay $22,900.00 at end of 10 years with interest compounded at 5 per cent		$ 1,820.55
Annual simple interest on $22,900.00		1,145.00
		$ 2,965.55
Annual sinking fund payment required to provide for payment at end of 7 years of $2,160.00 for 2-inch plank overlay deck with compound interest at 5 per cent		$ 265.29
Total Annual Payment		$ 3,230.84
Long Term Cost of first wharf for 10 years:—$3,230.84× 10		$ 32,308.40
Second Wharf:—		
Cost of demolishing old wharf	$ 1,000.00	
Cost of new wharf	22,900.00	
	$ 23,900.00	
Annual sinking fund payment required to repay $23,900.00 at end of 10 years with interest compounded at 5 per cent		$ 1,900.05
Annual simple interest on $23,900.00 at 5 per cent		1,195.00
		$ 3,095.05
Sinking fund (annual payment) for overlay, as in Wharf No. 1		265.29
Total Annual Payment		$ 3,360.34
Long Term Cost of second Wharf for 10 years:—$3,360.34 × 10		$ 33,603.40
Cost of Third Wharf—same as second, only 6/17 of its life required to complete the 40-year period under discussion.		
Then chargeable amount for Third Wharf:— 6/17×Long Term Cost, or 6/17×$33,603.40		$ 11,860.02
Total Cost of Untreated Wharves for 40 Years:—		
First Wharf	$ 32,308.40	
Second Wharf	33,603.40	
Third Wharf (6/17 life)	11,860.02	
	$ 77,771.82	
Treated Wharf:		
Annual sinking fund payment required to repay $39,700.00 at end of 20 years with interest compounded at 5 per cent		$ 1,200.53
Annual simple interest at 5 per cent		1,985.00
		$ 3,185.53
Annual sinking fund payment required to provide $3,700.00 for resurfacing at end of 20 years with interest compounded at 5 per cent		111.89
Total Annual Payments		$ 3,297.42
Long Term Cost of Treated Wharf:— $3,297.42 ×20		$ 65,948.40
Plus sinking fund for field treating piles at end of 2 years and at end of 10 years		1,000.00
		$ 66,948.40
Long Term Cost Untreated Wharves (say)		$ 77,800.00
Long Term Cost Treated Wharf (say)		67,000.00
Difference		$ 10,800.00

While the actual computed long term cost saving is approximately $10,800.00, there are, of course, the added factors represented by the intangibles. Loss of the facility while reconstructing the untreated wharves; also added contingent costs, due to future increases in materials and labour costs. Other intangibles presented themselves in varying degrees of import, and were given due weight.

THE
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The Ottawa Conference

The forthcoming Imperial Economic Conference at Ottawa, of which so much is expected, will not deal merely with tariffs and preferences on raw materials. Many of its problems will relate to industries in which engineers are concerned and will have to do with the exchange of manufactured materials, machinery, engineering equipment and the like. The future development of the manufacturing industries of all the members of the Commonwealth of Nations will depend upon the decisions taken with regard to these points and, in this respect, we shall be particularly affected by the attitude which the representatives of Great Britain will assume.

The point of view which will presumably be taken by the Canadian representatives as regards our manufacturing industries has been well expressed recently by the president of an important manufacturing company. In his address he observed that the Conference would be approached by all in the hope of strengthening and broadening the commercial relations between Canada, the other Dominions and the Mother Country, by an arrangement for mutual co-operation. He pointed out that each participant in the Conference will have domestic considerations which must guide its actions and that no agreements are likely to endure which ignore the principles of self-preservation. He considered that the main purpose of the Conference will be to see what possibilities there are of changing in favour of Empire trade the flow of imports of such goods as are not now produced in Canada, rather than the consummation of any action which would be calculated to menace the position of the Canadian producer.

The events of recent years have demonstrated that there can now be no question of limiting freedom in establishing or maintaining particular lines of manufacture. All must be free to follow such policies as are considered best suited to their circumstances. This, indeed, is now recognized in Great Britain, as well as in the Dominions. For example, commenting on the Conference, "The Times" recently urged that if orderly complementary production is to replace the present promiscuous competition which is conducted under frequently changing tariff restrictions, it will be necessary to obtain hearty co-operation between those engaged in the same branches of industry in different parts of the Empire. This co-operation, the article continued, is not likely to be secured immediately in all trades, but a beginning can be made with some, always bearing in mind that the fixed policy of the Dominions is opposed to any general tariff reductions which would expose newly established industries in the Dominions to the competition of the older industries in Great Britain without compensatory advantages.

We may take it, therefore, that the work of the Conference in regard to industrial questions will be based on these principles. The crux of the matter will be, to ascertain how far Great Britain is prepared to go in guaranteeing a market for Dominion food stuffs, and to what extent effective preference can be given to British manufactures by Dominions which are developing their own manufacturing industries. It is now of little use to look back over the last eight years, a period of drift during which no comprehensive action along this line has been taken. The Conference in 1930 attempted to deal with economic questions, it is true, but at that time it was faced with an insuperable obstacle in England's adherence to free trade. Since the British election of 1931, however, the situation has undergone a complete change, and therefore the Conference of 1932 has possibilities which have never existed before. But to take advantage of these, there must be a spirit of give and take in which local viewpoints must be subordinated as far as possible to the larger vision. There should be wider recognition of the principle that no country should continue to subsidize an industry that has no economic justification.

There is another aspect of the situation, and a promising one, which has been outlined by Mr. L. S. Amery. If the Empire markets for manufactured goods could be pooled effectively, they would provide a demand which would justify a large increase in our scales of production of certain kinds of materials, machinery and equipment. This would make possible an economy in cost comparable with that reached in the American mass-production plants which have as their customers the 120,000,000 people of the United States. The British Empire market, in fact, offers possibilities of this kind which do not appear to exist elsewhere. Will the Conference be able to make a definite advance in this direction?

In considering the rationalization of industry within the Empire, the Conference cannot possibly deal with individual industries in detail, but can and should agree on the general principles upon which such rationalization must depend. In doing this, it will be necessary to face many difficulties, such as those regarding currency and exchange, emigration and immigration, price regulation and a host of related questions, answers to which will have to be found before working agreements can be framed.

There is, of course, the possibility that when the delegates meet in Ottawa the expectations of many of the watchers will prove to have been too sanguine. In the case of such a Conference, it is natural to assume that progress will be more rapid and agreements more readily reached than is actually possible. Surely if the work of the Conference is to endure and begin a period of orderly development which will co-ordinate our present unrelated trade activities, it is above all necessary that the foundations be well and not too hurriedly laid. The plans for the proposed structure must be logical and command general approval before they can be worked to. If the Conference provides such plans, its main object will have been attained, constructive work can proceed and there will be every prospect of success when operation begins.

We may well agree with Dr. Leacock that the Conference must be no mere meeting of business men trading wheat for coal, for it will have to deal with world forces and world failures. In order to succeed, it must depart a long way from what has been hitherto the accepted course of international trade. But if successful in finding for us a way of reorganizing our trade, industry and exchange in the Empire so that our production shall match our consumption, that way will be the way back to prosperity.

E-I-C News

In the last issue of the E-I-C News, it was necessary to announce that for the remainder of the year that publication would be issued only once each month—on the 20th.

This change was ordered by Council and was made for reasons of economy.

It is proposed to resume weekly publication as soon as conditions warrant it.

Meeting of Council

A meeting of Council was held at Headquarters on Friday, April 15th, 1932, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and six other members of Council present.

The membership of the Legislation committee as submitted by the chairman, was approved as follows:

F. Newell, M.E.I.C., chairman
C. A. Bowman, A.M.E.I.C.
A. S. Gentles, M.E.I.C.

The membership of the Committee on Standard Forms of Construction Contracts, as submitted by the chairman, was approved as follows:

A. H. Harkness, M.E.I.C., chairman
H. R. McClymont, A.M.E.I.C.
G. G. Powell, M.E.I.C.
W. Storrie, M.E.I.C.
J. G. R. Wainwright, A.M.E.I.C.

Discussion took place on the report of the Finance committee, which indicated the probability that further reductions in current expenditure would be unavoidable. Consideration was given to the desirability of omitting the Plenary Meeting of Council this year, this being the principal direction in which economy is now possible. Final decision on this point was, however, postponed until the June meeting of Council, the members of Council present being of the opinion that it will be inadvisable to hold a Plenary Meeting of Council this year unless the financial condition of The Institute shows improvement within the next two months.

The newly elected officers of the Toronto and Calgary Branches were noted.

Council received a preliminary report from the committee under the chairmanship of H. H. Vaughan, M.E.I.C., which is planning for the welcome and entertainment of the members of the Institution of Mechanical Engineers who are visiting Canada in August and September of this year, and it was noted that the arrangements for the programme in Toronto are being dealt with there by a committee under the chairmanship of Professor E. A. Allcut, M.E.I.C.

On the motion of F. Newell, M.E.I.C., seconded by J. A. McCrory, M.E.I.C., it was unanimously resolved that the President, the Vice-President from Toronto, and the Secretary, should be asked to represent The Institute at the Semi-Annual Meeting of the American Society of Mechanical Engineers to be held at Bigwin, Ontario, in June 1932.

The attention of Council was drawn to the desirability of supplementing and developing the work done by our Employment Bureau and of formulating a definite policy regarding the unemployment of engineers, looking to the future and the encouragement of action in this matter by the various Institute branches. The Council fully approved of this suggestion, and a small committee was appointed to study the question and report, with recommendations, to the next meeting of Council.

The Secretary presented a letter from the Honorary Secretary of The Royal Society of Canada, advising that the Fiftieth Anniversary Celebrations of that Society would be held in the National Research Laboratories in Ottawa, on May 26th, 27th and 28th, 1932, and requesting that The Institute be represented. It was unanimously resolved that President Camsell be asked to represent The Institute on that occasion.

Three resignations were accepted, nine members were placed on the Suspended List, two requests for Life Membership were considered, and a number of special cases were dealt with.

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

Elections		*Transfers*	
Assoc. Members	1	Assoc. Member to Member	2
Juniors	1	Student to Assoc. Member	1
Students admitted	23	Student to Junior	1

The Council rose at ten fifty-five p.m.

OBITUARIES

William Brouard MacKenzie, M.E.I.C.

In the death of William Brouard MacKenzie, M.E.I.C., which occurred at Daytona, Florida, on March 16, 1932, The Institute loses one of its oldest and most highly esteemed members.

WILLIAM BROUARD MACKENZIE, M.E.I.C.

Mr. MacKenzie was born in Kenzieville, Pictou County, N.S., on February 16, 1847. He studied engineering at Pictou Academy and after graduating, was for some years in the Nova Scotia Crown Land Office at Halifax. He was appointed office assistant in the engineers office of the Intercolonial Railway at Halifax, November 1, 1872, and was transferred to Moncton July 1, 1875. He received the appointment of assistant chief engineer of the Intercolonial April 1, 1879, and chief engineer August 21, 1897. He retired from the service September 1, 1914. During the fifty-seven years the late Mr. MacKenzie was a resident of Moncton, he took an active part in community affairs and was one of the leading citizens.

Mr. MacKenzie was elected a Member of The Institute (then the Canadian Society of Civil Engineers) on November 11, 1887, and at the time of his death was a Life Member. He was a Member of Council for eight different years and was a past-chairman of Moncton Branch.

James Albert Beatty, M.E.I.C.

We regret to record the death of James Albert Beatty, M.E.I.C., which occurred on March 28th, 1932, at Peterborough, Ont.

Mr. Beatty was born at Fergus, Ont., on May 8th, 1879, and graduated from the School of Practical Science, University of Toronto, in 1903.

Following graduation, Mr. Beatty was for a time engaged on steel construction with the Riter-Conley Co., at Pittsburgh, Pa. In 1905-1906, he was connected with Ross and Holgate, consulting engineers, Montreal, and in 1907 joined the staff of the Dominion Engineering and Construction Co., Montreal, and supervised general construction. In 1908, he became a member of the firm of Morrow and Beatty, Ltd., contractors, Peterborough, Ont., and at the time of his death was vice-president of the firm. Among the structures completed by Messrs. Morrow and Beatty are the Kipawa dam, Gordon Creek dam and Quinze dam for the Dominion government, the Abitibi Power and Paper plant, the Mattagami pulp and paper plant at Smooth Rock Falls, and a hydro plant for the Southern Canada Power Company at Drummondville, Que. The firm were also contractors for the hydro-electric power development at Chats Falls on the Ottawa river.

Mr. Beatty joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on October 24th, 1907, and became a Member on September 25th, 1922.

Charles Henry Keefer, M.E.I.C.

Charles Henry Keefer, M.E.I.C., whose death occurred at Ottawa, Ont., on April 12th, 1932, was one of the oldest and most prominent members of The Institute.

Mr. Keefer was born in 1852. In his early days, he was employed on many important railway works, among them being the construction of the Canada Central Railway between Ottawa and Carleton Place, the Chaudiere branch of the St. Lawrence and Ottawa Railway, the location of the proposed line of the Canadian Pacific Railway through the Yellowhead Pass of the Rocky Mountains, and the location of the Canada Atlantic Railway. During the years 1872-1875 he was assistant engineer on the construction of the Ottawa Water Works, and in 1878 was employed on the Montreal harbour works. In 1881-1885, Mr. Keefer was division engineer on the construction of extensions of the New York, Lake Erie and Western Railway, having charge of the construction of the Kingan viaduct, and in 1884-1885 was in charge of the construction of a division of the Canadian Pacific Railway through the Kicking Horse Pass, Rocky Mountains. Later Mr. Keefer acted as engineer for the contractors in connection with the Tay canal. Since his retirement Mr. Keefer had been a resident of Ottawa.

Mr. Keefer was one of the original members of the Canadian Society of Civil Engineers, joining on January 20th, 1887, at the first meeting at which members' names were taken. He was a member of Council in 1892, 1893 and 1903, and a vice-president in 1904-1905.

Christopher James Yorath, M.E.I.C.

Widespread regret will be felt at the death of Christopher James Yorath, M.E.I.C., which occurred at Calgary, Alta., on April 2nd, 1932.

Mr. Yorath was born at Cardiff, Wales, On November 4th, 1880, and graduated from the University of Cardiff

CHRISTOPHER JAMES YORATH, M.E.I.C.

in 1905. He was later articled to James Allan, a Cardiff engineering contractor. Until 1913, Mr. Yorath was deputy engineer, Acton Borough Council, London, England, engaged on the design and supervision of municipal engineering works. Coming to this country in 1913, he was appointed city commissioner of Saskatoon, which post he held until 1921, when he became commissioner of Edmonton. As city commissioner, Mr. Yorath was responsible for all public works and municipal administration, including the operation of public utilities, street railway, electric light and power, waterworks, etc. In 1924 Mr. Yorath resigned as commissioner in Edmonton upon his appointment as president and managing director of Northwestern Utilities, Ltd.; a year later the Canadian Western Natural Gas, Light, Heat and Power Company, gas distributors in Calgary, Lethbridge and intervening towns in southern Alberta, came under his management. He also became president and managing director of Gas Production and Transportation Co., Edmonton, the Union Power Company, Drumheller, Nanaimo Electric Light Heat and Power Company, Duncan Utilities and Canadian Utilities Ltd. He was elected a Member of the Institution of Civil Engineers (Great Britain) in 1927, having entered that body as an Associate Member in 1908.

Mr. Yorath joined The Institute (then the Canadian Society of Civil Engineers) on June 27th, 1916, as an Associate Member, and became a Member on May 18th, 1926.

PERSONALS

W. G. Chace, M.E.I.C., of Sullivan Kipp and Chace, Ltd., Winnipeg, Man., has retired from the firm, and will move to Toronto, where he will continue his professional work. Mr. Chace, who is a graduate of the University of Toronto, was at one time president of the Canada Lock

Joint Pipe Company, Ltd., Toronto. He has been a member of the firm from which he now retires since 1924.

O. M. Falls, A.M.E.I.C., was recently appointed Commissioner of Works for York township. Mr. Falls, who is a graduate of the University of Toronto, was for a time on the engineering staff of Frank Barber and Associates Limited, and was appointed assistant to the township engineer of York township in 1923, and principal assistant engineer in 1929. Mr. Falls has always taken a keen interest in the affairs of The Institute, and was for a time secretary-treasurer of the Toronto Branch.

C. B. Leaver, A.M.E.I.C., has been appointed general manager of the Imperial Oil Refineries, Ltd., Toronto, Ont. Mr. Leaver, who has been with the company for a number of years, was formerly located at Sarnia, Ont. He graduated from the University of Toronto in 1910 with the degree of B.A.Sc.

J. L. E. Price, M.E.I.C., is president and managing director of the newly-formed firm of J. L. E. Price and Company, Ltd., Montreal, which will operate in association with Higgs and Hill, Ltd., of London, England. Mr. Price received his early education in Wales, his birthplace, attending technical school classes concurrently with his articled pupilage in 1903-1906. In 1907-1908, Mr. Price was assistant engineer with The Ebbw Vale Steel Iron and Coal Company, Wales, and in 1909-1910 was works manager for the Ebbw Valley Construction Company. Coming to Canada, he was engaged until 1914 in various engineering capacities with the Department of Natural Resources of the Canadian Pacific Railway Company, Calgary, and from 1915 to 1918 was overseas as a lieutenant in the Canadian Expeditionary Force. Returning to this country in 1919 he became assistant to the chief engineer and general manager during the design and construction of the Riordon Company's sulphite pulp mill and hydro-electric development at Temiskaming, Que. From 1922 until the present time Mr. Price has been vice-president of the George A. Fuller Company of Canada, Ltd.

W. G. Mitchell, M.E.I.C., executive in charge of manufacturing, with Price Brothers and Company, Ltd., Quebec, has retired from that firm with which he has been connected

W. G. MITCHELL, M.E.I.C.

since 1921. Mr. Mitchell received the degree of B.Sc. in 1913, and that of M.Sc. in 1914, from McGill University, and from 1914 to 1916 was in charge of the division of wood preservation for the Forest Products Laboratories, Montreal. For the next three years he was with R. Martens and Company, Ltd., of London, England, as mining engineer on the investigation of timber and mining industries in Scandinavia, Finland, European Russia, Serbia and Manchuria. During the latter part of 1919 he was engaged in private practice in Canada and the United States, following which he was appointed special technical representative of the Canadian Export Paper Company, Ltd., Montreal. In March 1921, he became associated with Price Brothers and Company; in 1922 he took charge of the operation of the company's pulp and paper mills as assistant to the president; in 1926 he was transferred to the executive staff of the company at Quebec; and in 1930 was appointed to the position from which he now retires. Mr. Mitchell served as a vice-president of The Institute from 1926 to 1930, and was the first chairman of the Saguenay Branch.

W. P. Near, M.E.I.C., who has been city engineer of London, Ont. since 1923, has been appointed divisional manager for Toronto and district of the Supertest Petroleum Corporation, Ltd., Toronto. Mr. Near is a graduate of the University of Toronto, from which he received his degree of B.A. in 1903 and B.Sc. in 1907. In 1909 he joined the staff of the city engineer's department, Toronto, and for the following four years was engaged chiefly on the construction of trunk sewers in that city. In 1913 he was appointed city engineer of the city of St. Catharines, Ont., which office he held until he went to London. Mr. Near is active in the affairs of The Institute, and has represented the London Branch on the Council from 1928 to the present time.

A. S. Rutherford, B.Sc., A.M.E.I.C., has resigned from the George A. Fuller Company of Canada Limited and become associated with J. L. E. Price & Company Limited. Mr. Rutherford, after graduation from the Royal Military College of Canada in 1920 and McGill University in 1922, entered the employ of Church Ross Company Limited as field engineer, later becoming superintendent for that Company. In 1928 he joined the George A. Fuller Company of Canada Limited as superintendent of construction of the Dominion Square building, Montreal, and following its completion had charge of the erection of the Architects' building and Canadian General Electric building in Montreal.

R. H. Wallace, Jr.E.I.C., has joined the staff of the Canada Starch Company at Cardinal, Ont. Mr. Wallace graduated from the Royal Military College, Kingston, in 1922 and from McGill University in 1926, securing the degree of B.Sc. from the latter institution. In 1922-1923 he was with Kerry and Chace, Ltd., in Toronto, as a draughtsman and in 1923-1924 acted as instrumentman and on estimating with the resident engineer on hydro-electric construction for the same firm. From 1926 until the present time, Mr. Wallace has been with the Laurentide Paper Company, Grand'Mere, and the Canada Power and Paper Corporation, its successor. For the past three years he has been in the Control department of the Belgo Division at Shawinigan Falls, Que., and since 1929 has been in charge of the department.

Allan Turner Bone B.Sc., A.M.E.I.C., has taken an interest in J. L. E. Price & Company Limited. Mr. Bone was born in Glasgow, Scotland, and received his schooling at Western Canada College, Calgary. He graduated with honours from McGill University in 1916. Following graduation he spent three years in Halifax on the construction of the Halifax Ocean Terminals. From 1919 to 1922 he was with the George A. Fuller Company in Moncton, Temiskaming, and Montreal as field engineer and estimator. Six months were spent with A. F. Byers & Co. Ltd. as estimator, and then in of 1922 he joined the Shawinigan Engineering Co. Ltd. as job office engineer on the construction of the 150,000 h.p. development at La Gabelle. From 1924 to 1928 he was with the George A. Fuller Company of Canada Limited in Toronto, Ottawa and Montreal as superintendent and assistant construction manager, following which he became construction manager in their Montreal office, retaining that position until his resignation in March of this year.

ELECTIONS AND TRANSFERS

At the meeting of Council held on April 15th, 1932, the following elections and transfers were effected:

Associate Member

*RENSAA, Egil Mikkelsen, (Bergens Tech. Sch.), designer, C.N.R., Suite 14, Eugenie Apts., Norwood, Man.

Junior

BRANT, Theodore Jack, B.A.Sc., (Univ. of Toronto), demonstrator in hydraulics, dept. of mech'l. engrg., University of Toronto, Toronto, Ont.

Transferred from the class of Associate Member to that of Member

JAMIESON, Robert Edwards, B.Sc., M.Sc., (McGill Univ.), Professor of Civil Engineering, McGill University, Montreal, Que.

ROSS, Kenneth George, Grad. S.P.S., (Univ. of Toronto), vice-president, Lang & Ross Ltd., Engineers, Sault Ste Marie, Ont.

Transferred from the class of Student to that of Associate Member

SMALLHORN, Edward Robert, B.Sc., (McGill Univ.), managing-partner, Aerocrete Construction Co., Montreal, Que.

Transferred from the class of Student to that of Junior

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

Students Admitted

BOWEN, John Alfred Clarke, (Univ. of Toronto), P.O. Box 294, Long Branch, Ont.

DARLING, William Stanley, (Queen's Univ.), 236 Perth St., Brockville, Ont.

EVANS, Daniel, Jr., B.S. in Eng., (Princeton Univ.), (Grad. Student), 60 Pleasant Ave., Montclair, N.J.

GONZALEZ, George Albert, B.Sc., (McGill Univ.), 1610 Sherbrooke St. West, Apt. 9, Montreal, Que.

INGLES, Charles Leycester, (R.M.C.), Kingston, Ont.

LANGMAN, John N., (Queen's Univ.), Aurora, Ont.

MacDONALD, Charles Donald, (Mount Allison Univ.), 29 Spring St., Amherst, N.S.

MacLACHLAN, Jas. Robert, (Queen's Univ.), 5 Pansy Ave., Ottawa, Ont.

MacLAREN, James Isbester, Grad. R.M.C., Lieut., R.C.E., (McGill Univ.), 61 Thornhill Ave., Montreal.

McKENZIE, Ralph Boynton, (Univ. of Alta.), University of Alberta, Edmonton, Alta.

REINHARDT, Gerard Victor, (Mount Allison Univ.), La Have, N.S.

WALSH, Geoffrey, Grad. R.M.C., Lieut., R.C.E., (McGill Univ.), 3547 University St., Montreal, Que.

WISHART, William Donald, B.Sc., (Univ. of Man.), Lieut., R.C.S., Camp Borden, Ont.

WOOLSEY, John Townley, (R.M.C.), Kingston, Ont.

Undergraduates at the Nova Scotia Technical College:

BAYER, Douglas Thomas, 47 Brenton St., Halifax, N.S.

CONNELLY, Alan Burton, Grad. R.M.C., Lieut., R.C.E., Wellington Barracks, Halifax, N.S.

CORKUM, Perry Daniel, 15 Dresden Row, Halifax, N.S.

LOMBARD, Robert Alexander, Halifax, N.S.

McGEE, Henry Conlon, Big Island, Pictou Co., N.S.

McTAVISH, Frank Alexander, Grad. R.M.C., Lieut., R.C.E., Wellington Barracks, Halifax, N.S.

O'LEARY, Bernard Augustine, Halifax, N.S.

PRESCOTT, Ronald Reid, Halifax, N.S.

WILLIAMS, Cameron Scott, P.O. Box 209, Antigonish, N.S.

*Has passed Institute's examinations.

BOOK REVIEWS

An Introduction to Aeronautical Engineering

Vol. 2: Structures

Richard J. Moffett*

By J. D. Haddon. Gale and Polden, London, 1931, cloth, 5¾ x 8½ in., 128 pp., photos, figs., tables, 6/-net.

The author has succeeded in producing, without advanced mathematics, a short survey covering most of the general problems met with in the design of aircraft structures and this book is recommended as a preliminary study to students interested in aircraft.

To those with a knowledge of the Theory of Materials but unfamiliar with aircraft, "Structures" will indicate the application of the theories to the general problems of aircraft design.

The chapters on Mechanics and Frames, although short, present the information in a simple and readable form and the non-technical should obtain from them very clear conceptions.

Chapter VI, Strength of Materials, advances a little too fast for the general reader (with the restrictions on space it is difficult to see how this could have been avoided) but this chapter and particularly those sections dealing with elastic stability are recommended for engineering students.

The remaining sections of the book, dealing with Forces in the Structure and detail design are good and should be studied by every draughtsman who desires to enter an aircraft drawing office. The appendices are very suitable for the university student.

The whole book is profusely illustrated and the large number of examples given add materially to its use.

*Chief Engineer and Designer, Aircraft Department, Canadian Vickers Limited, Montreal East, Que.

Handbook of Business Administration

W. J. Donald, Editor-in-chief. Sponsored by American Management Association. McGraw-Hill, New York, 1931, leatherette, 4½ x 7 in., 1,753 pp., figs., tables, $7.00.

On glancing over a technical handbook the volume usually seems to be made up of a profusion of diagrams, numerical tables, graphs, and pages of condensed information. The book now reviewed produces a somewhat different impression, for although there are a number of graphs and diagrams, it is composed of a series of well written articles, which deal with a great variety of topics connected with business management, and in many cases are somewhat detailed descriptions of systems adopted and the results obtained in practice by the various authors. This characteristic makes the book easy to read, although the descriptive method adopted leads in some cases to an apparent lack of conciseness. Over one hundred and twenty contributors have collaborated in the production of this handbook, among whom are actuaries, vice-presidents in charge of sales, purchasing agents, engineers, treasurers, insurance men, economists, personnel managers and statisticians, to name only a few of their varied occupations. The articles are systematically arranged and presented in six sections, as follows:

Marketing	11 Chapters
Financial Management	9 Chapters
Production Management	13 Chapters
Office Management	9 Chapters
Personnel Management	13 Chapters
General Management	8 Chapters

The chapters are, of course, not all of equal merit, and in some of them the topics are discussed quite briefly. For example, the subject of advertising is handled in thirty pages, and hardly does more than sketch the nature of the problem presented to a business man who contemplates expenditure on this item. There are, however, very few points on which serious criticism can be offered, and the sections on office management and personnel management are of marked value.

The bibliographies included at the end of each chapter might well have taken a somewhat more extended form, and the very difficult problem of indexing a book of this kind has not been completely solved. For example, under the heading "Women" there are only two references, although many other topics connected with the employment of women have been treated and are probably indexed under other headings. The index covers only 32 pages.

The handbook may, however, be strongly recommended and will be found of particular value, for example, to engineers who wish to get a general picture of existing practice in business management methods, as well as to department heads in business concerns for whom it provides much needed information as to the operations and duties of departments other than their own.

The book is excellently produced, and in attempting the formidable task of assembling data on all important phases of business management, the editors have achieved a remarkable degree of success. Several of the sections are so good that any one of them alone would justify the publication of the book.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Consulting Engineers, Inc.: Constitution and By-Laws and List of Members, Mar. 1, 1932.
American Society of Mechanical Engineers: Record and Index, 1931.
The Institution of Water Engineers: Transactions, Vol. 36, 1931.
American Society of Civil Engineers: Year Book, 1932.

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E. Long Limited, Orillia, Ont., announce that arrangements have been completed with the Ross Screen and Feeder Company of London and New York, to build their complete line of equipment in Canada for use in conjunction with material handling equipment made by this company and their Montreal associates, Messrs. Williams and Wilson, Limited. The Ross feeder consists of a curtain of heavy endless steel chains driven by an overhead tumbler and suspended to lie on the material and to travel with it. It is particularly for use in mines, quarries and coal plants, etc.

BRANCH NEWS

Border Cities Branch

H. J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.
B. A. Berger, S.E.I.C., Branch News Editor.

The regular monthly meeting of the Border Cities Branch was held in the Norton Palmer hotel on Friday, February 12th, at 6.30 p.m.

The speaker was Mr. W. J. D. Reed-Lewis, of the Super Cement Company, who addressed the meeting on "Cement."

Cement

Mr. Reed-Lewis discussed the manufacture and use of Portland Cement at the present time, explaining the effect of the various constituents on the quality and strength of the product.

There are at least four raw materials essential to the manufacture of cement, Silica (SiO_2), Alumina (Al_2O_3), Iron (Fe_2O_3) and Lime (CaO).

These, combined in proper proportions, are burned in a kiln to form what is known as clinker. The latter is cooled either outdoors, by the use of water, or mechanically. Gypsum is then added for regulating the set of the cement.

The following chemical reactions take place in the kiln.

The iron combines with part of the alumina and lime to form tetra-calcium-aluminum-ferrite ($4\ CaO,\ Al_2O_3$).

The remaining alumina combines with lime to form tri-calcium-aluminate ($3\ CaO,\ Al_2O_3,\ Fe_2O_3$).

The silica first combines with lime to initially form di-calcium-silicate ($2\ CaO,\ SiO_2$).

The di-calcium-silicate takes up more lime, if more exists, and becomes tri-calcium-silicate ($3\ CaO,\ SiO_2$).

The extent to which the di-calcium-silicate is converted into tri-calcium-silicate depends on the excess lime available after the di-calcium-silicate has been formed.

It follows then, that the higher the lime the more tri-calcium-silicate can be formed. Also, none can be formed unless lime is still available after the di-calcium-silicate has been formed.

The above process is a continuous one and is considered primary.

Specifications demand that cement be ground in ball mills until upwards of 80 per cent will pass a 200 mesh sieve.

Now it has been determined that there is a definite relation of particle size to the strength age curve. This indicated a method of attacking the problem. Two samples of the same clinker were ground in different mills at the same time to a fineness of 90 per cent passing a 200 mesh sieve, and though produced from the same clinker they differed so radically as to strength that it was evident that they must differ radically in the sub-sieve sizes.

Since the results were unsatisfactory they were obliged to go below 325 mesh. Air separation was resorted to and four sizes arbitrarily chosen:—

(1) $<$ 325 mesh and $>$ 30 mikrons
(2) $<$ 30 mikrons and $>$ 20 mikrons
(3) $<$ 20 " " $>$ 10 "
(4) $>$ 10 "

$$\text{one mikron} = \frac{1}{25{,}400}\ \text{inch.}$$

By varying the relative finenesses, their respective effects on the one or more day strengths were completely determined. Thus, due to the above observations they had been able to overcome the necessity of running lime as high as others do.

The process is not only mechanical, but involves other materials not normal to cement, e.g. tannic acid is used as a catalyst to produce greater hydration, i.e. more hydrate. It also produces a noticeable difference in plasticity, a greater plasticity being highly desirable.

According to specifications, a cement to which tannic acid has been added would at first sight appear to be no longer a Portland cement. However, due to the specifications definition of gypsum (requiring only 65.5 per cent of the gypsum used to be pure gypsum) it can be seen that the addition of tannic acid or anything up to 35.5 per cent of the gypsum is permissible. The proportion of tannic acid used is approximately 1 in 3,000. Incidentally, the tannic acid is not admitted to be part of the cement; it is simply a catalytic agent. It has also been found that cutting down the gypsum and adding plaster of paris improves the cement.

In concrete, the thinner the layer of hydrated cement on the surface of the aggregate, the stronger will be the concrete and the greater the durability.

During the process of hydration, water penetrates the cement particle, hydrates it, and forms a water resisting coat. Therefore the core of the particle cannot at any time contribute to the strength of the concrete. If shrinkage occurs during induration, small cracks appear and admit water, forming more hydrate. However, this continued movement would have a weakening rather than a strengthening effect. Thus, for a particle that has been ground smaller, there is approximately the same depth of penetration, but less unhydrated material.

Hence it can be seen that by the proper control of clinker and hydration, it is possible to obtain greater strengths without the use of lime.

Up to the present, the tendency has been to measure the quality of a cement by tensile and compressive tests and to forget that failure most usually results from disintegration, although the latter is the more important phase.

Therefore, in the future one must look to quality more and accept only such cements that have been shown by chemical analysis to be high in resistance to destructive agents, i.e. low in excess lime and producing the greatest volume of hydrated material.

Keeping in mind that plasticity or capacity to hydrate is most important next to chemical stability, one might be able to work out a desirable, permanent cement.

At the close of the lecture, Mr. Reed-Lewis answered numerous questions and it was with the hearty and unanimous approval of all present that the chairman conveyed to him the vote of thanks of the meeting.

Calgary Branch

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

Northern Transportation

An audience of eighty-five gathered at the Board of Trade rooms on Thursday, March 31st, to hear an address by C. C. Ross, M.E.I.C., on some of his experiences in travelling over northern Canada as supervisory mining engineer for the Department of the Interior. The meeting was held under the joint auspices of the Canadian Institute of Mining and Metallurgy and The Engineering Institute of Canada, with Lieut.-Col. F. M. Steel, M.E.I.C., in the chair.

In selecting transportation as the main feature of his address, the speaker explained that in a territory of 1,400,000 square miles the problems of communication follow very closely on the heels of any mineral strike and the facilities for inspection and survey had been immensely improved within recent years.

After describing the characteristic geology and topography of the four major divisions of the North West Territories, it was explained that there are three main routes by which northern Canada is accessible by established transportation, viz., from the east by ship into Hudson Bay, from the west by ship through Behring straits and along the Arctic coast, and from the south by railway and river steamers through waters of the Mackenzie system to the Arctic. All these services were developed in the interests of the fur trade which still furnishes the principal part of their freight. Recently with the extensive flying operations in the north, gasoline has formed an important part of the northbound cargoes.

For land transportation in the north, a suitably designed tractor would meet the requirements satisfactorily.

Flying operations have been carried on in the north for about four years during which practically all the country between Hudson Bay and the Arctic has been covered, and the various seasonal conditions encountered. From these experiences the possibilities and the limitations of flying in the north have been determined.

In a country of vast distances great service can be given by wireless telegraph stations placed at strategic points, especially during the period of exploration and early development. They remove the isolation of the outpost and serve as observation stations.

In proposing a vote of thanks to the lecturer, S. G. Porter M.E.I.C., referred to the value of pioneer investigations in northern Canada, where the pontential resources may prove of immense value to the future development of Canada.

Annual Dinner

The annual dinner of the Branch was held at the Renfrew Club on Saturday, April 2nd, when R. C. Harris, M.E.I.C., presided. The occasion was taken to present A. W. P. Lowrie, A.M.E.I.C., with a set of draughting instruments in recognition of his services as honorary secretary-treasurer for the past two years. In making the presentation, the chairman referred to the importance and multiplicity of the secretarial duties and expressed his personal appreciation of Mr. Lowrie's co-operation and able conduct of the Branch business affairs.

Proposing the toast of the city of Calgary, R. S. Trowsdale, A.M.E.I.C., traced the history of city utilities since 1909, when he arrived to take up residence, and Commissioner Graves replied explaining some of the problems confronting the present administration.

Mr. D. A. McCannel of the Calgary Herald quoted some news items of twenty years ago to indicate how history repeats itself in engineering problems as a subject of public interest.

In replying to the toast of The Institute, S. G. Porter, M.E.I.C., outlined some newly draughted objects of The Institute to include "means whereby its members might be of service to the profession and the community in general." He pointed out that economic and social service had not kept pace with physical science in recent years, and there was an increasing need for a knowledge by governments of the principles of engineering practice.

The toast of the guests was appropriately proposed by Lieut.-Col. Steel, M.E.I.C., and Mr. R. M. Edmundson and Dr. W. H. McFarlane, as presidents of the Calgary Bar and Medical Associations respectively, replied. R. J. Gibb, M.E.I.C., conveyed greetings from Edmonton in his dual capacity of chairman of the Edmonton Branch of The Institute and president of the Alberta Association of Professional Engineers. The other guests included Dean R. S. L. Wilson, M.E.I.C., and Mr. A. C. Ballantine, editor of the Calgary Albertan.

At the close of the meeting it was learned with sorrow that C. J. Yorath, M.E.I.C., had passed away during the evening after a short illness.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
W. J. DeWolfe, A.M.E.I.C., Branch News Editor.

The regular meeting of the Halifax Branch was held at the Nova Scotian hotel on February 18th. It was a supper meeting presided over by A. F. Dyer, A.M.E.I.C., chairman of the Branch, 35 members being present.

Following the regular business, A. Scott, A.M.E.I.C., entertained the members with two rolls of films (through the courtesy of the Anaconda American Brass Company, Ltd., and the energy of R. R. Murray, A.M.E.I.C.) depicting the mining and reduction of copper ore and its manufacture into all types of copper products.

Mr. Scott next introduced J. J. MacDonald, M.E.I.C., chief engineer of the Halifax Harbour Commission, who had been loaned to the Saint John authorities to superintend the re-construction at Saint John last year.

West Saint John Harbour Reconstruction

Mr. McDonald gave a general description of Saint John Harbour before the fire of June 22nd, 1931, showing a chart of the harbour and general plan of the pre-fire facilities on the west side and showed slides of the fire on June 22nd, 1931, when the west side facilities were completely burned out, with the exception of the C.P.R. Elevator "B."

A preliminary survey and inspection of the site was begun about the 1st of July, under Sir Alexander Gibb & Partners, consulting engineers for the Department of Marine. The first contractor's men arrived July 15th.

The object of the reconstruction programme was to provide sufficient berths (not less than six) to accommodate the probable traffic for the coming winter season, completely equipped with transit sheds and facilities and grain conveyor galleries, to be ready for use December 1st.

It was decided to reconstruct berths 5, 6 and 7 at the north end of the terminals area, and berths 15, 16 and 17 at the south end.

The programme was enlarged later to include berth 14 and fitting out pier at old No. 2.

Slides were shown of the general details of pier construction, sheds, etc., before the fire, and of the new designs prepared for the reconstruction.

The designs for the new fire-proof construction were prepared in the several weeks' interval afforded by the demolition operation.

The main features of the new designs for substructures, transit sheds, grain galleries, etc., were commented upon.

Progressive views were also shown of several typical aspects of the work, from the 1st of August to the end of November, showing the various steps in the progress of the work from the demolition to the completion of the job.

The more important features of the work were: seven berths rebuilt from practically low water level, complete with transit sheds, new grain conveyor system with all equipment, ready for operation four and a half months from the day the first man was on the job.

Frost-proof potato warehouse, 400 feet by 96 feet, constructed ready for use in six weeks.

An all-steel interconnecting shore grain conveyor gallery, 1,300 feet long, was built, equipped and put in operation in a period of twenty days (on account of the necessity to acquire the property rights to the site).

About 4,400 tons of structural steel were supplied within a period of three and a half months from placing of the order to the completion of erection. This included preparation of shop drawings for two types of transit sheds, intricate gallery work, etc.

Berths 5, 6 and 7 constitute a pier about 1,400 feet by 200 feet and berths 16 and 17 constitute a pier about 800 feet by 300 feet.

Transit sheds equal a total length of 3,770 lineal feet, a total area of 7½ acres.

Conveyor galleries equal a total length of 1¼ miles and a total area of 2½ acres of floor space.

Representative quantities of materials used show nearly 6½ million feet b.m. of timber, 200,000 lineal feet of piling, 4,400 tons structural steel, 100,000 sacks of cement, 5,400 squares of sheet metal, 6¾ miles of rubber belting for conveyors.

Sir Alex. Gibb & Partners, were the consulting engineers for the work to the Department of Marine.

The speaker was chief engineer in charge of design and construction, subject to the direction of the consulting engineers.

John S. Metcalf Company Limited, were the consulting engineers for the grain conveyor system, including galleries and all equipment.

The Foundation Company of Canada Limited and the Northern Construction Company & J. W. Stewart Limited were the general contractors.

A vote of thanks, moved by W. J. DeWolfe, A.M.E.I.C., and seconded by C. S. Creighton, A.M.E.I.C., expressing the appreciation of all present was tendered to Mr. MacDonald at the conclusion of his excellent and informative address.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affiliate E.I.C., Branch News Editor.

Joint Meeting with the Engineering Society of Babcock-Wilcox and Goldie-McCulloch Limited, Galt.

An enthusiastic joint meeting of the Hamilton Branch of The Institute and the Engineering Society of Babcock-Wilcox and Goldie-McCulloch Ltd., was held on April 8th in Galt in the general office of the Babcock-Wilcox and Goldie-McCulloch Company. A dinner in the Iroquois hotel, Galt, preceded the meeting at which members and guests were present from Hamilton, Galt, Montreal, Preston, Brantford, Kitchener, Waterloo and other places in the district, to the number of 68.

Mr. G. H. Wilkes, chairman of the Engineering Society of Babcock-Wilcox and Goldie-McCulloch Ltd., in calling the meeting to order thanked the Hamilton Branch for the good attendance and turned the meeting over to E. P. Muntz, M.E.I.C., chairman of the Hamilton Branch.

Locomotive No. 8000

The speaker of the evening was Mr. W. A. Newman, chief mechanical engineer, of the Canadian Pacific Railway Company, whose subject was "Locomotive 8000," a locomotive embodying many unusual features which was completed in the Angus Shops of the C.P.R. in May 1931.

The new locomotive, stated Mr. Newman, utilizes a very novel and interesting system in the generation of steam which offers an improvement in economy. Every improvement in design of locomotives aims at the development of increased power with decreased costs. In railroad language this can be expressed as hauling a heavier load at less cost. The history of increasing boiler pressures means that water tube boilers must be used, the principal reason being that small tubes can have an ample factor of safety with comparatively thin walls. One disadvantage in water tube boilers is that impurities are left behind as solids when ordinary water is used. These solids become fastened on to the metal surfaces, forming a scale which interferes with the transmission of heat. In marine and stationary plants this is easily overcome by the use of condensers, but with a moving locomotive, weight and space limitations do not allow for the same methods as in stationary plants. The problem then resolves itself into how to construct a water tube boiler without scaling difficulties.

The Locomotive 8000 is of the "Multi-Pressure" type. That is, there are three pressure systems with which three instead of two cylinders are used, and in this way it is radically different from ordinary locomotives.

The three pressure systems are, respectively, the "closed steam generating system," employing a boiler pressure of 1,350 pounds, the "high pressure system," employing a boiler pressure of 850 pounds, and the "low pressure system," employing a boiler pressure of 250 pounds. The closed steam generating system is a box-like structure built up of a large number of tubes filled to a set level with distilled water and sealed. This system absorbs a large amount of heat to form steam, which when condensed gives out the same amount of heat. This is accomplished by collecting the steam in two longitudinal drums at the top of the firebox and then delivering it to a series of coils placed in the inside of a seamless steel drum and submerged in water. These are called heat transfer coils and the surrounding water condenses the steam and absorbs the heat given out. Condensation is then led from the bottom of the coils back to the lowest point in the closed system and is then re-evaporated.

The system therefore has a continuous sponge-like action, absorbing and giving out heat. On account of the use of distilled water no scale can accumulate.

The locomotive burns fuel oil, the capacity being 4,100 gallons and the capacity for water supply being 12,000 gallons.

Following Mr. Newman's interesting introduction, of double value because of the clear manner of its presentation, a number of moving pictures were shown. These first showed by means of animated diagrams the location of the different pressure systems and then showed the action which takes place in the functioning of these systems. Then followed a film which showed the building and finishing of some of the principal parts of the locomotive, the assembly of these parts and by degrees the completion of the locomotive. It was apparent to everyone present that these pictures showed how carefully planned and engineered is a locomotive of the type of the 8000.

An interesting discussion followed the address, during which Mr. Newman told additional facts concerning the locomotive. The efficiency of the power plant had been increased 25 per cent over the previous type. Asked what use had been made of special alloys in the construction of the locomotive, the speaker stated that without these such high pressures could not have been attained and that the weight had been very materially reduced.

Mr. J. H. Hanright, chief engineer of the Babcock-Wilcox and Goldie-McCulloch Company, moved a vote of thanks to the speaker, seconded by H. G. Bertram, M.E.I.C., for his very interesting address.

NOMINATIONS FOR EXECUTIVE COMMITTEE

Prior to Mr. Newman's address the report of the Nominating committee of the Branch was presented. The Nominating committee recommended that the Chairman, Vice-Chairman and Secretary-Treasurer be re-elected and that Messrs. J. J. MacKay, M.E.I.C., and T. S. Glover, A.M.E.I.C., become the two new members on the Executive committee. The report was adopted and if no further nominations are received these gentlemen will be on the new Executive committee.

EXECUTIVE COMMITTEE MEETING APRIL 12TH, 1932

A meeting of the Executive committee was held in the Royal Connaught hotel on the evening of April 12th at which a lot of routine business was transacted. For some time the Executive committee have been quietly organizing for the purpose of entertaining the members of the Institution of Mechanical Engineers when they visit Hamilton during their Canadian meeting next Autumn. The date on which they will visit Hamilton has been set for September 2nd. In a discussion it developed that it was the opinion of the Executive committee that it would be better to include the whole Hamilton Branch district rather than the city of Hamilton only. The following committee was appointed to handle the final arrangements: E. P. Muntz, M.E.I.C., Chairman; F. W. Paulin, M.E.I.C., H. A. Lumsden, M.E.I.C., W. D. Black, M.E.I.C., J. B. Carswell, M.E.I.C., P. Ford-Smith, M.E.I.C., J. C. Callahan, V. S. Thompson, A.M.E.I.C., C. Anderson, A.M.E.I.C., T. S. Glover, A.M.E.I.C., F. P. Adams, A.M.E.I.C., F. Roberts, J. R. Dunbar, A.M.E.I.C.

The Secretary reported the replies that have been received to a circular which has been sent out to the Branch membership regarding the preparation of papers. The replies have been very satisfactory, over sixteen titles having been suggested. The interest in the following titles seems to be sufficient to organize a committee immediately to prepare the papers: "Transportation," "The Value of Photography to Engineering," "The Status of the Engineer in Industry," "Hamilton Under Ground."

Kingston Branch

L. F. Grant, M.E.I.C., Secretary-Treasurer.

FIXATION OF ATMOSPHERIC NITROGEN FOR USE IN FERTILIZERS AND THE UTILIZATION OF WATER POWER

On February 8th, Dr. L. F. Goodwin read a paper on the "Fixation of Atmospheric Nitrogen for use in Fertilizers and the Utilization of Water Power." The lecturer stated that he could best describe the subject in five headings, or phases of its evolution, and would avoid the use of too much scientific detail.

1. The oldest method historically, the fixation of nitrogen in the form of oxides, and its subsequent working up and utilization in the form of calcium nitrate, or as nitric acid, has just become defunct. It was, however, most important historically. Nearly a century ago, it was shown by Cavendish that nitrogen and oxygen combined under the influence of the electric spark to give oxides of nitrogen. Professor Birkeland, studying the phenomenom of the Aurora Borealis, applied the magnetic field to an electric arc, causing the latter to spread out into a thin circular disc of flame. In conjunction with an engineer, Eyde, he applied this principle to obtain more intimate contact between an electric arc and large volumes of air.

Eventually the development of the Birkeland and Eyde furnaces, at first of 1,000 kilowatt capacity, but which rapidly grew to 4,000 kilowatt, solved the problem of the fixation of atmospheric nitrogen on a commercial scale. The power requirements were great, one kilowatt-hour only producing sixty-seven grams of nitric acid. Although various small factories were established in other countries, the process was only worked on a large scale in Norway, where the cheap electric power from the Rjukan Foss I and II provided about 100,000 h.p. at the unsurpassed cost of $5.00 per h.p. year.

2. The second phase of nitrogen fixation was in the form of calcium cyanamide, developed at about the same time by Drs. Caro and Frank. In this process nitrogen is passed over heated calcium carbide—the nitrogen being rapidly and completely absorbed. The resulting product was either worked up by means of steam into ammonia, or by means of a further modification into cyanide for use in gold extraction.

For many years it supplied the bulk of the cyanide requirements for the mines, but the factories producing it are now turning their attention towards the manufacture of ammonia compounds, chiefly phosphates for use as fertilizers.

3. The next and most important phase was fixation in the form of synthetic ammonia and was due to the work of the renowned physical chemist Dr. Haber, in Karlsruhe, who associated with him an English chemist, Le Rossignol. It was common knowledge that ammonia on heating decomposed into nitrogen and hydrogen, and that this was an example of an equilibrium or reversible reaction, $2NH_3 = N_2 + 3H_2$.

Attempts had been made to synthesize ammonia from the gases nitrogen and hydrogen, but the low yield made manufacture out of the question.

Based on strictly thermo-dynamic reasoning and physical chemical laws, Haber concluded that to synthesize ammonia, high pressures of the order of 100 to 200 atmospheres were required, a low temperature such as could be obtained by means of a catalyst, and the discovery of an efficient catalyst. The reversible reaction written above shows that one volume of nitrogen and three volumes of hydrogen combined to give two volumes of ammonia. There is, therefore, a great reduction in volume, and according to the principle of Le Chatelier this reaction must therefore proceed towards ammonia formation, if great pressures are applied.

Haber devised a triple tube heat interchanger-catalyst furnace, such that the highest temperature was obtained in the innermost tube (heated electrically) whilst the incoming gas at a pressure of 100 or 200 atmospheres traversed the outer tube. By this means the outer tube which had to stand the highest pressure was at the lowest temperature, and this spelled success.

There was great difficulty in convincing even highly-trained industrialists that a reaction which only gave a yield of five or six per cent could be made a commercial one. Of course, what happens is, that the five or six per cent of ammonia synthesized is washed out or absorbed by water under pressure, and the remaining 95 per cent of uncombined gases are re-circulated, until ultimately quantitative production results.

Several modifications of this process have been developed, such as the Claude which utilizes hyper-pressures of 1,000 atmospheres, the Fauser, the Casale, and that of the Nitrogen Engineering Corporation, which utilize pressures between 200 and 400 atmospheres. The lecturer showed a number of slides, illustrating the construction of the apparatus and pipe lines as well as views of large plants in Germany, France and England.

The greatest improvement eventuated about three years ago, when the Mont Cenis process was perfected at Herne in Germany. This process has succeeded in working at pressures below 200 atmospheres and at temperatures below 450 degrees, which had been unattainable previously. Their success is due to the invention of a highly efficient catalyst, which gives a conversion of 20 per cent as against the five per cent of the original Haber process.

The synthetic ammonia process in any of its modifications is now thoroughly well-established, and it is now merely a question of reducing working costs.

Electrolytic hydrogen is the purest and most expensive, but in view of the enormous water powers available in Canada and elsewhere, their employment can, in rare circumstances, be considered.

THE ONTARIO LAND DRAINAGE ACT

On March 18th, the Kingston Branch was addressed by Dr. J. L. Morris, M.E.I.C., on "The Ontario Land Drainage Act."

Dr. Morris reviewed the various provincial acts dealing with land drainage commencing with the act regulating the drainage of lands in Upper Canada, of 1859. Until 1873 all drainage was under the Department of Public Works of the province, and action on the report of an engineer could be taken only by the Legislature.

The act of 1873 allowed appeal to a Court of Revision rather than to the Legislature. In 1889 an act was passed consolidating the various acts of the past, and this act was amended in 1894 by providing for a referee in drainage disputes, this referee having the powers of a justice of the Superior Court.

The present act was passed in 1927 and particularly specifies the parties concerned in a drainage proposal as the petitioners, the municipality inaugurating the scheme, the engineer or surveyor concerned, the Court of Revision, the county judge and the contractor. This act has proved satisfactory.

Dr. Morris gave a number of cases showing how the act operated, and particularly emphasizing the functions of the engineer. He closed with a most interesting and timely discussion of the opportunities which this act and certain others afford for professional work by engineers and surveyors in private practice in the province of Ontario.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.
G. W. Rowe, Jr.E.I.C., Branch News Editor.

A highly varied programme greeted members and affiliates of the Lethbridge Branch of The Engineering Institute of Canada at their final meeting for the season held March 5th, 1932, at the Marquis hotel.

A. E. Pollard, British Trade Commissioner at Vancouver, who is on an official tour of the prairie provinces, was a guest of the Branch. Mr. Pollard briefly addressed the gathering, discussing the functions of his department in assisting Old Country manufacturers to place their goods on the Canadian market.

The main speaker of the evening was W. Russ, district plant chief at Lethbridge for the Alberta Government Telephones.

Mr. Russ was introduced to the members by N. Marshall, M.E.I.C., Branch chairman, and his subject was "The Storage Battery" with special reference to its use in telephone equipment. The talk was illustrated by a motion picture and the thanks of the branch are extended to Cyril Watson who has so generously given of his time during the past season in operating the projector and who again assisted on this occasion.

The orchestra under the direction of George Brown again entertained during the dinner and assisted in community singing which followed. This comprises Mrs. George Brown, piano, Gordon Henderson, 'cello, Harold McIlvena, clarinet, and George Brown, violin, and their entertainments during the season have been greatly appreciated.

The guest soloists of the evening were Mrs. I. Garrison and Ben Martin who delighted with vocal numbers.

The entertainment committee comprising James Haimes, A.M.E.I.C., and J. A. Jardine, are to be congratulated on the splendid programmes they have arranged. That the members appreciated their work was readily recognized by the response to the vote of thanks proposed by G. S. Brown, A.M.E.I.C.

Following the dinner and social hour the minutes of the last meeting were read and the annual report of the Secretary-Treasurer received. That the Branch greatly appreciated Mr. Meldrum's splendid work for the season was shown by the hearty applause and unanimous passing of the report.

The Storage Battery

In opening his address Mr. Russ traced briefly the early history of the telephone. After a short discussion of the work of the early scientists notably Orsted in 1820 in the field of electro-magnetism and the development of the telephone in 1876 by Bell. Mr. Russ showed that the first record of a battery being used in telephone work was in 1881.

From this Mr. Russ went on to discuss the construction of the simple dry cell.

In modern telephone systems the dry cell is usually used on rural telephone systems but in the larger manual exchanges two wet cells are used. The main battery in the Lethbridge exchange operates at 48 volts and contains 25 cells. In addition 7 counter-cells are used to control the voltage on the lines.

Mr. Russ followed this with a description of these batteries and the method employed in charging them.

He concluded his remarks with an invitation to the members to inspect the local exchange.

The vote of thanks to the speaker was moved by W. Meldrum, A.M.E.I.C., and was generously applauded.

At the conclusion of the address there followed an informal half hour discussion on Institute and Branch affairs following largely along the lines suggested by an address appearing in the December issue of The Engineering Journal, by the chairman of the Hamilton Branch.

The discussion was led by P. M. Sauder, M.E.I.C., and J. B. DeHart, M.E.I.C., and many members availed themselves of the opportunity to express their opinions and to offer suggestions.

The following are the elected officers of the Branch for the 1932-1933 season.

Chairman	W. Meldrum, A.M.E.I.C.
Executive	James Haimes, A.M.E.I.C.
	R. Livingstone, M.E.I.C.
	H. W. Meech, A.M.E.I.C.
	G. S. Brown, A.M.E.I.C.
Ex-officio	N. Marshall, M.E.I.C.
	J. B. DeHart, M.E.I.C.
	G. H. Houston, M.E.I.C.

London Branch

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

The regular meeting was held on the 25th of February, 1932, in the City Hall Auditorium, the speakers being E. V. Buchanan, M.E.I.C., manager of the Public Utilities Commission, and Dr. Hugh Stevenson, ex-M.L.A.

The chairman, D. M. Bright, A.M.E.I.C., presided, and first called upon the Secretary to read the minutes of the last meeting.

A presentation of a beautifully chased silver cigarette case engraved with name and years of office was then made to the retiring Secretary, Frank C. Ball, A.M.E.I.C.

The chairman, in making the presentation, eulogized Mr. Ball's services during the past seven years and expressed the thanks and appreciation of the members for the adequate manner in which he had fulfilled the duties of the office.

E. V. Buchanan then gave his address, entitled the "Profession of the Engineer."

The Profession of the Engineer

Mr. Buchanan began by pointing out the undoubted right of engineering to be recognized as a profession, although this recognition is not accorded so freely as in the case of law and medicine. The speaker reminded his audience that in the days of Plato and Aristotle the inner consciousness or the intellect was regarded as the source of all knowledge, and that later when philosophers began to recognize the importance of observation and experiment, they still adhered to the belief that the function of knowledge was largely to furnish mental exercise and to elevate the mind. The methods based on this view were first attacked in the 13th century by Roger Bacon, but experimental philosophy was not considered seriously until after the work of Galileo in the 16th century. The development of natural science since that time has been the basis of all engineering progress.

The training of the engineer leads him to observe and collect facts, and then by consideration and analysis, and by clear reasoning, the solution of a problem is eventually worked out. In this training, therefore, the engineer will have acquired powers of concentration, capacity to apply methods of analysis, and ability to differentiate between the essential and the unimportant. He will have learned to search for the truth and respect this truth when found, planning his course of action upon this basis.

The speaker pointed out that this type of training has its disadvantages, one of which is its tendency to hamper the pioneer. Many startling results had been achieved by comparatively untrained men, who had the courage and imagination to pursue their original ideas in spite of opposition from people of more conservative views. The engineer should be on his guard against the limitation of enterprise in this manner.

A fundamental difference between pure science and engineering is that of necessity the latter in its problems includes essential economic and financial factors. The engineer's solution of a problem must be in terms of money, and his work in design will not add to his reputation if he has not always kept foremost in his mind the economics of the problem. Notwithstanding this dominating economic aspect the engineer should have his ideals, although he is striving for an economic objective rather than for one of beauty or spiritual interpretation.

In many respects, remarked Mr. Buchanan, the engineer's training fits him for executive leadership, but it is noteworthy that the industrial leaders of the present day are mainly lawyers, bankers or politicians; these men excel in their knowledge of human nature, but they often fail in dealing with concrete realities. Leadership requires a practical reconciliation between science and idealism, and those who take a purely materialistic view of their work cannot be leaders in the present day world. The engineer who finds such a reconciliation is likely to take a front place among the leaders of his time.

Dr. C. Sivertz, Professor of Chemistry at the University of Western Ontario, expressed his pleasure at being privileged to hear Mr. Buchanan's paper and he voiced his opinion that students in the present-day were kept so close to their individual studies that they had not the chance to take the broader viewpoint of the profession as a whole and consequently when they were through with their studies they were faced with problems bearing on their work from different angles which they were at a loss how to solve. Particularly is this so with regard to the financial side of their work. Scope should be given students to realize the importance and necessity of dealing with these broader viewpoints.

Beryllium

Dr. Hugh Stevenson, the next speaker, informed his hearers that perhaps the most important object he had in taking his recent tour of Brazil and the Argentine was to investigate the possibility of mineral deposits of the new metal known as Beryllium and its uses in alloys.

He then exhibited three or four reels of moving pictures taken by himself at Buenos Ayres, Rio Janeiro, and other places. The magnificent water falls on the River Plata were shown and the speaker emphasized the enormous amount of water power available.

The thanks of the meeting were tendered to both speakers by the chairman, together with expressions of appreciation and interest by all present.

At the conclusion of the speaking the Entertainment committee served light refreshments.

About forty members and guests were present.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Junior Section of the Montreal Branch

The first general meeting of the Junior Section of the Montreal Branch was held at Headquarters on Thursday, March 17th, 1932, at 7.45 p.m.

There were about twenty members of the Section present.

S. Farquharson, A.M.E.I.C. acted as chairman. E. A. Ryan, M.E.I.C., addressed the meeting on behalf of the chairman of the Montreal Branch. H. W. Lea, Jr.E.I.C., R. Lanctot, Jr.E.I.C., E. Smallhorn, S.E.I.C. and G. Lanctot, S.E.I.C. representing the University of Montreal, and H. G. Seybold representing McGill University, spoke on the aims and proposed work of the Section.

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer of the Montreal Branch, also said a few words regarding the organization of The Institute.

The following gentlemen were then elected temporary officers of the Section:

Chairman	S. Farquharson, A.M.E.I.C.
Vice-Chairman	H. W. Lea, Jr.E.I.C.
Secretary	R. Lanctot, Jr.E.I.C.
Committee	R. F. Legget, A.M.E.I.C.
	E. Smallhorn, S.E.I.C.
	H. G. Seybold.
	D. Coolican.
	G. Lanctot, S.E.I.C.
	J. Benoit.
Ex-officio	C. K. McLeod, A.M.E.I.C.

E. G. Adams, S.E.I.C., then presented his paper on "Some Economic Problems Confronting a Wider Application of Railroad Electrification in America." At the present time, some 1,800 miles of various systems are in electrified operation in the United States though about 21 are using electric motive power on some part of their systems. However, nearly all this has been made to meet local conditions. With the construction of the "system electrification" of the Pennsylvania Railroad comes a significant forward step in the application of electricity to steam railroads, however, there were many major problems involved.

The paper brought out some of these economic problems which would have to be solved before electrification could be further greatly extended. It dealt only with the electrification in its strict sense, that is, only cases where power is delivered to the train through a third rail or trolley.

The latter part of the paper was devoted to a summary of what has already been done to solve and investigate the economic problems and advantages and disadvantages.

Recent Developments in Aerial Photography

The usual courtesy dinner extended to out-of-town lecturers was held at the Windsor hotel, Montreal, on March 24th, prior to the weekly meeting held at The Engineering Institute headquarters.

The speaker of the evening was A. M. Narraway, M.E.I.C., controller of surveys in the Topographical Survey Branch, Department of the Interior, Ottawa. Captain A. F. Ingram, Affil.E.I.C., presided.

The lecturer gave a very complete and interesting talk on how the aeroplane and camera combined were put to use in mapping the unknown northern lands. Special work done in the neighbourhood of Great Bear Lake, which is about the size of Lake Ontario, was shown and explained by Mr. Narraway. It consisted of mapping 2,000 square miles and took forty days with two planes.

The finished map was shown on the screen, compared to an old map of the same area, and it did not appear to be the same lake. The scale of the Great Bear Lake map is one-half mile to the inch, but accurate maps can be made at one or two miles to the inch. The best working altitude was around 10,000 feet. Numerous lantern slides were shown of the Great Bear Lake district. Mr. Narraway stated that about 700,000 aerial photographs are on file and are being increased very rapidly.

Mapping by air does not displace the ground engineer or surveyor even though it is the greatest single agency to attack the resources of the country, but the key of a problem is easily found by the aerial photographs when the man on the ground works for a long time blindly.

A vote of thanks was tendered the speaker by C. C. Lindsay, A.M.E.I.C.

At the weekly meeting of the Montreal Branch held on March 31st, a very interesting paper was read by C. S. Kane, A.M.E.I.C., of the Dominion Bridge Company, Montreal. P. L. Pratley, M.E.I.C. was in the chair and every available seat in the hall was filled.

The Kane System of Composite Construction

In introducing his subject, "The Kane System of Composite Construction, "the speaker dwelt on the development of new and substantial materials of construction to make buildings permanent as well as sanitary and vermin proof, and more economical.

A brief description of the past systems was given and of a test made at the Lachine plant of the Dominion Bridge Company of haunched beams by three of Canada's leading university professors.

About eight years prior to this the speaker had conceived the principle involved in the "Kane System of Composite Construction," but as welding was only being developed, this system of construction would have been unpractical.

The first opportunity presented itself when the Architects building, situated at the corner of Dorchester street and Beaver Hall Hill, Montreal, was contemplated, the then conventional design of structural steel was made and owing to the cost, a reinforced concrete construction practically adopted. The Kane system was proposed and economy was foreseen, therefore it was adopted and the design drawings submitted to the Superintendent of Buildings of the City of Montreal, who, after the necessary consideration of design and details, granted approval.

The steel frame was started in September, 1930, and completed before the middle of November, 1930, since which date, eight other buildings have been built or contracted for using the Kane system.

Lantern slides of isometric drawings were shown of several jobs such as the Western Hospital, Royal Victoria Hospital, the Gatehouse building, etc.

A general description of the system was given, in which I-beams and where possible plate girders are replaced by welded trusses which are haunched in concrete according to standard fireproofing practice.

The design of the various members was completely described and the important features of the various buildings under construction at the present time were explained.

The speaker remarked that the "Kane System" is somewhat similar to a sheet frame construction, known in the United States and Japan as "System S," a description of which may be found in the Engineering News-Record of May 12th, 1927, and July 9th, 1931.

Heating of Buildings

The weekly meeting of the Montreal Branch of The Institute was held on April 7th, 1932, F. A. Combe, M.E.I.C., presiding.

The speaker of the evening was G. Lorne Wiggs, A.M.E.I.C., manager of the Montreal Branch of C. A. Dunham Company, Ltd.

In his paper, Mr. Wiggs described the advances in heating practice, the most significant of which have been made during the past ten years. He also described the development of heating systems during the past century.

Numerous charts were shown for conditions at Montreal regarding temperature, wind, sunshine, air conditioning, the effect of window and wall construction etc., and many other slides.

Modern heating systems were described: (1) unit heaters which are rapidly supplanting cast iron pipe coil radiators in industrial buildings; (2) concealed radiators, which bid fair to replace the exposed radiators in a wide area of the construction field; (3) the circulation of steam at pressures approaching a perfect vacuum which has added new flexibility to an old heat transfer medium; (4) the use of orificing or metering devices to control steam distribution; (5) the development of temperature regulation devices for individual radiators, groups of radiators and entire heating installations; (6) the use of insulating materials; (7) the development of oil fuel combustion and the entry of gas fuel in competition with oil and coal; (8) the sharp trend towards electrification of control equipment.

The speaker explained a system developed in England where wall, ceiling and floor panels are being used and based on the recognized fact that heating systems should not be designed to give a certain temperature as much as to prevent the body losing its own heat too rapidly.

Humidifying radiators and the degree day system of computing heating requirements, as sponsored by the American Gas Association, were explained.

The chairman congratulated the speaker on his excellent paper and there followed a most interesting discussion. A vote of thanks was proposed by F. J. Friedman, M.E.I.C.

Ottawa Branch

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

Engineering Aims of the National Research Council

Dr. H. M. Tory, D.Sc., LL.D., F.R.S.C., President of the National Research Council of Canada, was the guest speaker at the noon luncheon at the Chateau Laurier on Thursday, March 17th. In the absence of the chairman, G. J. Desbarats, C.M.G., M.E.I.C., presided at the meeting. The following guests were also present at the head table: John Murphy, M.E.I.C., Group Captain Lindsay Gordon, A.M.E.I.C., Dr. E. S. Archibald, J. B. Hunter, J. G. Parmelee, T. W. Fuller, F. H. Peters, M.E.I.C., K. M. Cameron, M.E.I.C., Dr. G. S. Whitby, W. P. Dobson, M.E.I.C., of the Ontario Hydro-Electric Commission, Toronto.

Dr. Tory spoke upon the subject of "Engineering Aims of the National Research Council." He stated that the professions of the engineer and the man engaged in research were not very far apart.

He divided the field of research into three divisions: first, the understanding of nature; second, the study of nature in order to copy her methods; and third, the use and adaptation of the methods of nature to the development of processes of value to mankind, such as, for instance, in connection with chemical combinations.

During the first three-quarters of the nineteenth century there were only two kinds of engineering recognized, civil and military. Today engineering is divided into many different branches such as civil, mechanical, hydraulic, electrical, mining, chemical, etc. With regard to the last mentioned branch, namely chemical engineering, this has resulted in the development of many industries.

As yet the term biological engineer is not in extensive use although it has already entered the realms of agriculture.

In the field of organic chemistry much has already been accomplished but there is still a great field open for investigation.

Another feature which has characterized the past generation or so has been the rise of the great schools of science. Once there were no engineering schools in Canada and scientific men were not accorded much recognition in the eyes of the "intellectual" men of that time.

A few eminent men have distinctively combined the characteristics of the physicist and engineer; the late Lord Kelvin, and Sir Charles Parsons were examples. In these men there was exhibited an inborn tendency to seek after truth and to put it to the use of mankind, characteristics which are generally the attributes of separate individuals.

With regard to the National Research Laboratories much has been done in the matter of research in connection with engineering problems. The speaker here made reference to the building in course of erection which is to house the engineering laboratory, a laboratory which when fully equipped would be equal to anything of its kind in North America. With men of the proper type to carry on the work it was hoped to place engineering research on a firm and solid basis in Canada. In this connection Dr. Tory stated that it was ultimately hoped that at the head of this Department there would be placed an engineer of the very highest rank to look after its activities.

The plan of the Research Council during the past year has been in the realm of physics and chemistry respectively to have associated with it in an advisory capacity a committee including leading physicists and a committee including leading chemists in Canada. It was also hoped, and in fact initial steps had already been taken, to form a committee of eminent Canadian engineers in connection with the work of the Council.

Dr. Tory stated that it was his personal ambition for many years to do what he could toward putting Canada on a parallel in the matter of research with the other countries of the world. The next generation should be able to take its place in the forefront of progress along these lines and an organization such as The Engineering Institute of Canada could do a great deal to assist in this ideal. It is the desire of the National Research Council to work in harmony with all the organizations of the country and it asks for the sympathy, co-operation and help of all. "It has," stated Dr. Tory in conclusion, "no desire but to help all men who are trying to accomplish something which is worth while."

Contrasted Methods of Engineering Education

At the luncheon on March 31st, the speaker was Dean Augustin Frigon, D.Sc., M.E.I.C., Director General of Technical Education for the Province of Quebec, and Dean of L'Ecole Polytechnique, University of Montreal, the subject of his address being "Contrasted Methods of Engineering Education."

The meeting was presided over by C. McL. Pitts, A.M.E.I.C., chairman of the local Branch. In addition to the chairman and the speaker, the head table guests included J. E. A. Dubuc, M.P., Noulan Cauchon, A.M.E.I.C., Colonel A. E. Dubuc M.E.I.C., H. H. Ward, G. J. Desbarats, C.M.G., M.E.I.C., Dr. H. M. Tory, Hon. Alfred Duranleau, C. L. Burton, Georges Gonthier, C. A. Bowman, A.M.E.I.C., Lieut.-Commander C. P. Edwards, O.B.E., A.M.E.I.C., E. S. Rogers and J. E. St. Laurent, M.E.I.C.

From the student's point of view, the problem of engineering education, stated Dr. Frigon, is generally that of acquiring knowledge whereby he may be enabled readily to earn a living. So far as the employer is concerned the courses should give good practical training to the student and should be somewhat specialized. From the point of view of the nation there should be an adequate number of students turned out, so that the national requirements will be fulfilled both as to number and quality. The educator approaches the subject from the point of view that education is primarily for the purpose of imparting knowledge and that personal characteristics of the student vary and have to be taken into account when specialization is the object.

The speaker then outlined the features of the technical educational systems existing in various countries such as Canada, England, Germany, and referred in greater detail to the system at present in vogue in France.

In France twelve years is the period for primary school education. Then the secondary school provides for three years more, after which the student may branch off into any one of many divisions of college training. A list of the higher schools of education was given, some of which had their inception almost two hundred years ago and were of the very highest standing. In the French system of technical education the creative faculty is highly developed in the student, this contrasting with the practice in some other countries, where the system of technical education tends towards a standardization of the product. In the French system of technical education the courses are highly competitive, so that of a number taking a course of training a small proportion only might be awarded degrees of engineering, those with lower standing being given merely certificates as graduates. The creative type of mind produced by the French system encourages individualism. This, however, may have a fault, commented the speaker, in that such a mind might take too strongly the mathematical viewpoint, instead of the productive.

Dean Frigon believed that it would be impossible to apply the American system, where standardization seems to be the main feature, in France, or the French system in the United States. At the Ecole Polytechnique, University of Montreal, of which the speaker was Dean, the policy had been to steer a middle course between the two systems, taking the best out of each.

Peterborough Branch

W. F. Auld, Jr.E.I.C., Secretary.
A. R. Jones, Jr.E.I.C., Branch News Editor.

Electrical Layout of Hydro-Electric Power Stations

At the meeting of the Peterborough Branch of The Institute held on March 24th, 1932, Mr. T. R. Millar, of the Hydro-Electric Power Commission of Ontario, Toronto, addressed the Branch on the "Electrical Layout of Hydro-Electric Power Stations."

Mr. Millar discussed the various aspects which have to be considered in the design of the electrical portion of hydro-electric power stations. The two main requirements in the design of the station are the conservation of space and procuring an economical design. Mr. Millar discussed these factors with respect to the superstructure, the switchgear, layout, the station control room and the station service equipment. Some of the important new developments discussed in this connection were: umbrella type generators, metal clad switchgear, outdoor transformers and cutting down on waste space in the control room.

Judging by the discussion, this paper was very much appreciated. G. R. Langley and H. R. Sills, Jr.E.I.C., contributed some interesting comments on the design of station control and generators respectively.

Quebec Branch

Marc Boyer, S.E.I.C., Secretary-Treasurer.

Sur la Relativite

A un déjeuner-causerie de la Section de Québec, tenu au Chateau Frontenac le 25 janvier, Mr. Adrien Pouliot, I.C., Membre de la Société de Mathématiques de France et professeur à l'Ecole de Chimi de Québec, présentait, avec la compétence que lui connait le public québecquois, une intéressante causerie intitulée "En Marge des Théories d'Einstein."

Après un rappel des débuts du grand savant et des faits saillants de sa carrière, le conférencier exposa plusieurs aspects de la doctrine relativiste, dont il illustra les données par des exemples et des citations choisies qui ne manquèrent pas d'impressioner et les plus compétents et les humbles profanes en haute science mathématique.

Très complaisant par ailleurs, Mr. Pouliot sut ménager son auditoire, et de spirituelles reparties démentaient l'aridité que pouvait promettre, à la suite d'un repas, le titre d'une telle causerie.

De chaleureux applaudissements marquèrent la fin de cette intéressante causerie, et Mr. Pouliot, présenté par le président local, Mr. Hector Cimon, M.E.I.C., fut remercié en termes heureux par MM. A. R. Décary, M.E.I.C., et T. J. F. King, A.M.E.I.C.

A la table d'honneur, outre le président et le conférencier Mr. Pouliot, on remarquait MM. A. R. Décary, M.E.I.C., A. B. Normandin, A.M.E.I.C., Alex. Larivière, A.M.E.I.C., J. A. Duchastel, M.E.I.C., T. C. Dennis, A.M.E.I.C., Arthur Amos, A.M.E.I.C., J. H. E. Drolet, A.M.E.I.C., et A. G. Sabourin, A.M.E.I.C.

Trois Causeries

Lundi soir, le 8 février, la Section de Québec réunissait ses membres dans les salles de l'Hôtel de Ville. Le but de cette assemblée était de mettre en relief le groupe des jeunes ingénieurs de la Section de Québec, et le programme de la soirée comportait à cet effet trois brèves causeries par des membres locaux. Le président, Mr. Hector Cimon, M.E.I.C., présenta les conférenciers.

Avec comme titre de la première causerie, "Figures of Speech," A. M. Robertson, A.M.E.I.C., du Belle Telephone Co., exposa quelques problèmes sur la distribution et le contrôle des appels téléphoniques à Québec, et sur la répartition efficace du personnel, pour rencontrer la densité variable des appels aux différentes heures du jour. Un exposé du contrôle des appels "longue distance" fut particulièrement intéressant. Citons quelques chiffres mentionnés au cours de la causerie:

25,000 appareils téléphoniques en service à Québec,
195,000 appels par jour, soit 8 appels par station par jour,
80% des appels longue distance complétés pendant que l'aplant demeure aux écoutes.

La causerie suivante, donnée par Robert Wood, S.E.I.C., du Quebec Power Co., était intitulée "Operation of a Power System."

Le conférencier expliqua le fonctionnement d'une compagnie distributrice de pouvoir dans ses trois phases principales: génération, transmission et distribution. La Quebec Power Co. possède six stations génératrices formant un total de 43,325 h.p. En hiver, alors que la force motrice générée est minimum et que la demande est élevée, la compagnie achète du pouvoir de la Shawinigan Water and Power. Un fait notable sur lequel le conférencier attira l'attention est que durant l'année 1931, le pouvoir ne fut interrompu que durant 40 minutes. La discussion qui suivit la causerie fut fort intéressante et le conférencier fut longuement applaudi.

La dernière causerie, par Lionel Bizier, A.M.E.I.C., de la Commission du Hâvre de Québec, avait pour titre "Draguage et Sondages à l'Anse-au-Foulon." Du lit du fleuve, à l'Anse-au-Foulon, 6,000,000 de verges cubes de matériel furent enlevées depuis 1925 par deux dragues à succion et une drague à godets, qui opérèrent durant plus de 21,000 heures. Une profondeur de 40 pieds est maintenant assurée à marée basse. Les methodes employées pour exécuter les sondages furent ensuite décrites par le conférencier, qui fut chaudement félicité à l'issue de sa causerie.

A. B. Normandin, A.M.E.I.C., à titre de nouveau président de la Zone C de L'Institut, clôtura la séance par un compte-rendu de l'assemblée annuelle de l'Engineering Institute, tenue à Toronto récemment.

25e Anniversaire de Fondation

Lors d'un banquet tenu au Château Frontenac, le 22 février 1932, la Section de Québec fêtait son 25e anniversaire de fondation. Une trentaine de membres de la Branche assistaient. Parmi les invités d'honneur on remarquait le Dr. Arthur Surveyer, M.E.I.C. un ancien président de l'Institut et représentant officiel du Président, le Dr. Charles Camsell, M.E.I.C., le Dr. O. O. Lefebvre, M.E.I.C., vice-président, et R. J. Durley, M.E.I.C., secrétaire-général de l'Institut.

Hector Cimon, M.E.I.C., président de la Section de Québec, dans un joli discours, passa en revue les 25 ans d'existence de la Branche, et rappela le travail que s'étaient imposés les pionniers de l'association pour jeter les bases de l'organisation qui devait grandir jusqu'à nous. La Section de Québec, ajouta Mr. Cimon, s'est occupé en maintes occasions de présenter aux autorités provinciales des recommandations dont la Province a amplement fait son profit. Mr. Cimon pria ensuite Arthur Surveyer, M.E.I.C., de dire quelques mots. Le Dr. Surveyer encouragea les membres de la Section de Québec à continuer leurs brillantes activités, qui contribuent à maintenir le prestige de l'Institut et de la Profession, ce dont chacun bénéficie. O. O. Lefebvre, M.E.I.C., Ingénieur-en-chef de la Commission des Eaux Courantes de Québec, fut chargé de présenter à la Section de Québec, sa charte officielle. Mr. Lefebvre offrit à l'association locale ses félicitations, et fit remarquer que malgré le petit nombre de membres qui la compose, la Section de Québec égale en activités ses branches-sœurs des villes plus grandes. A. E. Doucet, M.E.I.C., l'un des membres fondateurs de la Branche, accepta la charte au nom de la Section de Québec, et ajouta quelques mots, rappelant les débuts de l'association. MM. A. R. Décary, M.E.I.C., et E. A. Evans, M.E.I.C., deux des membres fondateurs de la Branche, prirent la parole pour exprimer leur satisfaction de voir que l'organisation qu'ils avaient lancée il y a 25 ans ait put réaliser de si beaux progrès.

A. B. Normandin, A.M.E.I.C., nouveau vice-président pour la Zone C de l'Institut, et R. J. Durley, M.E.I.C., secrétaire-général, les deux orateurs suivants, furent vivement applaudis.

Quatre des treize membres fondateurs: A. R. Décary, M.E.I.C., A. E. Doucet, H. E. Huestis et E. A. Evans assistaient à ce dîner. Avaient pris place à la table d'honneur: MM. Hector Cimon, Président de la Section de Québec, Arthur Surveyer, M.E.I.C., ancien président de l'Institut, O. O. Lefebvre, M.E.I.C., vice-président, A. R. Décary, M.E.I.C., président honoraire à vie de la Section de Québec, R. J. Durley, M.E.I.C., secrétaire-général de l'Institut, Ivan Vallée, A.M.E.I.C., sous-ministre des Travaux Publics de Québec, E. A. Evans, M.E.I.C., A. E. Doucet, M.E.I.C., H. E. Huestis, A.M.E.I.C., et A. B. Normandin, A.M.E.I.C.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. G. Clark, S.E.I.C., Branch News Editor.

Through the courtesy of the Canada Cement Company, Limited, a series of lectures on Cement and Concrete were given before the Saint John Branch of The Engineering Institute of Canada from February 29th to March 4th. Lectures were given on four evenings by J. M. Portugais, A.M.E.I.C., technical engineer of the Canada Cement Company. The subjects covered by the lecturer included:

Fundamentals of Concrete.
Manufacture of Portland Cement.
Aggregates.
Manufacture of Concrete.
Curing of Concrete.
Design of Mixtures.
Tests of Cements and Concretes.
Quality Control in the Field.
Pavements.

The complete set of lectures in book form was presented to each person attending the lectures.

On the last evening of the series Mr. D. O. Robinson of the Canada Cement Company gave a demonstration covering various tests of sand and aggregates including: colorimetric tests of sand, sieving of aggregates, and bulking of sand. Two motion pictures were also given showing the manufacture of cement, and the laying of highways.

The lectures were well attended by members of the Branch and others interested, and a great many valuable points were brought out during the discussion following each lecture.

The total attendance was as follows:—Monday 57, Tuesday 75, Wednesday 59, Thursday 62, Friday 97.

Saskatchewan Branch

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

The Annual Meeting of the Saskatchewan Branch of The Engineering Institute of Canada was held in Regina on March 18th, 1932, when J. D. Peters, A.M.E.I.C., Moose Jaw, was elected chairman for the ensuing year.

Other officers elected were: vice-chairman, P. C. Perry, A.M.E.I.C., Regina; secretary-treasurer, Stewart Young, A.M.E.I.C., Regina; Executive, D. A. Smith, A.M.E.I.C., Regina; R. A. Spencer, A.M.E.I.C., Saskatoon, and J. M. Campbell, A.M.E.I.C., Moose Jaw; Auditors, J. McD. Patton, A.M.E.I.C., Regina, and E. W. Murray, A.M.E.I.C., Regina.

The meeting went on record as strongly favouring the extension of hydrometric surveys and passed a resolution urging upon the federal and provincial governments the extreme importance of continuing all hydrometric records where previously secured. Copies of the resolution are to be sent to the federal Minister of the Interior and to the Minister of Natural Resources of Manitoba, Saskatchewan and Alberta.

Approximately thirty-five members of the Branch attended. Entertainment numbers were contributed by F. Meeker, Messrs. Allsupp and Ross and members of the Roumanian Canadian Cultural Club. Miss Helen Matheson was accompanist.

How an Engineer Views the Present Depression

The main speaker was J. M. Campbell, A.M.E.I.C., division engineer of the Canadian Pacific Railway, Moose Jaw, who chose as his subject "How an Engineer Views the Present Depression." He based his talk largely upon the economic theories for the establishment of credit as outlined by Major C. H. Douglas.

A feature of the meeting was the presentation of past-president badges to H. R. MacKenzie, A.M.E.I.C., Regina, A. M. MacGillivray, A.M.E.I.C., Saskatoon, and Prof. W. G. Worcester, M.E.I.C., also of Saskatoon, by H. S. Carpenter, Deputy Minister of Highways. As Professor Worcester and Mr. MacGillivray were absent, the presentation to these two was made by proxy.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch held on February 26th was addressed by Mr. J. McDonald, of the Algoma Steel Corporation, who gave an account of the early development of metallurgy leading up to modern practice in steelwork. He described briefly the methods in use at the Algoma Steel Corporation. Following discussion, moving pictures were shown of the rolling of rails, rods, plates, etc. at the mills of the United States Steel Corporation.

At the March 18th meeting, Mr. C. E. Horton of the Bell Telephone Co. showed moving pictures of some of the main features of the telephone industry.

The following reels were shown:

1. Products in the manufacture of a desk telephone.
2. Course of the current to complete an ordinary telephone conversation.
3. "Voices across the Sea"—a Trans-Atlantic Call.
4. Telephone exchanges and methods in European countries.
5. Apparatus necessary for television.
6. More unusual uses of the telephone.

In conclusion, Mr. Horton remarked on the apparently unlimited future possibilities in telephony.

Vancouver Branch

W. O. Scott, A.M.E.I.C., Secretary-Treasurer.

South Fork Dam at Nanaimo, B.C.

On February 29th, 1932, a meeting was addressed by H. B. Muckleston, M.E.I.C., on the "South Fork Dam at Nanaimo, B.C."

This dam was designed by Mr. Muckleston for the Nanaimo waterworks system and incorporated several features which are radically different from the usual Canadian practice. It is the first example of the use of the Vogt system of differential pressure grouting for the correction of the secondary stresses of which a general outline was given in a paper by Mr. Muckleston, Trans. XXXVI, Page 439.

Attendance, 35.

Mechanical Stress Analysis of Indeterminate Structures

On March 8th, 1932, the Branch attended an address in the Applied Science building at the University of British Columbia by Professor A. H. Findlay, M.A.Sc., on "The Mechanical Stress Analysis of Indeterminate Structures."

Professor Findlay's paper was adequately illustrated by means of lantern slides and following the talk he gave a demonstration of Begg's Deformeter Apparatus applied to two model structures.

Discussions followed the address. Messrs. J. R. Grant, M.E.I.C., S. S. Hodgson, A.M.E.I.C., Honeyman and A. E. Foreman, M.E.I.C., complimented Professor Findlay on the paper and the admirable way in which it was presented. Attendance, 70.

An additional meeting was held on March 14th, 1932, in the Medical-Dental Building Auditorium to hear F. C. Knewstubb, A.M.E.I.C., chief engineer, Water Rights Branch, Provincial Department of Lands, Victoria, B.C.

Investigation of High Head Power Sites in B.C.

Mr. Knewstubb had chosen as his subject the "Investigation of High Head Power Sites in British Columbia," and gave a general survey of the work of his department in this connection, the information collected and the data compiled.

Messrs. R. C. Farrow and S. H. Frame, A.M.E.I.C., very ably assisted in giving further details of their respective parts of the general paper.

The paper was exceptionally well illustrated with lantern slide scale maps, relief maps and photos to give a conception of the type of country where the investigation was made. Mr. Knewstubb had presented this paper already to the Victoria Branch and it commanded such interest as to have editorial comment in the newspaper.

A very hearty vote of thanks was extended to the speaker and his assistants for coming over from Victoria to present the paper to the local Branch.

Attendance, 50.

Victoria Branch

I. C. Barltrop, A.M.E.I.C., Secretary-Treasurer.
Kenneth Reid, Jr.E.I.C., Branch News Editor.

A. G. Graham, A.M.E.I.C., city engineer of Nanaimo, delivered a most interesting paper before a well attended meeting of this Branch at Victoria on March 18th, dealing with the construction of the "Variable Radius Arch Dam on the South Forks of the Nanaimo River."

Variable Radius Arch Dam on the South Forks of the Nanaimo River

This dam, which was designed by H. B. Muckleston, M.E.I.C., was necessary to improve the water supply for Nanaimo and is unique in the province of British Columbia: as will be seen from the measurements which Mr. Graham gave, the section is extremely economical and it was brought out that by adopting this form of structure in place of the usual gravity section, the cost of the project was cut in two and the city was saved $100,000 thereby.

Owing to the nature of the structure, the highest class of workmanship was necessary and Mr. Graham praised the city council in having unreservedly placed their interests in the hands of the engineering profession.

Mr. Graham dealt with the events leading up to the decision to build the dam, referring to the several designs submitted and the adoption of Mr. Muckleston's design which provided for raising the head 71 feet above that of the old dam, the installation of 15-inch and 18-inch steel pipe, which will result in a discharge, on completion of the pipe line, of two million gallons per day.

A thorough geological examination was made of the walls and bed of the canyon by Dr. Victor Dolmidge, of British Columbia, following which, the site having been pronounced as safe, tenders were called and a contract let to the lowest bidder.

In addition to the building of the dam the works consisted of clearing the area to be flooded, which was heavily timbered, the building of a coffer dam to divert the water and the construction of a tunnel through rock, to serve the dual purpose of temporarily by-passing the water during construction and of acting as a conduit for the intake pipe which was set in concrete in the tunnel, the tunnel eventually being blocked except for the 24-inch intake. Aggregate for the concrete was obtained from the floor of the canyon which was stripped in preparation for foundations.

The contractor commenced work in the summer of 1930 and made good progress, but in the latter part of the year, very serious floods occurred which undid practically the whole of the work of the previous summer. Although labouring under some financial difficulty, the contractor, having obtained an extension of time, recommenced operations in the spring of 1931: profiting by his previous experience, he adopted different and more successful methods and by the end of June the canyon was unwatered, foundations to bed-rock being completed a month later.

Mr. Graham gave a highly interesting description of the actual construction of the dam, with full details regarding the form-work, the concrete-mix and the result of tests on the concrete.

The dimensions of the finished dam are as follows:—

Height from crest to lowest point in foundation	100 feet 2 inches
from crest to bottom of Canyon	84 feet
Thickness at the base (Elev. 730)	10 feet 6 inches
at Elev. 740	7 feet
at Elev. 820	3 feet
at Elev. 821.25 (crest)	5 feet
Length from tower to tower (length over crest)	166 feet 2 inches
Overhang of top of wall downstream on centre line	31 feet 5 inches
Radius of extrados at 730 Elev	64 feet 8 inches
of extrados at 820 Elev	97 feet 5 inches
Impounded water, approx	550 million gallons
Area flooded, approx	70 acres

An air-duct 24 inches in diameter was constructed in the crest with 6-inch outlets spaced at 10-foot intervals under the lip of the crest, the duct continuing vertically into towers at either end of the structure, this arrangement being provided to break the vacuum which otherwise would exist between the falling sheet of water and the structure.

A feature of special interest is the use, for the first time in B.C., of the "Vogt Patent Process of Differential Pressure Grouting," a process which is ably described in a paper by Mr. Muckleston appearing in the November 1930 issue of The Journal. Briefly, the object of the pressure grouting is to reduce or reverse the negative stresses in the arch by introducing compressive stresses prior to application of the live (or in this case "water") load, as for instance by cutting the arch at the crown and by driving a wedge from the intrados side, thus setting up compressive stresses which to some extent neutralize the opposite stresses which must occur when the live load is applied.

In the case under consideration, a vertical pocket was provided for the entire height of the dam at the crown on the down-stream side of the neutral axis and this pocket was filled with a 2 to 1 quick-hardening cement-sand grout under a mtaintained pressure of 30 pounds per square inch.

Many other details were given by Mr. Graham who concluded his paper by showing some seventy excellent slides, fully illustrating the job in all its stages.

The Branch was fortunate in having present, as a visitor, Mr. H. B. Muckleston, the designer of the dam, who very kindly dealt with the theoretical side of the design of this and similar structures and who answered many questions.

Major J. C. MacDonald, M.E.I.C. led the discussion and congratulated the speaker on his paper, at the same time pointing out many interesting features; a general discussion followed, members evincing keen interest in this novel and interesting structure.

The meeting was under the chairmanship of H. L. Swan, M.E.I.C., chairman of the Victoria Branch.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.

Herewith is a report of the regular meeting of the Winnipeg Branch held on March 3rd, 1932.

There were 46 members and visitors present according to the register, the chairman, T. C. Main, A.M.E.I.C., occupying the chair.

The minutes of the meeting of February 4th and of the Annual Meeting of the Branch were read and confirmed.

The report of the Supper-Dance committee was read by S. E. McColl, A.M.E.I.C., chairman of the committee.

Moved by S. E. McColl, seconded by E. W. M. James, A.M.E.I.C., that the report of Supper-Dance committee be adopted. Carried.

E. V. Caton, M.E.I.C., and Professor A. E. Macdonald, A.M.E.I.C., spoke to the motion and requested permission to add to the motion "that the thanks of the Branch be expressed to the Committee and to the ladies who had managed the decorations."

The mover and seconder agreeing, the addition was carried.

Moved by E. V. Caton, M.E.I.C., seconded by G. S. Roxburgh, A.M.E.I.C., that a standing Social Committee be appointed. Carried.

The chairman then introduced the speaker of the evening, E. N. Johnson, A.M.E.I.C., engineer of track, Canadian National Railways, who delivered an instructive address under the title "Detection of Hidden Defects in Steel Rails."

Detection of Hidden Defects in Steel Rails

In his address the speaker discussed briefly existing methods of detecting defects of internal origin in rail heads. These consist frequently of transverse fissures and give rise to failures in service which it is impossible to foresee unless some method of examining the rail in the track is employed. Three general types of apparatus have been proposed for this purpose depending on the use of X-rays, or on magnetic or electric observations. The thickness of metal in a rail can only be penetrated by very powerful X-ray apparatus, and in any case X-ray methods require laboratory examination and are therefore useless for track work. The magnetic devices which have been tried depend on the change in magnetic permeability of the rail, which, however, is very slightly affected by transverse fissures which have practically no air gap at all. Magnetic methods therefore have so far been comparatively unsuccessful.

As an example of the successful application of electric methods Mr. Johnson described the theory and operation of the Sperry detector. This equipment depends for its operation upon the fact that an electric current flowing along the rail is compelled to pass around a fracture, inclusion or separation in the metal, so that at these points the magnetic lines of force surrounding the defective rail are disarranged. If an inductive pick-up device mounted directly over the rail head passes along the rail no electromotive force will be generated in the case of sound rail where the magnetic flux surrounding the rail is uniform, but at a fissure the magnetic flux is different and this results in a generated potential at the terminals of the pick-up. This change in electromotive force can be amplified and recorded in an autographic apparatus, thus furnishing an automatic record of the rail condition as the apparatus passes along the track.

Mr. Johnson concluded his address by an interesting description of the Sperry self-propelled signal unit detector car, its equipment, operation, and the results obtained. The current flowing along the rail under examination is as a rule from 2,000 to 3,000 amperes, and at any point where a defect is indicated by the recording apparatus the car is stopped and a more detailed examination made at the location of the defect. The car has a 50-h.p. power plant and can examine both rails while proceeding at about five miles per hour.

At the close of the address discussion took place, among those taking part being Messrs. J. F. Cunningham, Affil.E.I.C., G. H. Herriot, M.E.I.C., C. T. Barnes, A.M.E.I.C., H. L. Briggs, A.M.E.I.C., J. T. Rose, A.M.E.I.C., J. M. Morton, A.M.E.I.C.

A vote of thanks moved by J. M. Morton, A.M.E.I.C., seconded by J. W. Sanger, A.M.E.I.C., was carried with much applause.

New Power Plant Opened in Russia

On May 1st, power began to flow at Dnieprostroy, Russia, when what is intended ultimately to be the world's largest hydro-electric plant was given its first official trial, states an article appearing in the Montreal Gazette. The current was turned on merely as a test "formal opening" as power for the actual use in this area will not be transmitted until August 1st. Designed and built by foreign engineers and equipped with foreign machinery, the plant is destined to supply electric energy to an area of 70,000 square miles and a population of 16,000,000, including the important Donetz coal basin and the great metal works of Dnieproprovsk now being constructed nearby. When completed it will have a generating capacity of 756,000 h.p. with an annual production of 2,500,000,000 kw. hours. It represents an investment of 220,000,000 roubles (nominally $110,000,000) and it will be finished in all its units during the spring of next year.

Canadian General Electric Company, Ltd., Toronto, announces a new floodlight, the "Senior," which is designed for general-utility floodlighting, and employing a 200-watt incandescent lamp. Offered as a supplement to the 100-watt handy floodlight projector, the new "Senior," smaller and less expensive than the standard floodlighting projectors, is expected to find new uses on farms and estates, in households, in and around garages, at wayside road stands, and in other uses where light requirements do not necessitate the larger, standard floodlighting units. Giving double the amount of light obtained from the smaller 100-watt floodlight, it will fulfill requirements where a higher intensity of illumination is desired. The new "Senior" weighs approximately six pounds, measures less than 15 inches in height with its supporting stand, and has a depth of 12½ inches from the centre of the lens to the tip of the lamp holder. The diameter of the special heat-resisting lens measures 10 inches.

Preliminary Notice

of Applications for Admission and for Transfer

April 23rd, 1932

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, 1932.

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

DAVIS—CLINTON HAROLD, of 5608 St. Urbain St., Montreal, Que., Born at The Gore of Lochaber, Co. Labelle, Que., Feb. 1st, 1908; Educ., 1922-25, grad., Montreal Technical School; 1930-31, evening matric. course, and 1931-32, evening science course, Sir George Williams College, Montreal; 1925-29, took Bell Telephone Company's student course in plant dept., served as inspr. most of the time; 1929-30, engrg. lab. asst., testing high freq. carrier equipment and special telephone apparatus, and 1930 to date, estimating engr., (prices for toll and carrier equipment), Northern Electric Co. Ltd., Montreal, Que.
References: A. J. Lawrence, B. B. Shier, H. C. Nourse, W. H. Jarand, W. N. McGuinness, W. V. Cheshire.

HORSPOOL—GIFFORD, of Seebe, Alta., Born at Galesburg, Ill., U.S.A., May 26th, 1897; Educ., Technical Institute, Calgary, 1918-20; I.C.S.; 1915-16, electr'n., Star Electric Co.; 1916-19, telephonist, C.F.A.; with Calgary Power Company, Ltd., as follows: 1920-25, operator; 1925-26, asst. chief operator; 1926-27, chief operator; 1927 to date, plant supt.
References: G. H. Thompson, B. Russell, A. W. P. Lowrie, H. J. McLean.

HUTCHISON—DAVID, of Montreal, Que., Born at Owen Sound, Ont., July 31st, 1892; Educ., B.Sc. (Honours), Queen's Univ., 1924; 1919-24, with the Foundation Co. of Canada as diver on various jobs; 1924-26, with same company as diver doing underwater inspections and reporting on four C.P.R. bridges in Quebec. Also field engr. on Gatineau Storage-Baskatong Reservoir. Also asst. supt., Anticosti job; Dec. 1926 to date, with Power Corporation of Canada, engrg. studies on Back River, Quinze Extension, and Upper Notch hydro developments, Quinze-Rouyn and Upper Notch-Quinze transmission lines. In direct charge as constrn. supt. of all field work on the above jobs, except one year as res. engr. on Quinze extension.
References: J. S. H. Wurtele, L. C. Jacobs, R. E. Chadwick, J. E. Beatty, O. O. Lefebvre.

JOHNSTON—JAMES HOMER, of Peace River, Alta., Born at Brampton, Ont., Aug. 23rd, 1887; Educ., 1907-10, three years course in Mining Engrg., Queen's Univ.; D.L.S., A.L.S.; 1908, levelman on constrn. Detroit river tunnel; 1910-11-12, supervising constrn. concrete bridges, Essex County, Ont., asst. on Dom. Land Surveys; 1913-14, contractor on Dom. Land Surveys; 1915-18, D.L.S. in charge of surveys in Alberta Peace River District; 1919-22, private practice, public works in municipalities; 1923-25, res. engr. on highway constrn., and 1926 to date, district engr. in charge of public works constrn. for Dist. No. 10 (Peace River District), for Public Works Dept., Prov. of Alberta.
References: A. W. Haddow, F. H. Kitto, T. W. Brown.

KREBSER—LOUIS E., of Toronto, Ont., Born at Aachen, Switzerland, April 1st, 1890; Educ., Left High School in 1907, and attended Technical School in Aachen and later the Bautechnicum in Burgdorf, filling in between with practical work in architects' offices in Germany and Switzerland; May 1913, joined the staff of Painter & Swales, Architects, Montreal, later with Nobbs & Hyde until 1917. 1918-30, with Ross and Macdonald, Architects, in engrg. dept. For the last ten years supervised the design and layout of some of the largest bldgs. in the country, writing specifications, checking drawings, etc.; Dec. 1930 to date, managing Toronto office of W. J. Armstrong, M.E.I.C. (formerly with Ross and Macdonald).
References: W. J. Armstrong, J. A. Kearns, P. Ackerman, J. B. Bladon, K. R. Rybka, A. H. Harkness.

LaPLANT—JOHN FREDERICK, of Simcoe, Ont., Born at Cornwall, Ont., Sept. 26th, 1888; Educ., Passed prelim. exam. O.L.S. Member, Assn. Prof. Engrs. Ont.; 1912, asst. engr., county and township bridge constrn., drainage work, etc., County of Norfolk and Town of Simcoe; 1913, asst. engr., sewage disposal plant, pumping stn., etc., Town of Simcoe; 1914-23, res. engr. for Town of Simcoe, sanitary sewer constrn., roadway constrn., highway bridges, etc.; 1921, asst. engr. to G. R. Marston, A.M.E.I.C., on constrn. of Strauss Bascule Bridge at Port Dover, E. H. Darling, M.E.I.C., consltg. engr.; 1924-29, with Russell A. Murdoch, now Pate, Hamann & Kern, consltg. engrs., Detroit, Mich., designing and constrn. supervision for water system, wells, pump house and elevated tank, trunk and lateral sewers in open cut and tunnel, concrete paving, curbing, storm sewers, and concrete sidewalks for Berkley, Mich.; 1929-31, engr., estimator and constrn. supervisor on tunnel and open cut sewers, water mains, concrete reservoirs and gen. contracting, for Thos. D. Nolan, Contractor, Detroit, Mich. At present, general municipal work for Town of Simcoe.
References: G. R. Marston, A. L. S. Nash, E. H. Darling, H. A. Lumsden, F. H. Midgley, F. P. Adams.

LAWSON—HORACE HETHERINGTON, of Kingston, Ont., Born at Toronto, Feb. 2nd, 1889; Educ., Grad., R.M.C., 1910. O.L.S.; 1910-12, 1913-14, hydrographic survey; 1912-13, survey, Port Nelson; 1917 to date, associate professor of surveying, Royal Military College, Kingston, Ont., 1919 to date, also in charge of courses in mechanics of materials, graphic statics, mech'l. drawing.
References: L. F. Grant, W. P. Wilgar, E. J. C. Schmidlin, A. Macphail, D. M. Jemmett.

NEIL—JOHN STUART, of 744 Crescent Road, Calgary, Alta., Born at Gourock, Renfrewshire, Scotland, Feb. 1st, 1907; Educ., B.Sc. (C.E.), Univ. of Alta., 1930; 1924-25, rodman on drainage work on irrigation project of C.P.R. at Brooks, Alta.; 1925-27, instr'man. on above project; 1927-31 (except school sessions), design of reinforced concrete with Truscon Steel Co. of Canada, Calgary; 1931 to date, designing, dfting. and gen. munic. engrg. work, city engineer's office, Calgary, Alta.
References: A. S. Chapman, J. R. Wood, V. A. Newhall, A. Griffin, R. S. L. Wilson.

PETURSSON—HANNES J., of 123 Home St., Winnipeg, Man., Born at Foam Lake, Sask., Oct. 24th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1930; 1930-31, course at Univ. of Man. in secondary stresses and indeterminate structures; 1928 (June-Sept.), rodman, Man. Good Roads Dept.; 1930 (May-Sept.), instr'man., on constrn. of Slave Falls power plant; 1929 (May-Sept.), res. engr., Man. Good Roads Board; July 1931 to date, res. engr., Dept. of Northern Development, Dryden, Ont.
References: J. N. Finlayson, G. H. Herriot, W. H. Hunt, R. W. Moffatt, E. C. Cowan.

RUTHVEN—FREDERICK FRANCIS, of 12 Ellis Park Road, Toronto, Ont., Born at Quebec, Que., Feb. 25th, 1898; Educ., 1911-14, Toronto Technical School; Evening classes, Toronto Tech. Sch., Harbord Collegiate, and Corres. Course in engrg.; 1914-15, junior in arch'ts. office; 1915-18, junior in dfting dept., Northern Aluminum Co., Toronto; 1918-20, C.E.F.; 1926-28, chief dftsman., and 1928-29, asst. master mechanic, Aluminum Company of America; 1920-26, tool designer and dftsman., and 1929 to date, plant engr., Aluminum Co. of Canada, Ltd., Toronto, Ont.
References: M. N. Hay, J. W. Schreiber, T. M. Moran. H. R. Wake, J. W. Ward, G. K. Waterhouse.

TURNBULL—DONALD ORTON, of Rothesay, N.B., Born at Rothesay, N.B., Aug. 6th, 1905; Educ., Grad., R.M.C., 1929; 1928 (2 mos.), R.C.E., Petewawa, Ont.; 1930 (5 mos.), Candn. Hydrographic Survey, Saint John River; Nov. 1930 to date, field engr., Foundation Co. of Canada Ltd., at present, power house engr., Masson power development.

References: H. M. Jaquays. H. V. Serson, M. A. MacKinnon, E. J. C. Schmidlin, L. F. Grant, J. L. H. Bogart, O. T. Macklem.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

CLARKE—JOHN LEONARD, of 124-44th Ave., Lachine, Que., Born at Birmingham, England, Oct. 31st, 1887; Educ., B.Sc., London Univ., 1909; 1910 to date, with Bell Telephone Company of Canada as follows: 1910-12, plant constrn., 1912-16, divn. plant inspr., 1916-20, asst. engr., outside plant divn., engrg. dpt., 1920-24, foreign wire relations engr., 1924-29, transmission engr., and 1929 to date, transmission and foreign wire relations engr. (*A.M. 1922*)

References: R. V. Macaulay, W. C. Adams, C. P. Edwards, A. Lariviere, J. H. Thompson, J. H. Trimingham, C. V. Christie, P. F. Sise.

HARVEY—DAVID WILLIAM, of 10 Shorncliffe Ave., Toronto 5, Ont., Born at London, Ont., Feb. 24th, 1887; Educ., B.A.Sc., Univ. of Toronto, 1910; Summer work: 1906, T. & N.O. Rly.; 1907, inspr., Terminal Bldgs., North Bay; 1908, G.T.R., shop constrn., Stratford; 1909, asst., D.L.S. party, western Alta.; 1910, Ontario Power Co., Niagara Falls, Ont.; 1910-11, dfting and erection, Toronto Structural Steel Co.; 1911-21, City of Toronto, Dept. of Works, in immediate charge of constrn. and operation of the civic street rly. system which became a part of the Toronto Transportation Commn.'s system on Sept. 21st, 1921, when that Commn. assumed control of local transportation; 1921-24, asst. mgr., and 1924 to date, gen. mgr., Toronto Transportation Commission, Toronto, Ont.; 1927 to date, President, Gray Coach Lines, Ltd. (*S. 1909, A.M. 1914.*)

References: E. L. Cousins, E. G. Hewson, G. G. Powell, G. W. Rayner, N. D. Wilson.

LARIVIERE—ALEX., of Quebec, Que., Born at Lotbiniere, Que., Jan. 26th, 1891; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1913; Degree of E.E., granted in May 1916, after post-graduate course; Summer work, 1910, bridge constrn., Phoenix Bridge & Iron Works; 1911, surveying, munic. and gen. engrg. work, Beique & Charton, consltg. engrs., Montreal, also wharf constrn., for Dept. Public Works, Canada, Quebec Distr.; 1912, same as above with deGaspe Beaubien, M.E.I.C., and Dept. Public Works; 1913 (May-June), asst. engr., elect'l. dept., Montreal Harbour Commission; 1915-16, engr. for W. Prenovost, road contractor; with Prov. Roads Dept., Quebec, as follows: 1913-14, engr., 1914-15, in charge of constrn. of central section, Montreal-Quebec Highway; 1916-18, in charge of road mtce. work; 1918-19, district engr., Quebec; 1919-20, in partnership with J. J. Seguin, elect'l. contracting work; 1920-22, in partnership with Edouard Hamel, as consltg. engrs.; 1916-22, engr., 1922-31, chief engr., and from July 1931 to date, Member of Quebec Public Service Commission, Quebec, Que. (*S. 1910, Jr. 1914, A.M. 1917.*)

References: A. R. Decary, O. O. Lefebvre, A. Frigon, A. Fraser, A. B. Normandin, H. Cimon.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BLUE—ALBERT CRAWFORD, of 94 Heddington Ave., Toronto, Ont., Born at Dutton, Ont., Aug. 5th, 1898; Educ., B.A.Sc., Univ. of Toronto, 1921; 1923 (Mar.-Sept.), foreman, gear shaper dept., Detroit Gear & Machine Co.; Sessions 1923-24, 1924-25, demonstrator in mech'l. engrg., Univ. of Toronto; 1924 (May-Sept.), test engr., Dominion Canners Ltd.; May 1924 to date, with Riley Engrg. & Supply Co. Ltd., as follows: 1925 (May-Dec.), asst. engr., 1925-28, asst. chief engr., and Sept. 1928 to date, mgr., works and engrg. (*S. 1920, Jr. 1927.*)

References: E. A. Allcut, W. T. Brickenden, W. S. Wilson, R. E. Smythies, D. F. Grahame, W. G. Chace.

FOR TRANSFER FROM THE CLASS OF STUDENT

FRASER—WILLARD BRUCE, of 4366 Wilson Ave., Montreal, Que., Born at Deney, Idaho, U.S.A., Dec. 15th, 1904; Educ., B.Sc. (E.E.), McGill Univ., 1927; 1927-28, test course, General Electric Co., Schenectady, N.Y.; June 1928 to date, gen. engrg. work, engrg. dept., Canadian Industries Ltd., Montreal. (*S. 1925.*)

References: L. deB. McCrady, I. R. Tait, H. C. Karn, A. B. McEwen, W. H. DeBlois, C. V. Christie.

MOLLEUR—GERALD OVILA, of 105 St. Cyrille St., Quebec, Que., Born at Montreal, Que., Jan. 14th, 1904; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1924; 1923-29, with Quebec Streams Commission for various periods totalling 41 months, as instr'man., in charge of topog'l. surveys and soundings, res. engr. office work, etc.; 1919 (4 mos.), rodman, C.N.R.; 1924-25 (9 mos.), National Research Council, Bursary, study of "Dielectric Losses"; 1927-28, engr. with Quebec Pulp & Paper Mills Ltd., projects, estimates, surveying; June 1931 to date, with the Quebec Streams Commission. (*S. 1924.*)

References: O. O. Lefebvre, S. F. Rutherford, A. Frigon, A. Duperron, P. E. Bourbonnais, L. A. Dubreuil.

MOORE—LEWIS NICHOLAS, of 355C Elgin St., Ottawa, Ont., Born at Leeds, England, Oct. 9th, 1904; Educ., B.Sc., McGill Univ., 1927; 1923-25 (summers), gen. shop experience, Can. National electric lines car shops, St. Catharines, Ont.; 1926 (July-Sept.), dfting. and elect'l. equipment repairs, Montreal Armature Works, Montreal; with the Bell Telephone Company of Canada as follows: 1927-28, asst. to divn. equipment engr., supervision of installn. and mtce. power equipment; 1928-30, asst. to divn. transmission engr., Montreal, designing and estimating trunk cable facilities; Dec. 1929 to date, asst. to divn. equipment engr., Ottawa, estimating, supervision of installn. and mtce. of manual and power equipment, and design of special circuits in connection with above. (*S. 1927.*)

References: J. A. Loy, R. M. Richardson, A. M. Mackenzie, C. V. Christie, E. W. Oliver.

MULLIGAN—HENRY L., of 3550 Shuter Street, Montreal, Que., Born at Dunsford, Ont., Jan. 13th, 1904; Educ., B.Sc., McGill Univ., 1926; 1925, topog'r. on townsite survey; 1926-27, chief of topographers, Lake St. John Industrial Survey; 1927-30, chief dftsman., Nashwood Pulp & Paper Co.; 1930-32, asst. engr., Crepeau & Hunter, consltg. engrs., Montreal. (*S. 1926.*)

References: H. G. Hunter, K. S. LeBaron, R. E. Jamieson, C. B. Bate, P. G. Gauthier.

SANDERSON—EDWARD L., of 97 Empress Ave., Willowdale, Ont., Born at Brockville, Ont., Oct. 13th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1928; 1927 (summer), and May 1928 to May 1929, dftsman and instr'man., and May 1929 to date, asst. engr., Township of North York. (*S. 1928.*)

References: A. E. K. Bunnell, J. Hvilivitzky, A. V. Delaporte, W. L. Dobbin, J. J. Spence, W. L. Sagar, G. L. Berkeley, H. A. Babcock.

FOR TRANSFER FROM THE CLASS OF AFFILIATE

EVANS—HERBERT GEORGE, of 69 Quebec St., Sherbrooke, Que., Born at London, Ont., July 15th, 1886; Educ., 1903-10, ap'ticeship in machine shop of E. Leonard & Sons, Saint John, N.B., manufacture and repair of steam engines and boilers, gasoline engines, sawmill and transmission mach'y. During ap'ticeship studied engrg. and drafting; 1911, passed exam. and recd. 1st Class Engineer's License, Prov. of Man.; 1910-13, district engr. for E. Leonard & Sons, Winnipeg, Man., designing and installing steam heating and power plants, including Sask. Parliament Bldgs., steam power plant for Finger Lumber Co., Le Pas, Man., etc.; 1913-14, installed 175 KVA steam electric power plant for Town of Humbolt, Sask., under direction of Chipman & Power, Consltg. Engrs., Toronto. Operated same for two months until taken over by owners; 1915-17, with T. McAvity & Sons, Saint John, N.B., as supt. and engr. in charge of designing and equipping 4.5 shell plant. After completing design and equipping above plant, operated it for two years (1917-19). Then transferred to the 9.2 shell plant being built by same company as night supt. in charge of installn. and operation; 1920, designed and installed oil-burning equipment on Dredge "Tornado," 3,600 H.P.; 1920, designed and installed oil burning equipment for Saint John Dry Dock & Shipbldg. Company's power house, 4,000 H.P.; 1920-27, with Canadian Ingersoll-Rand Co. Ltd., as New Brunswick sales representative and engr., engaged in engrg., sales and installn. 1928 to date, branch manager of Sherbrooke territory of same company, in charge of selling and installn. of pulp and paper mach'y., centrifugal pumps, condensers, mining hoists, mining mach'y. and air compressors. (1927 Member, Assn. Prof. Engrs. N.B.), (*Affiliate 1923*).

References: J. Stephens, H. V. Haight, E. G. Cameron, E. Winslow-Spragge, A. A. Bowman.

According to the report of the International Nickel Company of Canada, Ltd., for the year ended December 31st, 1931, nickel products more than retained their relative industrial position as judged by certain comparable industrial indices. Thus, the 1931 consumption of nickel in its largest market, the United States, amounted to 160 per cent of the average for the years 1920 to 1922, and to 85 per cent of the average for the years 1926-1927, whereas the similar figures for automobile and truck production in the United States during the same years were 115 per cent and 60 per cent, and those for the steel ingot production 80 per cent and 55 per cent respectively. Sales of nickel in all forms, including nickel in alloys, amounted to 55,739,047 pounds, compared with 75,284,352 the previous year. The world's consumption of nickel in all forms aggregated 73,000,000 pounds as compared with 88,000,000 in 1930 and 136,000,000 in 1929. Sales of monel metal, a product made direct from Creighton ore, totalled 13,158,745 pounds, as compared with 18,961,706 in 1930. Sales of rolled nickel were 4,084,084 pounds. Copper sales decreased from 109,743,747 pounds to 96,919,677. Gold sales were 23,384 ounces; silver sales, 822,983 ounces, and sales of the platinum metals, 51,585 ounces.

The report points out that although the amount of nickel cast iron produced in 1931 was less than in 1930, the amount of nickel used in cast iron per ton of iron castings produced increased by about 20 per cent. It is also shown that increased sales of nickel anodes in the United States in 1931 reflected the continued trend of recent years in the more scientific utilization of nickel and chromium-on-nickel plating, and the practice of employing heavier nickel coatings. Nickel-copper condenser tubes, introduced in England and spreading to Europe, made their first important appearance in the United States during 1931. Nickel-clad steel plate, a rolled steel plate having a nickel coating on one or both sides, has been successfully introduced into several fields, such as storage tanks and tank cars, evaporator bodies, chemical autoclaves, kettles, etc.

Figures published by the Southern Railway Company, says an item in *Engineering*, indicate how standardization has reduced the number of items in the articles carried by their Stores Department. The types of bolts, nuts and rivets stored, for instance, have been reduced from 4,317 to 1,105, a decrease of 74 per cent. Bricks and earthenware-pipe items have been cut down by 92 per cent, namely, from 640 to 51. Corresponding figures for electrical fittings show a reduction from 3,109 to 720 or 77 per cent; for gas and water fittings, from 2,741 to 330, or 88 per cent; for implements and tools, from 2,078 to 592, or 72 per cent; and for nails, screws and cotter pins, from 2,677 to 900, or 66 per cent.

The new bronze and iron foundries just completed by Jenkins Bros· Limited, at Lachine, were opened on April 6th and 7th, and the firm is to be congratulated on the completion of a new enterprise at a time when industrial expansion is becoming somewhat of a rarity. Over 93 per cent of all materials and equipment used in constructing this new plant were produced in Canada.

The main building is approximately 244 feet wide by 255 feet, one storey in height, and of modern fireproof construction. The roof lighting has been provided by monitors, and special attention has been given to light, heat and ventilation. The heavy iron foundry is in the western section of the building, and is provided with a 15-ton 40-foot span craneway running its full length, while the bronze foundry is placed in the east section of the building. The whole plant is heated by low-pressure steam, both direct radiation and unit heaters being used, and very complete provision has been made for the comfort, convenience, and cleanliness of the foundry workers. Electric power is furnished from the Lasalle station of the Montreal Light, Heat and Power Consolidated, the supply entering the plant at 12,000 volts.

The transformer equipment consists of three 200-kv.a. 12,000- to 575-volt transformers and a motor driven generator set of 35 kw. provides the direct current necessary for the operation of cranes, magnetic separators, etc. A 150-kv.a. electric furnace operated at approximately 90 volts is now installed, and provision has been made for two additional furnaces of the same capacity.

Great attention has been paid to arrangements for the rapid handling of materials from the cars on the siding into the raw material bins and to the cupolas and bronze melting furnaces, for making cores and moulds, and for handling the finished castings.

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SALES REPRESENTATIVE. Eastern sales organization wishes to open negotiations with individuals or engineering equipment houses with a view to arranging connections in the province of Ontario. In reply give full particulars as to lines now handled, experience, etc. Apply to Box No. 809-V.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

MECHANICAL ENGINEER, Jr.E.I.C. Univ. Toronto '22. A.A.S.M.E. Diversified experience, one year teaching, three years Canadian Westinghouse Co., past four years in charge of mechanical laboratory of leading manufacturer in U.S.A. Sound technical knowledge and good organizing and executive ability. Wishes to return to Canada. Position with industrial or commercial laboratory. Apply to Box No. 138-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. At present employed. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, B.A.Sc., C.E. of Toronto, P.E. of N.B., desires employment. Experience includes three years on highway pavements, six years on city pavements and bridges, as well as general municipal engineering, two years on railway construction, four years on mining, assaying and drainage work. At present near Saint John, but willing to go anywhere. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing or sales organization. Apply to Box No. 334-W.

CIVIL ENGINEER, A.M.E.I.C., married, thirty years experience in municipal engineering, highway and pavement work, also qualified sanitary engineer. For the past twenty years engaged as construction engineer on large works, including buildings, sewerage and water systems. Experienced executive and up-to-date methods used. Permanent position desired as engineer or superientendent. Location immaterial. Available at once. Apply to Box No. 336-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available immediately. Qualified Captain in military engineering. Apply to Box No. 377-W.

FILTER PLANT ENGINEER, B.Sc. (Honours Civil Engineering and Hydraulics), recently resident engineer on filter plant construction, finally in charge of operation, desires similar position. Experience of control of chemical treatment and knowledge of water analysis, running testing and adjustment of waterworks equipment. Can do laboratory work. Apply to Box No. 395-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and movable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 29, married; experience over the last nine and a half years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations of hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial, available at once. Apply to Box No. 477-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.Q., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in mining, pulp and paper industries, seeks association with manufacturer as designer and sales engineer. Holds some patents on machinery for trade. Apply to Box No. 633-W.

ELECTRICAL GRADUATE, McGill '30, S.E.I.C., with thirteen months experience on Gen. Electric test course, twelve months draughting and five months as instrumentman on power plant construction. Location immaterial. Apply to Box No. 644-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931, N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C., Experience: Installation staff Can. Gen. Elect.; student's test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years' experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

Situations Wanted

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, A.M.E.I.C., Canadian. Fifteen years experience since graduation, manufacturing, testing, erecting and operating electrical equipment of all kinds. Six years power house and substation design and layout. Thoroughly familiar with automatic and supervisory control equipments, and industrial control. Available immediately. Anywhere in Canada. Apply to Box No. 681-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available on short notice. Apply to Box No. 692-W.

ELECTRICAL ENGINEER, B.Sc. '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experienced in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (University of Alberta, '31), S.E.I.C., single, age 24. Experience consists of lumber manufacturing, chainman on subdivision survey, transitman on railway maintenance and assistant on highway right-of-way surveys. Available immediately for position anywhere. Apply to Box No. 724-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

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CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc. (Univ. of Man. '31), age 22. Experience includes two months surveying and two summers draughting maps and treated timber bridges with highway department. Interested in manufacture of electrical equipment, water power engineering, radio and telephone, highway engineering. Available on one month's notice. Apply to Box No. 747-W.

MINING ENGINEER, university graduate '30. Experienced in surveying, mapping, assaying, examination of prospects, diamond drilling and a season on Dominion Geological Survey. Employed at present but available on short notice. Apply to Box No. 748-W.

SALES ENGINEER, BSc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available shortly. Apply to Box No. 749-W.

CIVIL ENGINEER, M.A. (Cantab.), A.M.Inst. C.E., A.M.E.I.C. Age 27. Unmarried. Three years experience on hydro-electric construction, tunnels, dams, penstocks, etc., geodetic and general surveying. Three years experience on design of hydro-electric structures and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 751-W.

CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.), D. and S.L.S. Age 28. Available May 15th to September 15th. Will consider any offer for above period. Ten years experience in highway, drainage and railroad engineering; surveying of all types; sewerage and waterworks design; sales and newspaper work. Owns a car and has a thorough knowledge of prairie provinces. Apply to Box No. 760-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate '23, A.M.E.I.C., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box 770-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monumental and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

ELECTRICAL ENGINEER AND AVIATION PILOT, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

The Corporation of Professional Engineers of Quebec Annual General Meeting

Dr. A. R. Decary, M.E.I.C., superintendent engineer for the province of Quebec at the Department of Public Works of Canada, was re-elected for the thirteenth time president of the Corporation of Professional Engineers of Quebec on Wednesday, March 30th, 1932, at the annual general meeting, which was held at the headquarters of the Engineering Institute of Canada.

The following engineers attended the meeting: Messrs. R. J. Durley, M.E.I.C., B. Grandmont, A.M.E.I.C., A. R. Decary, M.E.I.C., J. M. Robertson, M.E.I.C., O. Graham, C. E. Olive, G. J. Papineau, A.M.E.I.C., M. Cailloux, K. B. Thornton, M.E.I.C., Paul Seurot, M.E.I.C., W. McG. Gardner, A.M.E.I.C., A. B. Normandin, A.M.E.I.C., W. E. Lauriault, A.M.E.I.C., P. L. Pratley, M.E.I.C., C. N. Monsarrat, M.E.I.C., O. O. Lefebvre, M.E.I.C., A. R. Sprenger, M.E.I.C., A. Lariviere, A.M.E.I.C., Gabriel Hurtubise, E. A. Ryan, M.E.I.C., M. Prevost, H. Labrecque, Walter Clerk, Hector Cimon, M.E.I.C., Adrien Barrette, A.M.E.I.C., J. T. Farmer, M.E.I.C., H. W. B. Swabey, M.E.I.C., J. E. Gibault, L. C. Dupuis, A.M.E.I.C., J. J. Richardson, A.M.E.I.C., D. C. Tennant, M.E.I.C., W. C. MacKinnon, C. J. Desbaillets, M.E.I.C., C. K. McLeod, A.M.E.I.C., M. R. Robichon, Charles Taschereau, H. Massue, A.M.E.I.C., J. Comeau, A.M.E.I.C., David E. Manny, J. A. McCrory, M.E.I.C., Fraser S. Keith, M.E.I.C., F. B. Brown, M.E.I.C., A. Duperron, M.E.I.C., Geo. K. McDougall, M.E.I.C., F. A. Combe, M.E.I.C., J. H. Hunter, M.E.I.C., S. F. Rutherford, A.M.E.I.C., A. Mailhiot.

Frederick B. Brown, secretary-treasurer, read the reports from the Council, the treasurer, and the different committees of the Corporation for the past year; all these reports show a great activity within the Corporation which is doing efficient work in the way of protecting its members.

The treasurer's report shows a surplus for the year 1931.

The members present took part in the discussions of several questions of general interest to the engineering profession. It has been decided to prepare a by-law by which the members of the Corporation would be authorized to have a seal with which they may stamp all official estimates, specifications, reports, documents and plans. The use of the seal would be optional. The seal would be obtainable only through the Council of the Corporation at the expense of the applicant.

The committees which had been nominated at the last annual meeting, to study the possibilities of improving the charter of the Corporation, and to deal with publicity about the engineering profession, were renominated for another year after a few additions had been made to these committees.

The question was put up to the meeting whether it is more advisable to have the general meeting of the Corporation during the day or the evening. The majority declared itself in favour of meetings during business hours of the day in order to permit members residing out of Montreal to attend.

The secretary read the report of the scrutineers, and the following members were declared elected: For the District of Montreal, Messrs. Frederick B. Brown and C. N. Monsarrat; for the District of Quebec, Dr. A. R. Decary and Z. B. Normandin.

At the close of the meeting, the Council met and elected officers as follows: President, Dr. A. R. Decary; Vice-President, Mr. J. M. Robertson; Secretary-Treasurer, Mr. Frederick B. Brown. The other members of Council are: Dr. O. Lefebvre and Messrs. C. N. Monsarrat, Geo. K. McDougall, A. B. Normandin and H. Cimon.

Adhemar Mailhiot was reappointed registrar of the Corporation.

British Standards Institution

Dimensions and Properties of British Standard Channels and Beams for Structural Purposes

A new list of British Standard Channels and Beams has been issued by the British Standards Institution (formerly the British Engineering Standards Association) as B.S.S. No. 4-1932. The original lists were first issued in 1903, the geometrical properties being published in the Section Book B.S.S. No. 6 in 1904. A revision of the lists was subsequently undertaken and a new edition of the Section Book appeared in 1924. Later it was found that many of the original sections were still ordered and a further revision of the lists was decided upon with a view of incorporating those of the original and revised sections most in demand and eliminating those which experience had shown to be little used. The present publication contains the combined lists as now agreed upon.

There are now forty-one Standard Channels prepared from twenty rolls, the thicker standards being produced by raising the rolls within a maximum of one-eighth of an inch. Two new sizes have been introduced, namely the 11 by 3½ and 13 by 4-inch channels with their attendant thicker sections.

The Standard Beams now comprise forty sections, and include an entirely new 24 by 7½ by 95 pound section which takes the place of the 1904 and 1924 sections weighing 100 pounds and 90 pounds per foot respectively.

Particulars of the profiles and weights per foot are given in the new lists, together with the moments of inertia, section modulii and other geometrical properties.

Railway Rail Design

The new 152-pound, 8-inch rail section that has been adopted by the Pennsylvania Railroad is the result of studies made by a committee representing the railroad and the leading steel mills, and it is characterized by four features:—1, The height is approximately 8 inches to give increased stiffnesses; 2, The head has as flat a top radius as is practicable to manufacture, to provide wide contact with the wheel tread; 3, The perimeters of the head, web and base are proportionate to their respective volumes, to make the rate of cooling as nearly uniform as possible and thus minimize the internal stresses due to cooling; and 4, The rail as laid is given an inward cant or slope of 1 in 40 by inclined tieplates, to assure a broad wheel contact.

In designing the new rail the basis used was axle loads of 100,000 pounds moving at 100 miles an hour compared with 80,000-pound loads at 80 miles for the 130-pound section adopted in 1916. These severe conditions represent a material increase beyond present loads and speeds, but are expected to provide for the transportation requirements of the next 25 years. A high-carbon steel having from 0.70 to 0.85 per cent of carbon, 0.70 to 1.00 per cent of manganese, 0.15 to 0.30 per cent of silicon and not more than 0.04 per cent of phosphorus was used for rails of this section, which were rolled by the Bethlehem Steel Corporation and have been laid for about 10 miles on a main track in the Pennsylvania's New York division.—*The Times Trade and Engineering Supplement.*

Electric Welding in Ship Construction

It is very desirable that those who have to frame rules for the design and construction of ships should agree to accept new methods and processes only after knowledge of their characteristics has become firmly established. In the case of electric arc welding, for instance, it was essential that authoritative test work should confirm the claims of its advocates, and that actual experience in services in which the consequences of failure are likely to be less disastrous than at sea should be accumulated before the actual replacement of riveting by welding could be authoritatively sanctioned for the construction of ships. Although the classification societies have not moved as quickly in this matter as those concerned with the development of welding process probably desired, it is clear that a conservative policy has much to justify it. Too rapid an advance and a serious failure might have held up the application for a long period of years. The establishment of standard methods of testing and the specification of requirements in electric welding materials has been of great benefit, not merely in the field of ship repairing, for which the classification societies framed them, but also in many applications in land work. With the accumulation of experience, the time has now passed when, in marine work, the arc-welding process must be confined to ship repairs, sufficient data having been accumulated to enable rules to be framed for its application to new construction. That the classification societies have recognized this is evidenced by the recent publication, by the British Corporation Register of Shipping and Aircraft, of "Provisional Rules for Electric Arc Welding in Ships."

In keeping with their customary procedure, the societies have adopted certain abbreviations to indicate the rules under which a ship is constructed and, in the case of the British Corporation, A.W. will, in future, be used to signify that the major part of the vessel has been arc welded, and A.W.p. that a portion only of the main structure had been built in that way. The society had adopted a set of acceptance tests for the prescribed forms of joints, but although these tests are specified and their recognition by surveyors is advocated, it is not contended that they are the only ones capable of providing uniform results. There is no attempt to limit the liberty of a welding expert in regard to procedure. Indeed, it is expressly provided that other methods than those incorporated in the Rules may be accepted, providing that the work can be properly performed by means of them, and that the test results are equally good. The stipulation that "welders are to be trained operators in the class of work on which they are engaged," without any definition of the terms involved is sufficiently open in meaning to allow freedom of action. When rules laid down by trades unions have not controlled matters, it has been found possible to train otherwise unskilled men to do eminently satisfactory work with electric welding in a short time, especially when all that is involved is repetition work with steel plates and sections. The Rules contain specific instructions for the production of particular types of joints, and provide that the surveyor shall check the methods of the operators from time to time. The welder must, at all times, see that the current passing through the arc is not more than 7½ per cent. over, or under, that used in preparing the acceptance tests. Further, he must put down the electrode metal in such a way that a standard 18-inch electrode gives a run of not less than 9 linear inches of deposit. It is recommended that No. 10 electrodes, that is to say those with the core metal of No. 10 S.W.G., should be used in welding all material up to 3/16-inch in thickness, and that no size greater than No. 8 should be used, where there is only one run. First runs, when a number are necessary to make the joint, are to be made with No. 10 electrodes. This applies to heavily-coated electrodes, but provisions are also incorporated in the Rules for "other electrodes." These show that the Corporation is prepared to accept any process on its merits, as far as those can be demonstrated by acceptance tests. —*Engineering.*

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Drought and Soil Drifting in Western Canada

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Paper presented before the Saskatchewan Branch of The Engineering Institute of Canada, February 26th, 1932.

SUMMARY.—Pointing out that for three years precipitation has been subnormal in a portion of western Canada, the author gives an outline of the factors on which climate, weather and precipitation depend, and analyses the relations between precipitation and yield in various portions of the prairie belt. He treats of the effect of soil drifting and suggests as solutions for the present difficult situation, the systematic planting of hedges, forestry conservation methods, the retention of sloughs and lakes, and the establishment of storage dams for spring run-off water, and suggests that it may be possible for agricultural experts to develop a kind of wheat which would require less water than the present varieties. The use of strip farming is advocated to minimize soil drifting while the hedges are growing.

The serious drought situation existing in southeastern Alberta, the southern half of Saskatchewan and southwestern Manitoba is common knowledge. For three years precipitation has been subnormal. The ground water elevation is low, wells are drying up, lakes are low and have shrunk to a fraction of their normal area; sloughs are dry and the flow in many streams is low. In this area some farmers have had three crop failures in succession. During the past season crops failed over practically the whole area.

It is essential for the economic welfare of western Canada that the proper solution of this serious problem be found. The public must shortly be informed that nothing can be done; or that the drought can be combated sufficiently to make the growing of yearly crops reasonably sure. In the former case no more money need be spent in salvaging the stricken area and the settlers can be moved away, or take a chance and stay, as they see fit; while in the latter case the settlers should be told of the proper methods of combating drought and should be assisted in this work.

This paper is an effort to enumerate the factors so far discovered, to summarize opinions held by recognized authorities and to discuss possible solutions for the menace itself. It is also hoped that further discussion and study of this problem, particularly by engineers and other technical men, will result.

It must be admitted that it is unfortunate that Canadians are so dependent on wheat for prosperity. Everything possible should be done to encourage diversification, particularly of agricultural products; however, it is not sufficient to recommend to the farmer that he should go in for mixed farming, including the raising of cattle, hogs and poultry. He can only afford to produce those commodities for which a reasonably sure and profitable market is indicated.

If, on the other hand, it can be made possible for the farmer in the dry area to raise sufficient stock and vegetables for his own use, making him more self-supporting, it would be a step in the right direction.

Those suffering from the calamity, and their more fortunate, but almost equally interested neighbours, to the east, north and west, are asking the following questions: (1) How long will the present drought last? (2) Will it return? (3) To what degree, if any, are the inhabitants responsible? (4) Can anything be done to prevent a recurrence of this catastrophe, or to modify the effects of drought if it does return? (5) If preventative, or modifying measures can be taken, will they be sound economically? (6) If nothing at all is done, and farming is carried on as in the past, will the situation get worse?

Before attempting to answer these questions, or offering solutions, it will be necessary to discuss the situation in detail, paying particular attention to climatic phenomena and meteorological theories.

Zones

For purposes of comparison the prairie provinces may be divided into three zones: (1) The Prairie Belt, (2) The Grove Belt, and (3) The Timber Belt. This classification is shown in Fig. 1.

The Prairie Belt is practically treeless, excepting for the occasional shelter planted around farm buildings. It is bounded on the south by the International boundary, and on the east, north and west by the Grove Belt. It is a country of wonderful potentialities. Its soil is exceedingly fertile but it has two drawbacks, i.e. (1) shortage of water for stock and domestic purposes, and (2) frequently shortage of moisture for growing crops. In defence of this area it must be remembered that it produces over half of the wheat grown in Canada.

The Grove Belt is bounded on the west by the foothills, on the south by the Prairie Belt, on the east by the Timber Belt, a few miles east of Winnipeg, and on the north by the Main Saskatchewan and North Saskatchewan rivers, although here and there it may extend a short distance to the north of these streams. While the soil is no better, and in spite of the fact that the average precipitation is less than in the south, the average yield per acre is greater. Here there is more water for stock and domestic consumption, and as the name implies, there are sufficient trees and shrubs to make it a more pleasant country in which to live. Owing to the fact that water, hay and shelter are readily available, more live stock is produced here than in the Prairie Belt.

The Timber Belt extends a considerable distance to the north of the Grove Belt and gradually merges into the northern Tundra. Here and there the soil is of excellent quality but in general it is light, the sandy loam being underlaid with pure sand over large areas. While this area appears to be well watered, in reality the precipitation is considerably less than in the Prairie Belt. With settlement, resulting in the cutting down of timber, draining of sloughs and muskegs and the consequent lowering of average humidity and increase of evaporation, this country would suffer more from drought than the south does at the present time but with intelligent settlement of the better areas no harm need be anticipated.

Climatic Phenomena

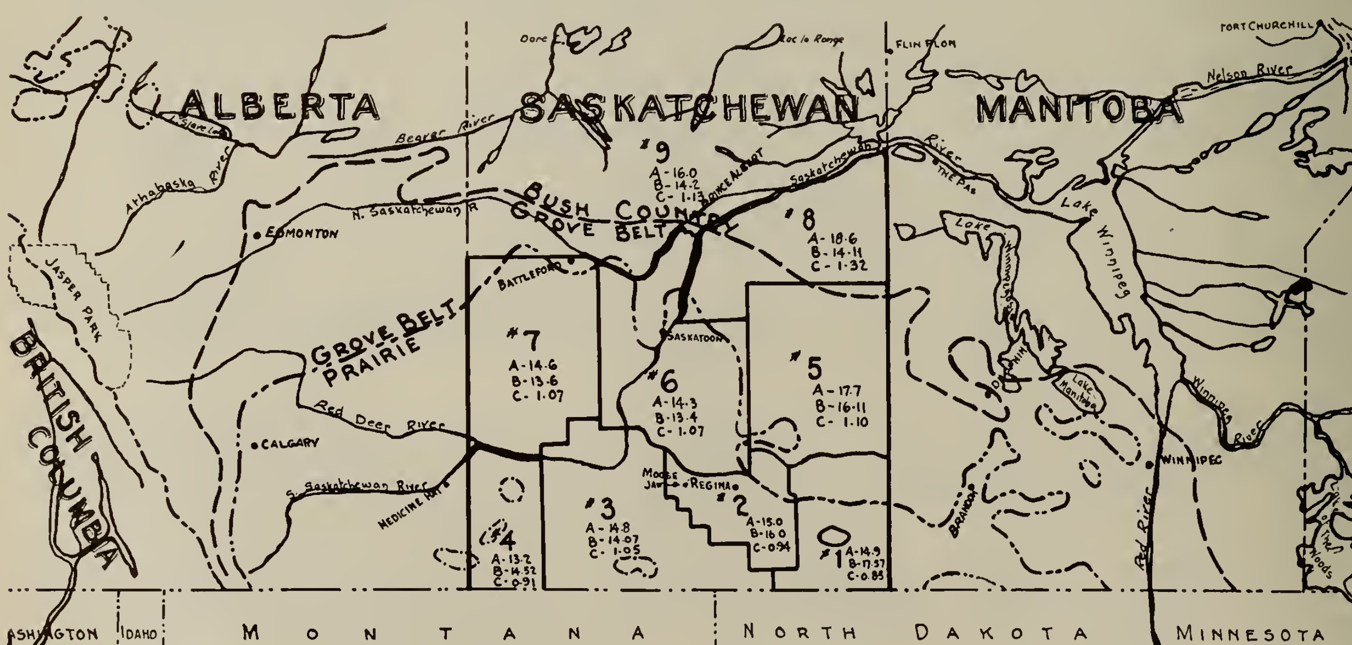
The amount of water vapour that air can contain depends upon its temperature and pressure, but chiefly on the former. It must be remembered that the amount of moisture the air actually does contain at any time depends also on the opportunity it has of obtaining moisture either by evaporation or transpiration. As air rises it expands and cools. During this process the water vapour condenses, and the result is clouds, and later, rain. As the temperature of the air increases its capacity for water vapour increases. One cubic foot of air at 70 degrees F. can hold 8 grains of water vapour, and it is then said to contain 100 per cent relative humidity. If the temperature is raised to 85 degrees F. the relative humidity will be reduced to 63 per cent as at this latter temperature air can contain nearly 13 grains of water vapour.

Evaporation is the process by which water is changed from the liquid or solid into the gaseous state. It has a cooling effect on the atmosphere, hence the coolness of the seashore compared to the heat of the desert.

Condensation, on the other hand, releases heat, thus tending to prevent lowering of temperature. Air at 70 degrees F. with 70 per cent relative humidity has a dew point of 59 degrees F. In other words it is saturated at the latter point and any further reduction in temperature causes condensation in the form of dew, cloud, hoar frost or, occasionally, rain. Humidity has a tendency to prevent the extremes of both heat and cold. At 50 degrees F. and 50 per cent relative humidity, if the temperature is falling, it will freeze before the dew point is reached at 31 degrees F. while at 50 degrees F. and 60 per cent relative humidity the dew point is reached at 36 degrees F. and from there down heat is generated as moisture is released, thus tending to prevent frost.

Water vapour in the air retards radiation of heat from the earth into space. Clear nights are relatively cold nights; cloudy nights are invariably warmer than they would be if the moisture in the atmosphere did not prevent the rapid radiation of heat from the earth's surface. In the desert, where humidity is naturally low, as there is no source from which the air can get its normal moisture content, the thermometer may register 120 degrees F. in the shade, if any shade can be found, while during the night following it may freeze.

There are three types of precipitation, i.e., convective, orographic, and cyclonic. Convective precipitation is mainly limited to equatorial regions where the chief air movement is vertical. As the air rises it is cooled and the water vapour condenses, resulting in rain. To a small extent this action takes place even in the northern region. Orographic precipitation is the name applied to the squeezing of moisture out of the air as it rises owing to increase in the elevation of the land. Rainfall on the western slope of



For each section the following figures are given:

A—Wheat yield bushels per acre—14 year average.
B—Precipitation in inches—16 year average.
C—Ratio $\frac{\text{Yield}}{\text{Precipitation}}$ or bushels per acre per inch of precipitation.

Fig. 1—Vegetation Belts and Crop Districts.

the Rockies is largely of this type. Cyclonic precipitation is due to winds blowing between regions of unequal pressure. Most of our rainfall is of this type. The wind, however, does not necessarily supply its own moisture. The wind or storm is merely the condition making rain or snow possible.

Climate and Weather

Climate is the average condition of the atmosphere. Weather denotes a single occurrence, or event, in the series of conditions that make up climate. The climate of a place, in this sense, is its average weather.

It is unfortunate that the average layman in discussing climate, is generally thinking of precipitation. While precipitation is a very important factor in climate, the two are by no means synonymous. For example, the average yearly precipitation at Minneapolis is 20 per cent greater than at London, England, but there is much more moisture available for the growing crops in the London counties than in Minnesota. Paris, France and Qu'Appelle, Sask., have approximately the same mean annual precipitation but the climates are entirely different. Winnipeg has 33 per cent more rainfall than Athens, Greece, but any one who has lived in both cities would believe that the situation is just the reverse. Prince Albert, Regina and Athens have approximately the same mean annual precipitation but their respective climates are vastly different.

The facts that London, Paris and Athens have more available moisture than Minneapolis, Qu'Appelle and Regina, respectively, in spite of the similarity in precipitation records can be accounted for by their smaller evaporation factor.

Evaporation, again, is the product of temperature, wind velocity, relative humidity, nature of ground, condition of vegetation and a few other lesser factors. If one or more of these factors are changed artificially, then the climate must necessarily be affected, even if precipitation itself is not changed.

Vegetation obtains its nourishment by absorbing weak chemical solutions from the ground. The solid matter, and a small amount of the water in the solution is used by the growing plant or tree, and the surplus water is exuded into the air through the pores of the leaves. This action is known as transpiration, and the water so discharged plays an important part in keeping the atmosphere at its normal humidity. It has been found that a forest of beech trees will supply the air with more moisture than an equal area of deep water under similar conditions.

Trees and plants are dependent on precipitation, so, if rain fails, eventually the plant starves to death, as the moisture is lacking to make its food available. Vegetation, however, does provide additional moisture to the extent that it reduces run off.

Source of Moisture for Precipitation

As the wind from the Pacific must pass over several ranges of mountains, most of the original moisture is lost, through the lowering of temperature and pressure, by the time it passes the summit of the Rockies, hence, very little moisture can come from this direction.

Northerly winds are proverbially cold as they come from a territory where the temperature is normally lower than ours. As the wind proceeds in a southerly direction its temperature (and hence its capacity for moisture) is increasing, so little rain can be expected from that direction.

Some moisture may come occasionally from the Atlantic Ocean and Great Lakes System, but these sources are relatively unimportant owing to the fact that most winds are from a westerly direction.

There is little doubt that much of our precipitation comes from the south. Normally cyclonic disturbances travel from west to east. Locally they rotate in an anticlockwise direction, and there is a tendency to draw in warmer air currents originating over the Gulf of Mexico. When these moist air currents collide with the colder westerly, or northerly winds, they are forced to rise. As they rise they are cooled, and ideal conditions for a heavy fall of rain or snow prevail.

Effect of Vegetation on Precipitation

The layman has an exaggerated idea of the effect of vegetation on precipitation. A few authorities on the other hand claim that there is no effect whatever. Most authorities agree that trees and other types of vegetation have some effect on precipitation; sometimes the effect is small and sometimes considerable.

Consider a section of British Columbia to find out the possible effect of trees on the rainfall there. Dickson says in "Climate and Weather," "The chief winter track (of the cyclone) starts near Japan, touches Kamchatka and closely follows the parallel of 50 degrees N. to Vancouver Island. But it does not end there, for notwithstanding the elevation of the western mountain and plateau system, and the low surface temperature, many of the cyclones, after discharging much moisture on the Pacific slope, continue their eastward way right across the continent."

Assume the Pacific slope to be bare rock devoid of trees and other vegetation. With X inches of rain per annum the run off through the rivers to the ocean would be practically 100 per cent, or X inches. In this case all precipitation would be coming from the ocean.

Again, assume that the whole area is covered with soil and that tree, and other vegetable growth, is rank. Again the west wind is blowing from the Pacific, and has sufficient moisture to produce X inches of precipitation. In this case the soil and vegetation prevent say 50 per cent of the rainfall from running off, and this amount is given back to the air by transpiration and evaporation. As the air has no choice but to accept the moisture of transpiration, unless it already contains 100 per cent relative humidity (in which case the additional moisture is immediately precipitated), it is obvious that more rainfall must necessarily result. Neglecting minor losses the increase would be $\frac{X}{2}$ inches or 50 per cent.

As the water vapour escaping over the summit of the Rockies would be the same per cubic foot of air in either case, it is obvious that the vegetation must have a very definite effect in this example. Of course the situation is not as simple as described as there are stray currents and anti-cyclones that would take their toll of water vapour, but this is the situation in either case submitted; this being merely an attempt to indicate a tendency.

The situation on the prairies is not so simple, as there are many factors here not present in British Columbia, but the tendency should be the same. Supporting this view, Geddes in his "Meteorology" says "This precipitation in the Amazon Valley forms part of the equatorial belt of rains, and though part of it is due to the water vapour carried in from the ocean by the trade winds, the rich vegetation along the whole valley also supplies a large quantity of vapour to the atmosphere."

Meyer in his "Hydrology" says: "It is a common misconception that most of the rain which falls on the land comes from moisture evaporated from the ocean. As a matter of fact, the greater portion of the rain which falls in the United States is water reprecipitated after having fallen as rain and having evaporated from the land area—the portion of the rainfall which is derived from moisture evaporated over the ocean varies in different parts of the country. In those regions where prevailing winds are off the ocean, the greater portion of the rainfall naturally represents moisture evaporated from the ocean. Among such regions are the Pacific Slope and the region bordering the Gulf of Mexico. The upper Mississippi and Missouri valleys and the eastern slope of the Rocky Mountains are typical of the areas which derive most of their rainfall from moisture evaporated from the land."

He continues: "If changes occur in the cultural conditions of the large land areas which increase evaporation, the result must inevitably be an increase in precipitation. On the other hand, if there are changes on the land area which increase the amount of water which runs off over the earth's surface, or through the rock strata, into the ocean, evaporation, and consequently precipitation, must be reduced."

In "Climate Through the Ages" Brooks says: "In the past fifty years the country (South Africa) has been suffering increasingly from droughts but the conclusion from expert evidence is that this is not due to an actual decrease in the amount of rainfall, but to a change in the nature of the soil and vegetation. When South Africa was first settled the country was covered by rich vegetation, the rainfall was steady and persistent, and a large proportion of it was absorbed. The effect of over pasturage has been to destroy much of the protective vegetation, and the soil has been washed away or trampled hard. The temperature contrasts have been increased owing to the heating effect of the bare ground, and the rain now falls largely in heavy instability showers, including destructive thunder storms."

Now a change in type of precipitation may be quite as important a factor as a change in amount received annually. A quarter of an inch of rain falling after a long dry spell seldom does much good, as normally 90 per cent of it will be evaporated within a few hours. On the other hand, a two-inch rain falling in an hour will probably do a good deal of harm, as most of it will run off and will carry a lot of valuable mineral and organic matter with it. The really useful rain is one that lasts for a day or two, and its beneficial effect is increased if the weather remains calm and cloudy for a day or so afterwards.

Again, during the summer months some rainfall is convective in character, generally in the form of heat thunderstorms. Geddes says in his "Meteorology," "Warm, moist and rapidly ascending air currents are necessary for the formation of these thunderstorms and consequently they occur with greatest frequency in the summertime and during the afternoon, over land areas from which sufficient moisture can be drawn. Storms of this type are never experienced over the open ocean, outside the tropics, because the surface temperature does not rise sufficiently high to give a rapid temperature gradient; neither are they found to occur over deserts, because there the air is found to be too dry for the formation of cumulo nimbus clouds. Over inland districts where there is sufficient moisture, they are much more frequent than on the coast."

After weighing the evidence pro and con, and giving a great deal of thought to the matter for a number of years, the conclusion is that the type and extent of vegetation and ratio of lake and swamp area to land area, in a country like the prairie provinces, will have a definite effect on the quantity and type of precipitation. Just how great this effect would be of course is quite impossible to forecast.

Effect of Vegetation, Lakes and Swamps on Climate

While there is disagreement as to the effect of vegetation on precipitation, authorities are pretty well agreed that the type and extent of vegetation has a considerable effect on climate. Lack of vegetation on a given large area results in great heat by day and cold by night; humidity will be low, surface velocity of wind will be high, evaporation high and (in northern territory) the frost will penetrate to a great depth. The run off from rainfall will be large and will result in flooding streams in addition to carrying away the humus matter from the soil. If the same area is covered with trees, rain and snow will be conserved, resulting in a smaller but more constant flow in the streams, moisture will be passed on to the air daily through transpiration resulting in higher humidity, surface wind velocities will be lower owing to friction; frost will not penetrate into the ground so deeply; less humus matter will be lost and the spread between day and night temperature will not be so great.

Sir Ray Lankester in "Water in Nature," observes that "forests have an immense effect on climate, causing humidity, and similarly causing moderate and persistent, instead of torrential, streams."

Lakes and swamps also have a beneficial effect on climate as they tend to increase humidity of the air, prevent floods and reduce extremes of temperature.

If it is agreed that the type and extent of the earth's vegetal covering, and the ratio of lakes and swamp area to land area, have some effect on climate, the necessity of having lakes, marshes and forests is evident; unfortunately for forty years Canadian forests have been cut, without any adequate reforestation; forests are allowed to be destroyed by fire, without any adequate scheme of fire protection; lakes and sloughs are drained, instead of creating additional water areas; large areas of land are summer-fallowed, instead of using crop rotation; and the prairie grass is pastured or cut so short that little, or no moisture for the air is available from this source. All of these factors are directly or indirectly causes of drought, changes in character of precipitation, soil drifting and floods.

Precipitation and Yield

The yield of grain on the fertile land under consideration is almost entirely a reflection of the amount of moisture available. Summer-fallowing is merely a method of creating a top soil condition that lessens evaporation, and hence retains moisture in the ground for the next crop. While this is fairly effective in retaining moisture it increases the tendency toward soil drifting, and this, in some districts, is as serious a menace as drought. Weeds are chiefly combated because they steal the moisture thus conserved.

A graph showing the relation between precipitation and yield per acre in Saskatchewan from south to north gives some unexpected results (see Fig. 2). It is found that precipitation is actually greater in the prairie country to the south then in the grove and timber country to the north. At first glance, this fact would tend to upset the theory of the effect of vegetation on rainfall. It is definitely known however that precipitation does decrease in the North Temperate Zone from south to north unless some other influence is at work to counteract this tendency. In western Canada the decrease is from an average of 18 inches at the International Boundary to about 13 inches at Lake Athabasca.

In spite of the smaller precipitation in the north, the yield of wheat per acre is greater than in the south. This, at first glance, demolishes the theory of our experimental farm experts who claim that yield on our fertile western clay soils is at present almost entirely a reflection of the amount of moisture available for the growing crop.

In crop district No. 1, in southern Saskatchewan, there was an average annual precipitation of 17.57 inches over a period of sixteen years. Of this amount over 5 inches were in the form of snow. This snow for the most part drifts into coulees and when spring comes it melts and discharges into the Saskatchewan and Missouri rivers and is entirely lost to the country. The experiments of our agricultural experts show that heavy winter snow has practically no effect whatever on crop yield on the prairie the following summer. Therefore the effective precipitation in this crop district is a little over 12 inches instead of 17.57 inches.

In district No. 8 in northern Saskatchewan the annual average precipitation is only 14.11 over the same period. Of this the snow amounts to about 4 inches. Much of the snow is retained by drifting into shrubs and trees and soaks into the surrounding soil and is available for growing crops.

Another factor helps to protect and conserve this moisture. Owing to occasional groves of trees the wind velocity in the north would naturally be less than in the

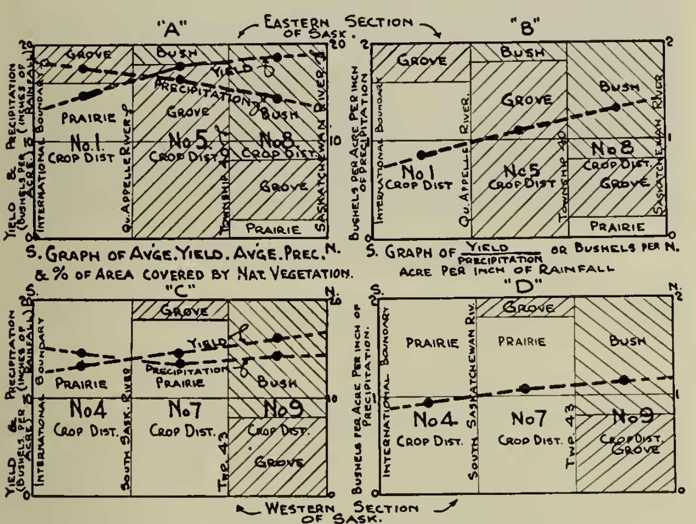


Fig. 2—Yield in Relation to Precipitation.

south, hence the evaporation would be less. This must be a considerable factor. It is probable also that the mean summer day temperature is slightly lower and night temperature higher in the Grove and Forest area than on the Prairie, although no direct evidence of this is available.

Some slight effect on evaporation might be expected from the higher relative humidity that probably exists in the north compared to the south but here again there is no direct evidence.

From the foregoing it will be obvious that the wheat fields in the northerly belts have more moisture than in the south, in spite of the fact that precipitation is less. This would account for the greater average yield per acre, and would agree with the belief that yield per acre is almost entirely dependent on moisture available.

A graph showing yield in relation to precipitation in eastern Saskatchewan (see Fig. 2) indicates a yield of 0.7 bushels per acre per inch of precipitation in the south to 1.4 bushels in the north, an increase of 100 per cent. In western Saskatchewan the variation is from 0.9 bushels in the south to 1.2 bushels in the north, an increase of 33 per cent.

Soil Drifting

So far the serious soil drifting that has occurred in the Prairie Belt this year has hardly been mentioned. While to a large extent drought is the parent of soil drifting, it is worthy of note that many farmers advise that they would have had some crop this year had it not been for this latter factor. In some cases there was sufficient moisture in the ground for germination, but when the crop was up an inch or so, soil drifting from adjacent summer fallow smothered it. On much prairie land the native grass was covered in the same manner, making it impossible for cattle to get their feed. This in turn forced the farmer to sell his stock for what they would bring or ship them to pasturage in the Central and Northern Belts.

No doubt the depletion of organic fibre, owing to the growing of too many cereal crops in succession, is a very important factor in soil drifting. The cure for this would seem to be the growing of hay and other crops that replace the fibre. This in turn would necessitate the raising of cattle, sheep, and hogs to consume the fodder. Perhaps science could aid by finding some economical method of replacing the fibre artificially. There seems to be little evidence of serious depletion of plant food in the rich prairie soils.

An additional effect of soil drifting is the filling up of highway and railway ditches, and excavations, resulting in the expenditure of public and private money to place these in working condition again. The aggregate cost to the country of soil drifting during 1931 must run into millions of dollars.

Conclusion

After studying this very interesting problem casually for a number of years, and intensely during the past few months, the answers to the questions enumerated on page 297 are as follows:

(1) While it is not known when this drought will end, it is exceedingly probable that it has now ended, or that at most it will not extend beyond 1932. While insufficient records are available here, extreme drought periods in similar latitudes seldom last longer than three years.

(2) There is no doubt of it coming back again, but the next severe drought of three years duration will probably not return inside of fifty years.

(3) While responsibility for the drought itself only rests to a limited extent upon the citizens, it is evident that a number of things have been done that increased its devastating effect.

(4) The dry period cannot at present be prevented from returning but much can be done to minimize its effect.

(5) The measures that should be taken to reduce the effect of drought are economically sound.

(6) The situation will get worse and worse if matters are allowed to continue as in the past.

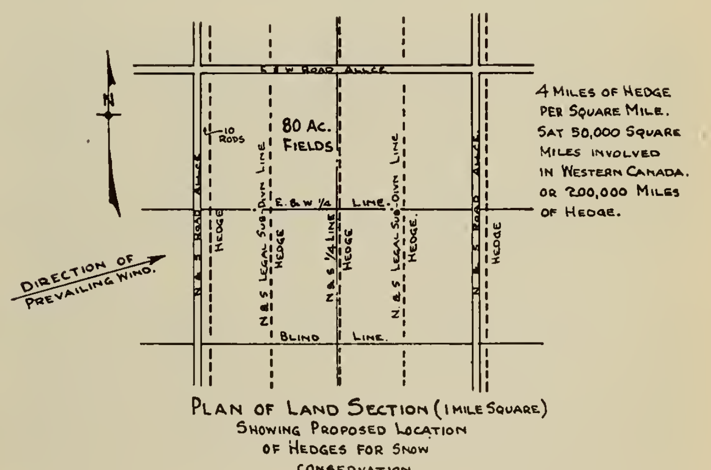


Fig. 3

Suggested Solutions

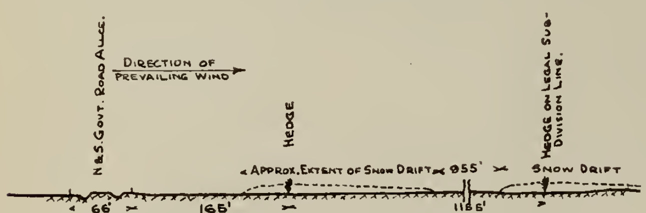
Of the many possible partial solutions for this drought and soil drifting menace the most effective would be the planting of hedges. Most of the other proposals have merit, and will probably have some beneficial effect, but there is something positive about the planting of hedges.

The proposed plan is that one mile of Caragana hedge be planted in each quarter section in a northerly and southerly direction approximately along the boundary of each legal subdivision. (This proposal is illustrated in Figs. 3 and 4.) The Caragana hedge will grow practically anywhere that wheat will grow, it is not affected by rabbits and if properly cultivated will be an effective hedge in five years.

Its important function is to catch snow that otherwise would drift into the coulees and be lost. As hedges would only be 1,320 feet apart the snow drifts should not be so large, even in a heavy snow year, as to seriously embarrass the farmer by keeping him off the land in the spring.

No doubt hedges planted in an easterly and westerly direction would also catch snow, but as the general direction of the winter winds is from the west, it is quite apparent that the north and south hedges will be the most effective. Indeed it is to be doubted if more snow would be collected by planting hedges in both directions, hence to save land, labour and money, only the north and south hedges should be recommended.

As there are about 50,000 square miles on which hedges should be planted, this would mean 200,000 lineal miles of hedge. It sounds like a titanic task but the biggest task probably will be to convince people that it should be done, although in southern Saskatchewan last fall, the farmer was in a very receptive mood. He is anxious to hear of anything that will help him along. The work of planting, of course, must be done by the farmer, although it might be necessary to provide a bonus of so much per mile for the first, second and third class hedges, and as the general prosperity of the country is at stake, this could be entirely



E & W Cross-Section of Land Showing Proposed Location of Hedges to Conserve Winter Precipitation.

Fig. 4

justified. One man and team should plant one-half mile of hedge in a day. Assuming that there is the equivalent of one man and team to every quarter section the whole programme could be carried out in two days. Further one man and team will cultivate a mile of hedge in one day; hence one day only per year need be set aside for cultivation of the hedges after they are planted. Surely this is not too much labour to be spent on works that are certain to produce so much additional moisture.

The effectiveness of a six-foot hedge can hardly be denied. Last October four farmers, in different parts of southern Saskatchewan, all of whom had long hedges, gave the same statement; that their largest crop in 1931 came from land within the influence of the hedges. This is quite remarkable, when it is remembered that, after the first storm in October, 1930, there was practically no more snow during the winter of 1930-31.

Figs. 5 and 6 give an idea of the effect of a hedge on a growing crop. The grain was collected and photographs taken by a government forestry man and the farmer who owns the land. The yield on a 500-foot strip adjacent to the hedge was just double that on the next 500-foot strip.

Hedges in the south will be more effective than the groves in the north as they are designed to trap the snow while the groves do it in a more or less haphazard fashion.

With effective hedges on the prairies as described some reduction in the average wind velocity near the ground would be expected and a small increase in the average humidity. Both of these factors would tend to reduce evaporation, hence more moisture would be available for the growing plants. The moisture from an 8-foot hedge after a winter of normal snowfall should influence land at least 500 feet to leeward and 150 feet to windward. The velocity of wind should be reduced for at least 600 feet to

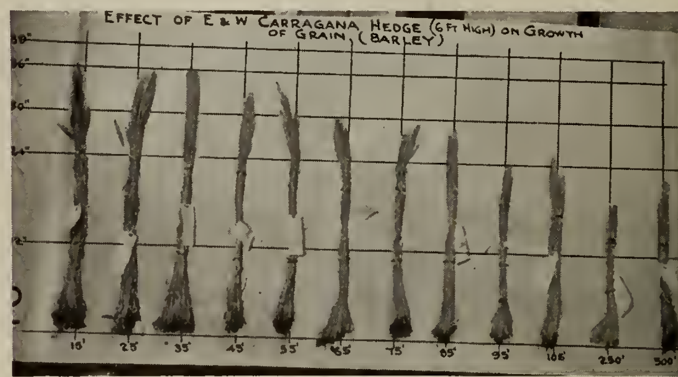


Fig. 5—Effect of Hedges on Growth of Barley.

leeward of a single hedge and to some extent the reduction would be cumulative.

Even during a drought, and after a winter of little snow, a strip of land to leeward of each hedge would trap sufficient moisture to guarantee some pasture, hay and vegetables, so that the farmer would not be dependent on charity for his existence if his general crop failed.

A curious by-product of the planting of hedges will be the increase of bird life in the country. It has been found that approximately one hundred birds to the mile of hedge can be figured on. These creatures weigh several ounces apiece, and normally eat more than their own weight daily of worms and grubs.

In order to prevent soil drifting until the hedges are sufficiently high and bushy to cause reduction in wind velocity, it would seem advisable to go in for strip farming as many farmers have done in southern Alberta, with considerable success.

New Varieties of Wheat

Progress has been made during the past thirty-one years, through the diligent efforts of agricultural scientists, in producing varieties of wheat that will ripen earlier, withstand rust and have better bread making qualities than

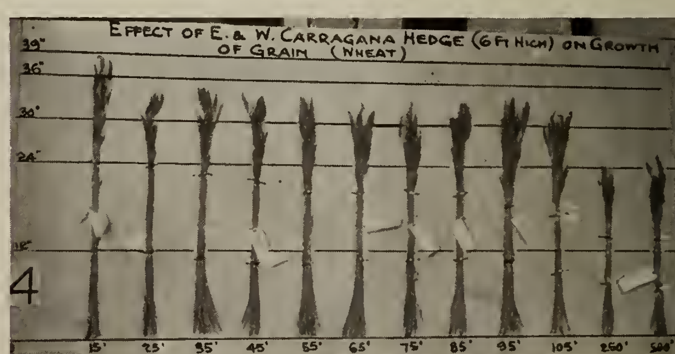


Fig. 6—Effect of Hedges on Growth of Wheat.

the former types. Present varieties consume about 550 pounds of water to produce one pound of dry matter. Would it not be possible to produce a wheat that would use say 100 pounds of water less per pound? This would be a step in the right direction.

Forests

The next suggestion to be considered is the preservation of present forest areas, reforestation of stripped land, and burned over areas, and afforestation of waste land suitable for the growth of trees. Whether or not the effect that such a policy would have on rainfall can be agreed upon, the effect on humidity, temperature, wind velocity, evaporation and flood control is well established. The economic value of the forests alone should urge the framing of a forest fire policy such that any fire could only be local. Again while the cutting of mature trees is quite right and proper, this could be arranged so that fifty years hence there would be just as many mature trees as there are now. To do this the new natural growth in the cut-over or burned-over area, should be protected and in both areas, reforestation resorted to as appeared necessary.

Certain areas in western Canada are entirely unfit for crop growing owing to the soil being exceedingly sandy. Many are entirely suitable for forest purposes and it would seem expedient to plant them with suitable trees. Quite apart from the economic value of such parcels from the standpoint of firewood in a district where this commodity is exceedingly scarce, the esthetic value is important; particularly in a prairie district where settlers have to drive a hundred miles to find a suitable location to hold a picnic or a sports event.

Conservation of Run-Off Water

Another recommendation is that the draining of sloughs, lakes and marshes be prohibited. It is curious in this country where there is much arable land ready for the plough and where there are few water areas, that people should be so ready to drain the sloughs, lakes and marshes that nature has provided. It is seldom that the draining expense is repaid by crops or hay obtained from the reclaimed land. One example of this folly will suffice. Quite a large lake in Saskatchewan was, at one time, a bird sanctuary, and the source of a fair sized stream. At the request of individuals, who believed they could cultivate the lake bottom, it was drained. The direct results are that the stream of which it was the source now goes in flood each spring, and dries up entirely in the summer. Furthermore, the lake bottom has not been successfully cultivated, the water fowl have lost a breeding place and the country has lost ten square miles of valuable water surface.

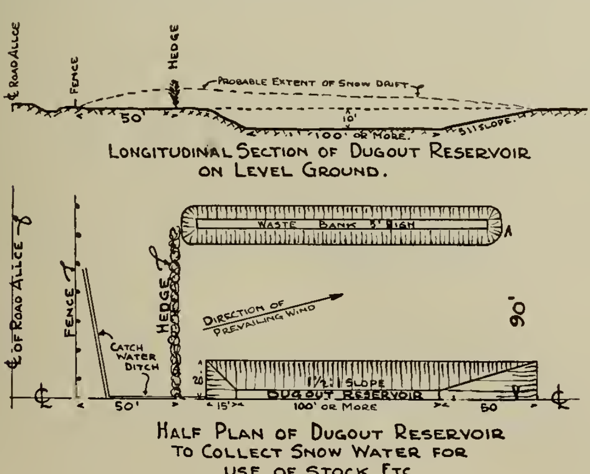


Fig. 7

Next in importance is the conservation of useless spring run-off water and it should be economically possible to hold 75 per cent of this water in natural and artificial lakes. This should be done at strategic points along a stream.

Some streams discharge into lakes with no outlet so it would be a waste of money to dam these in the upper reaches as the only effect would be to dry up the original lake.

In many cases it will be found that impounding water as suggested is economically sound quite apart from the value of such water surfaces from the standpoint of increasing the humidity of the air. In all cases water so held

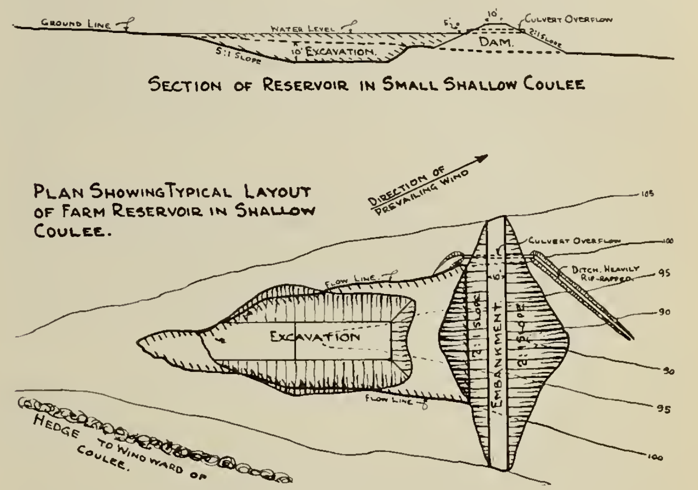


Fig. 8

would be valuable for live stock. Two prospects that have been considered would irrigate many thousand acres of land for the intensive production of vegetables and hay in a country where both commodities are scarce. Water used for irrigation purposes is soon returned to the air by transpiration, so it serves two useful purposes.

Many large lakes in southern Saskatchewan are very low at the present time, containing one quarter, or less of their normal volume. These are essentially alkaline in character and the concentration is now four times as great as when they were full. On many ranches bordering these lakes the cattle are thin, owing to their dislike for this water and to the effect of the heavy alkali concentration on their digestive systems. Nearly all of these lakes can be enlarged by damming their outlets. The advantages to the cattle business alone would repay the outlay.

Another reason would be the tendency to reduce spring floods and increase summer discharge in streams like the Qu'Appelle, Assiniboine, Frenchman river, Souris river and others.

The addition of a number of large bodies of water would provide summer breeding grounds for water fowl and fall shooting grounds for sportsmen, a by-product of considerable value.

Many farmers in the south depend on dugouts to provide water for their stock and frequently the amount of water collected in these reservoirs is disappointing. Again the hedge can be used to collect snow and a simple ditch will fill the dugout even on level land. When describing this method to a number of farmers in a southern Saskatchewan town one man stated that he used the same idea in a different way. It appears that each fall he hauls all his farm machinery to windward of his dugout to trap the snow. This method worked, but he admitted that the use of hedges might be easier on machinery. Figs. 7 and 8 illustrate the hedge method on the level and in a small draw respectively.

In many cases a municipal reservoir would solve the problem of shortage of water for stock and for domestic purposes.

It is found that many municipal and farm dams are incorrectly constructed with the result that they frequently fail, causing costly repairs and loss of a summer's water.

RECOMMENDATIONS

Summarizing the steps that should be taken to fight drought and prevent soil drifting in the prairie belt, the following are offered in order of merit.

1. Plant at least one mile of suitable hedge on each quarter section.
2. Use strip farming to minimize soil drifting until hedges are four or five feet high.
3. Set agricultural experts the task of producing a wheat that consumes less water per pound than the present varieties.
4. Adopt a forest policy that will make a serious forest fire impossible.
5. Arrange cutting of mature trees, conservation of young natural growth and reforestation where necessary, so that in fifty years there will be as much timber as at present.
6. Stop draining lakes, sloughs and marshes.
7. Store as much of the spring run-off water as is economically possible.
8. Set aside all light lands as forest reserves and plant these areas with suitable trees.
9. Develop the market for beef, pork, mutton, poultry, etc., so that farmers can go in for mixed farming.
10. Encourage the municipalities in the dry area to construct public water supplies, and the farmers to construct effective dugouts.

In closing, an opinion and warning from Ward in his "Climate" may be quoted. In an arid region man has a hard task if he is to overcome the climatic difficulty of his situation. Irrigation, the choice of suitable crops adapted to arid conditions and steady, thoughtful work, are absolutely essential. To a large extent an intelligent man may thus overcome many of the obstacles which nature has put in his way. On the other hand, a region of deficient rainfall, once thickly settled and prosperous, may readily become an apparently hopeless desert, even without the intervention of war and pestilence, if man allows the climate to master him."

Discussion

P. C. PERRY, A.M.E.I.C.[1]

Mr. Perry observed that the author was to be congratulated upon the work he had done in stimulating interest in the subject, and believed too that the author and the members of the Commission on Conservation wished a frank expression of views.

It was advisable therefore to look at a few additional facts. It was unfortunate that the drought period had come when all were having difficulties due to the economic depression, and there was a danger of blaming the drought situation for some of the distress which was part of the world wide condition. While the drought area did not cover the entire province of Saskatchewan, some idea of the situation could be obtained by comparing recent conditions in the province with those of previous years. The past three years had been trying ones but one needed to go back only to the years 1918, 1919 and 1920 to find a similar period. Owing to increased acreage, the production of all grains showed an increase of 21 per cent for the past three years as compared with 1918, 1919 and 1920. It was true that average yields of all grains showed a decrease of 7.8 per cent in comparing the last period with the first and while the situation was bad, he feared that many people had an idea of conditions even worse than they were.

Fig. 9 shows graphically the yields per acre for wheat in the various crop districts of the province, taken from a report of the Secretary of Statistics.

It would be seen that the acute situation of the past year or past three years centred upon the three districts to the southeast part of the province. The other districts had worse conditions in 1924 or in one of the years 1918 to 1920. The chart and figures quoted above did not give any idea of the difficulties experienced by the rural population, but would show that much of the distress should be assigned to causes other than conditions that affected agricultural production.

Pertinent information regarding the possibility of the climate changing should be brought out. Fig. 10 shows the precipitation for climatic years at Regina, Qu'Appelle and Fort Qu'Appelle for the periods covered by the records. At Qu'Appelle, a general increase up to 1927 would be noted with the three years of heaviest precipitation occurring since 1921. At Regina, the heaviest occurred during 1915-1916 and lightest, 6.59 inches, in 1893-1894.

Scientists of the United States Department of Agriculture and Weather Bureau had for years stated emphatically that there was no evidence that a permanent change of climate had taken place since the settlement of the country and they still held to that view.

A chart by Mr. Townsend showing precipitation at Calgary had appeared in the Report of the Better Farming Commission of 1921, and it would be noted that for eight consecutive years, 1889 to 1896, precipitation was below normal at Calgary with some extremely dry years. The report had stated that twenty-five years ago it was not expected that grain raising would be undertaken in the southwest part of the province and that it was not encouraged. In fact, ample evidence was available to show that there were dry periods in the past as bad as at the present.

ONLY LOCAL IMPROVEMENT PRACTICABLE

The author should be commended for suggesting many undertakings which could be justified from the standpoint of local improvement. Those who believed that the climate could be changed, were suggesting works somewhat similar to those which could be endorsed because of local results, but the differences were important. For instance, if water was to be impounded for its effect upon the atmosphere, large shallow lakes with greatest possible evaporating surface would be required. On the other hand, if water was collected for domestic purposes, irrigation, etc., evaporation should be kept at the minimum. Then, from the standpoint of effect upon the air, further expenditure would not be justified in those watersheds where surplus water was now being caught in lakes within the dry area. A familiar example of such a condition was the Lake Johnson watershed, where all local run off was impounded and surplus water evaporated.

Then the psychological side of the question was important. The promise of transforming the climate might give encouragement to people in the dry areas, but to offset that there was the danger of failure to take advantage of opportunity for local improvements while waiting for the government to do something. If local and individual effort was to be the deciding factor, the sooner that was known the better. He was convinced that the people of the prairie provinces possessed sufficient courage and resourcefulness to overcome these difficulties and nothing would be gained by misrepresenting the situation which existed.

He wished next to refer to some of the things which showed why efforts must be confined to improvements of local value.

[1] Division Engineer, Canadian National Railways, Regina, Sask.

Factors Affecting Precipitation

A study of the map illustrated in Fig. 11 and a study of the factors affecting precipitation would give a lot of information about weather. In most of the Manitoba area, precipitation steadily grew heavier as one moved to the southeast. This increase continued quite regularly to the Atlantic coast, from which it was justifiable to assume that the Atlantic had an important effect upon that area. In Saskatchewan, the same gradual increase or decrease was

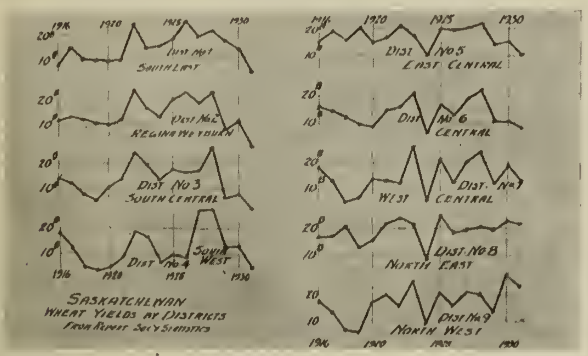


Fig. 9—Wheat Yields by Districts.

not found indicating that the effect of the Atlantic was not so pronounced. In Alberta, the effect of the Rockies coupled with the prevailing winds was quickly recognized and if the study was carried on to the Pacific, the effect of that ocean would be found sharply modified by the mountain ranges.

For the local variations in Saskatchewan and eastern Alberta, it might be more difficult to define causes, but the fact that relief had an important bearing was evident. The high precipitation in the vicinity of the Moose Mountain area and Cypress Hills must be due to the elevation of those areas above the surrounding plains.

The author had explained that there were three types of precipitation, convectional, cyclonic and orographic. It should be borne in mind however that there was seldom a sharp division between the influences which caused precipitation.

Briefly, the factors affecting precipitation for the prairie area were latitude, distance from oceans, air currents, temperatures and relief. The only thing of local nature which had any effect was the latter, for wherever marked local variations were found as between Fort Qu'Appelle and Qu'Appelle, hills might explain the condition. Reference had frequently been made to the difference in precipitation at Regina and Qu'Appelle and some had assumed that this was due to the tree growth around Qu'Appelle. But if Fort Qu'Appelle was compared with Qu'Appelle it was found that Fort Qu'Appelle had an average precipitation 3.39 inches lower than Qu'Appelle. These points were only 18 miles apart, both had tree growth and Fort Qu'Appelle was located beside the Qu'Appelle Lakes. Obviously, the difference was due to the difference in elevation which was about 500 feet. It was evident, therefore, that precipitation was influenced by factors entirely outside of human control. It was probable too that these factors were the most important ones affecting evaporation and humidity.

The author had suggested that absence of grass land and extent of summer fallow contributed to the dryness of the prevailing southwest wind, but it should not be necessary to introduce figures to show that grain fields represent a large percentage of the prairie area. The summer fallow was employed to conserve as much as possible of the moisture received one year for use the following, and the transpiration from the grain fields was comparable with that which formerly took place from the prairie grasses. The upland prairie grass, quite aptly spoken of as "prairie wool," was the poorest sort of vegetation from the standpoint of transpiration, and he was satisfied that when the dry winds swept over the prairies now they received just as much moisture as they did years ago. It was a fact that these winds took up our moisture at times without return, but that was no fault of the inhabitants—rather a geographic misfortune—a misfortune which was offset by other natural advantages. Fig. 12 showed graphically the effect of hills and mountains on precipitation and told better than words why a greater benefit of the Pacific was not felt.

A good deal of information was available concerning the run-off in the Surface Water Supply papers of the Water Powers Branch of the Department of the Interior. An average of ten years' measurements of the Assiniboine at Headingly showed a run-off of .525 inches over its drainage area, while an examination of measurements of its tributaries showed that the bulk of its flow comes from northern branches, the Assiniboine measured at Millwood showed 1.487 inches for the same period while measurements of the Souris at Wawanesa showed about .20 inches, and measured at Minot by United States Geological Survey showed an average run-off of .23 inches for a 22-year period. Taking into consideration the areas from which there was no run-off, he was certain that average run-off from the dry belt does not exceed .3 inches or 2 per cent of the precipitation. The measurements of small watersheds would show higher run-off per square mile, but considerable evaporation took place from the streams before the outer boundaries of the dry area were reached.

It was a surprise to find that the run-off from this dry belt was lighter than for any area of similar size in Canada, the lightest percentage of the precipitation, and considerably lighter than for streams in northern wooded areas where precipitation was about the same. Even the flood discharges in second-feet per square mile were lower for prairie streams than for streams from the northern area. The light run-off must be kept in mind in connection with all schemes for impounding water and also if all water now lost in run-off were conserved the evaporation would be increased by only 2 per cent.

Annual Variations

Seasonal variations have occurred from year to year and there was a marked tendency for maximum and

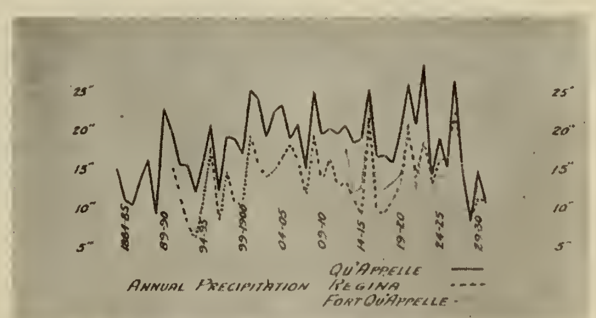


Fig. 10—Annual Precipitation.

minimum years to follow one another. Variability was important also in showing what had to be contended with when attempts were made to change conditions. Precipitation statistics of the past twenty-five years showed that 1916 was the heaviest year for the entire Canadian prairie area and a large area in adjoining states, while 1917 was the lightest. The high precipitation of 1916 filled sloughs, raised lake levels and probably left considerable moisture in ground. With this condition, and knowing that 1917 with its light rainfall had more drying days, it could be assumed that evaporation would be well above normal. With the normal evaporation of the dry area returning approximately 98 per cent of normal precipitation to atmosphere, how could the 1917 precipitation fall so far below normal? The answer, of course, was that moisture evaporated from the prairie area was carried hundreds, perhaps thousands of miles before being precipitated. It seemed unwise to spend money to increase evaporation when it might be precipitated in Labrador on the year when it was most needed.

Effect of Forests

It had been suggested that the better wheat yields obtained in northern districts indicated that the tree growth of the north had a general beneficial effect. The local effect of shelter upon crops could not be questioned, and at first glance one might believe in a general atmospheric effect due to the northern forests. It was found, however, that the general favourable conditions of the northern districts seemed to move to the south on some years such as 1915 and 1928 when heavy yields were obtained.

Mr. A. J. Connor, Chief Climatologist, Toronto, had stated in the "Leader-Post," December 18th, 1931, that precipitation was caused by favourable meeting of warm moisture laden air currents from the south with the cold northern air currents and when this meeting occurred over the southern parts of the province, we had as favourable conditions there as in the north.

It might safely be assumed too, that any deforestation which had been brought about in Saskatchewan must be in the northern districts, yet marked increase in yields per acre had occurred in those districts during past few years. On the other hand, districts one and five in the east part of the province had had a marked increase in tree growth during the past thirty years, and showed a bad falling off in recent crop yields. He was forced to conclude then that the effect of forest upon agriculture was limited to the local and direct shelter which it gave.

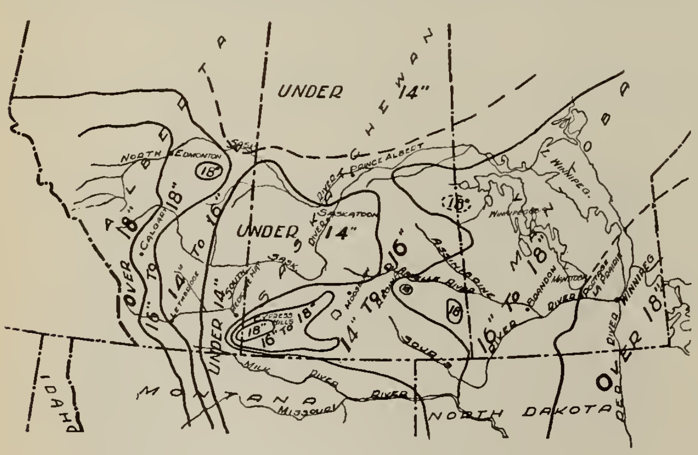


Fig. 11—Average Annual Precipitation.

He had found it necessary to divide the people who discussed this matter into two classes. The first, and larger class, included engineers, agriculturists, meteorologists, etc. who endeavoured to study all factors affecting stream flow and climate. The second group included the forestry expert and enthusiastic conservationist. He believed that the opinions of the first group conceded no effect of forest on climate, or made very modest claims for it, while the enthusiastic claims came from the second group.

An example of the viewpoint of engineers might be obtained from the book "Relief from Flood" by Alvord and Burdick which quoted a report of Lieut.-Col. Edward Burr, United States Engineers, on the effect of deforestation on the Merrimac river in New England as follows: "There has been no decrease in precipitation in the basin as a result of deforestation, or any increase with the reforestation of 25 per cent or more of its area. The precipitation for fifty to ninety years at points within the basin or within a few miles of its borders shows tendencies or cycles that bear no relation to the changes in forest areas.

"The average run-off through the river varies with the precipitation over its basin, and the percentage of run-off to precipitation is not appreciably affected by forest changes as great as 25 per cent or more of the basin.

"The frequency of flood has not been decreased by forestation, or increased by deforestation."

Other reports of a similar nature might be quoted.

He had some figures for the state of North Dakota, which showed very clearly what moisture was contributed to the air. In a Departmental Bulletin of January 1930 of the University of North Dakota, Dean E. F. Chandler stated that the average precipitation for the state was 17.4 inches and the average run-off .6 inches. The state had a splendid artesian basin fed from higher areas to the west and while the amount of water secured in that way was small compared with rainfall, it might safely be assumed that it balanced any water lost through deep seepage. He also stated that every drop of rainfall was finally included in *evaporation* or *run-off*, other parts of the paper indicating that rainfall included all precipitation and evaporation included transpiration. Therefore of 17.4 inches precipitation in North Dakota 16.8 inches was returned to the atmosphere over that area.

In the wooded area which adjoined the prairie on the east, the Winnipeg river measured at Slave Falls with a drainage area of 47,700 square miles showed an average run-off of 7.247 inches over drainage area, for a 10-year period ending September 1929. The precipitation according to government records was about 24 inches, the amount returned to atmosphere being 17 inches or less. For the wooded area north of the prairies the precipitation was 15 to 17 inches and run-off of two inches. Therefore the treeless area to the south returned to the atmosphere as much moisture as the wooded area to the east of the prairies and more than the wooded areas to the north.

This showed that some writers on forestry were not familiar with the fundamental facts concerning climate. Usually reference was made to the great benefit from transpiration, some writers stating that a forest would give to the air more moisture than an open water surface. How could that be of benefit in an area when an open water surface evaporated twice as much moisture as was obtained in precipitation and a field of wheat would use all that came in one season and all that could be carried over in summer fallow from the preceding year? Forest, it was believed, had a double effect in reducing evaporation from the soil, and increasing moisture in the air through transpiration. Some such benefit might be expected if precipitation came at the wrong time of the year. Actually, however, the average distribution of precipation through the year was nearly ideal.

He did not know to what extent those quoted by the author had studied conditions in Canada, but because of the difference of opinions expressed by eminent men, some must be discounted. The facts concerning the prairie provinces showed conclusively, to his mind, that forests have little or no general effect. The value of any forest work done, must, therefore, be judged from the standpoint of local and direct benefit.

The planting of trees could be endorsed for beautification and shelter belts around farm homes and as an ardent horticulturist, he would like to endorse all tree-planting proposals. He feared, however, that over-enthusiastic claims for their benefit would, in the end, have an adverse effect. He was aware that the Conservation Commission was practically committed to an experimental test on hedges but believed that frank opinion is still desired. He was afraid that experiments and study in this connection would bring disappointing results in as far as the extensive use of hedges on grain-raising farms was concerned, though he believed that the usual shelter belt idea could be extended to include several small plots around farm buildings, these small plots to be used for gardens, root crops, growing of feed, pasture etc.

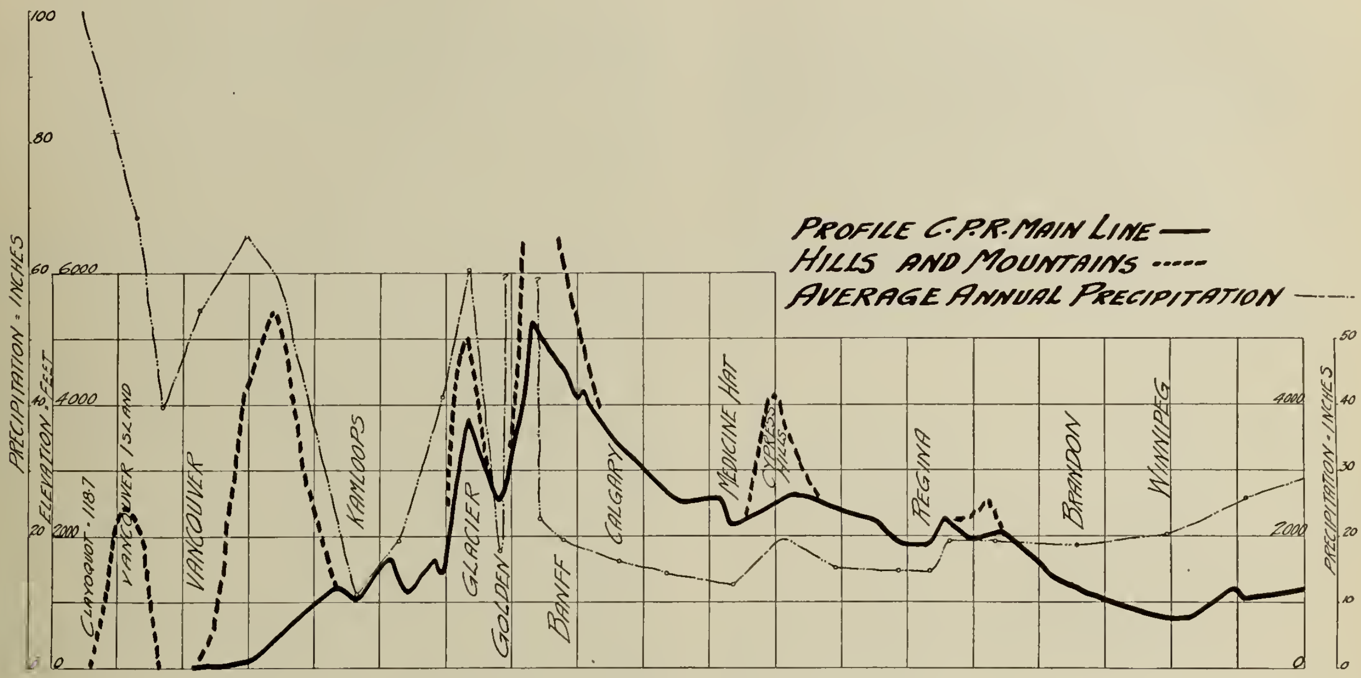


Fig. 12—Effect of Mountains on Precipitation.

The author had suggested hedges 1,300 feet apart. With a northwest or southwest wind there would be a sweep of approximately 1,800 feet and with a south or north wind, practically no shelter would be provided. He was convinced after very careful observation during the past two years, that hedges would have to be placed much closer to prevent soil drifting when the surface is finely pulverized. The usual claims for effect on crop were for a distance of ten to fifteen times the height of the hedge and the author's photographs would indicate that the marked effect on crops did not exceed 150 feet. If hedges were placed close enough together to have a beneficial effect for all the land, the operation of farm machinery would be severely cramped also the cost of planting and cultivation would be a considerable factor.

Some people were in the habit of assuming that devices which had proved satisfactory for catching drifting snow would be useful in checking soil drifting. It should be remembered, however, that snow usually came on the move and usually no harm was done if a drift four or five feet deep was collected. On the other hand, damage was taking place the minute that soil began to move and the treatment should be designed to prevent the start of soil drifting.

While the run-off from the Saskatchewan dry belt was extremely light when expressed as a fraction of the annual precipitation, it would be found to make up a large quantity of water when measured in terms of local use. Much good could be done in conserving this run-off water for use in domestic supplies which included water for stock, and for small irrigation projects. Suggestions along this line made by the author would meet with the hearty approval of all and he would particularly like to endorse his suggestion for municipal reservoirs.

In conclusion, he would like to state that the study had not shaken his faith in the prairie provinces. There appeared no need even to suggest the necessity for the general movement of settlers from the dry area of the prairie provinces. Difficulties did exist but would be overcome if squarely faced.

Discussion on "The Hydro-Electric Power Development at High Falls and Masson on the Lièvre River"

Paper by H. S. Ferguson, M.E.I.C.[1]

J. P. Growdon.[2]

Mr. Growdon stated that he would confine his written discussion of the paper to one specific feature of the Masson plant, namely, the use of a pressure tunnel to convey the water from the dam to the power-house, which appeared to have given a very satisfactory solution of the problem. The type of conduit chosen had many advantages over penstocks or an open canal.

He noted that it was necessary to locate the tunnel approximately 130 feet below the centre line of the turbine scroll case, and would be very much interested to learn of the method used to compute the amount of rock cover required to make the tunnel safe against the cracking of the unreinforced concrete lining.

James W. Rickey, m.e.i.c.[3]

Mr. Rickey observed that he had enjoyed the excellent brief description of two very interesting hydro developments. The Masson plant in particular involved some difficult design problems, which could not be covered in detail in a paper of this type.

He would be keenly interested in having further information on the following points:

1. The study and reasoning which had led to the decision to cover the High Falls penstocks with two-foot depth of concrete as compared to:
   (*a*) A lesser thickness, reinforced.
   (*b*) No concrete cover.
2. The reasons for placing the transformers and the 110 kv. switching equipment indoors at High Falls and the details of the fire protection.
3. The provision for raking racks, and for keeping racks free from ice at both plants.
4. The method of taking care of stresses in the various wye branches in the Masson conduit, particularly those at the power-house end, which were under fairly high pressure.
5. The minimum rock cover over the 25-foot diameter conduit tunnel at the up-stream end of the steel lining which extended into the tunnel from the power-house. (Masson tunnel.)
6. Was any grouting done behind the concrete tunnel lining? (Masson tunnel.)
7. Was the tunnel excavation on a 45-degree slope found to be expensive? (Masson tunnel.)
8. The study and reasoning which had led to the decision as to the area of intake gates and racks. (Masson plant.)

Professor R. W. Angus, m.e.i.c.[4]

Professor Angus remarked that he was sorry he had not seen the paper until the meeting and he was unable to discuss it fully, however, there were two points in the paper which deserved special attention. The first one was the intake construction. The author stated on page 61 that a laboratory model of the intake was built on a 1 to 24 ratio, but he did not understand exactly what features were investigated and whether any of the passages, as shown in Fig. 5, were the result of this experimental study or not. It would seem, at first sight, that to construct the openings in the form of four different tubes would naturally result in quite a serious loss of head. There was a loss of head of one inch in the intake, which he presumed was the loss up to the beginning of the 25-foot tunnel, but the construction of short pipes of the form shown forced the water to go somewhere it did not want to go, and there was likely to be a serious loss.

Unless the models showed differently, it would look as if less loss would have resulted if relatively thin concrete walls had been built between the gates and the 25-foot tunnel, (these walls being just sufficient to turn the water toward the tunnel), than actually resulted by making throttled openings through which the water had to go. One would think that the construction used would naturally result in greater losses of head than if the passages were left as free as possible, with thin walls to guide the water, and provide sufficient support for the concrete cover. He would like to ask if the models covered these features.

The only other point he had noticed was the rather interesting development with regard to draught tubes. In this country, for a long time, work had been done on conical tubes, although the turbines set up at High Falls were by the S. Morgan Smith-Inglis Company, and they have had the quarter turn draught tubes in nearly all their work. The turbines in the power house at Masson were built by the Canadian Allis-Chalmers Company, and while this company had very largely used the White hydraucone, yet it was interesting to note that the draught tubes, as shown on the drawing, were quarter turn tubes. It was also interesting to note that the bend at the elbow was almost a right angle, and that the design used in many plants in Europe was being followed.

H. S. Ferguson, m.e.i.c.[5]

The author in reply to Mr. Growdon observed that the tunnel was located at such a distance below the surface of the bedrock that at no point should a section of the rock between the tunnel and the surface, unit length measured along the axis of the tunnel, and of trapezoidal section in a vertical plane perpendicular to the axis, weigh less than twice the greatest unit pressure in the tunnel at that point multiplied by the diameter of the tunnel. In computing its weight, the width of the trapezoid was taken to be 26 feet at the centre line of the tunnel, the sides diverging toward the surface, each making an angle of about nine degrees with a vertical line.

The centre line of the tunnel had a constant slope between the inclined outlet sections at each end, and the profile of the rock surface above it was such that for almost all of its length the depth of rock exceeded that required by the rule given.

In answer to Mr. Rickey he observed that the surface of the rock, between the High Falls intake and power house, was so irregular that much excavation was necessary to provide reasonably straight routes for the penstocks. The result of the excavation work was that the penstocks lay partly in trenches, the depths of which were small at some points, and were nearly equal to the radius of the penstock at others.

Instead of building individual cradles of the dimensions and spacing required for adequately supporting and anchoring the penstocks to the very steep slope on which they mostly lay, it appeared to be as economical to entirely

[1] This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and published in the February 1932 issue of The Engineering Journal.

[2] Aluminum Company of America, Pittsburgh, Pa.

[3] Chief Hydraulic Engineer, Aluminum Company of America, Pittsburgh, Pa.

[4] Head of Department of Mechanical Engineering, University of Toronto, Toronto, Ont.

[5] Consulting Engineer, New York, N.Y.

fill the clearance spaces between the tubes and the rock trenches with concrete, throughout.

This plan resulted in completely covering the penstocks with concrete for the larger part of their lower semicircumference, and afforded more effective supports and anchorages.

It was thought desirable to cover the entire surface of the tubes to prevent the formation of ice on the inside of the steel plates. Another type of covering could have been used for the upper half, but since so much of the surface was to be covered with concrete in any case, it was decided to entirely surround the tubes with concrete, thick enough to obtain the desired rigidity of section without the use of steel reinforcement.

The ground around the High Falls station was very rough and precipitous and there were no level areas within a reasonable distance of the power house where the transformers could be located and convenient means for handling them could be provided. The most feasible location seemed to be at the rear of the main generator room.

There were in all seven single-phase transformers, one of which was a spare unit. The space that they occupied extended alongside the generator room for a little less than two-thirds of its length, or a distance of about 114 feet. The arrangement was such that each could be rolled forward into the generator room and then lifted and transferred by the overhead crane to a space in one end of the room where they could be dis-assembled and repaired. The area occupied by them was surrounded at the back and ends by reinforced concrete walls, and there were reinforced concrete barrier walls between them extending to a point well above the tops of the transformer tanks. The seven openings which connected with the main generator room were provided with steel rolling doors, and there were open pits beneath each transformer which were drained to points outside of the building, and in which the oil and water pipe connections were located.

No mechanical devices had been provided at either plant for cleaning the racks in place. The racks were built in several sections, so arranged that they could be hoisted into the gate house to be cleaned or repaired. At each station, one of the units could be taken off the line at almost any time, the head gate could be closed, and the racks lifted and cleaned whenever it was necessary to do so. In each gate house, one removable emergency gate, built in sections, had been provided. This could be placed in grooves above any of the intakes, should it be necessary for any reason to unwater a gate or the rack above it.

Nothing had been installed to keep the racks clear of ice, but provisions had been made for the future installation of electrical equipment for use in case trouble was experienced with frazil. It was not believed that difficulty from this source would be experienced, and during the two winters through which the High Falls station had operated, none had been.

The steel wye branches, tees and cylinders in the Masson conduit were designed to withstand longitudinal stresses corresponding to the effect of bulk-heading the ends of the tubes, as well as the radial stresses due to the internal pressure.

The tees from which the surge tank risers branch, were so deeply and solidly bedded in concrete with solid rock extending for a long distance beyond the concrete, that the support thus afforded was depended upon to resist those components of the forces which tended to produce lateral deformation. The stresses in the shell of the 18-foot diameter cylinder were carried around the opening cut for the branch by very heavy reinforcing plates.

In the wyes, the joints formed by the intersection of the two branches were made by riveting the shell plates to very heavy steel castings having three flanges, to two of which these plates were riveted. Heavy tie plates in the vertical plane were attached to the third flange and took the vertical components of the stresses in the shell plates at the joint.

At the lower end of the 25-foot tunnel, the surface of the rock was 165 feet above the centre of the tunnel and the surface of the ground is about 15 feet higher.

The lining of the tunnel had only been commenced at the lower end (April, 1932). Grouting under fairly high pressure would be employed throughout its length to insure complete filling of all seams and irregular spaces in the rock surface, particularly at the top of the arch where the grout pipes would be inserted at close intervals.

The costs of excavating the inclined shafts, compared with that of the main tunnel, were not known to the author, since the entire work was being performed under a contract in which the entire excavation work was included as a part of a single sum. Doubtless the unit costs of the excavation in the inclined shafts had been greater than that of the main tunnel, but it was believed that the cost had been but little greater, if any, than that of excavating the vertical shafts.

The areas of the intake gates and racks had been calculated to keep the velocities at these points within such limits that the head losses would be small. When water was passing through them at the maximum rate, the mean velocities at the face of the racks and gates were respectively 2.1 and 2.5 feet per second. No particular rule concerning the relation between the allowable head losses and the total available head was invoked in limiting the velocities to the rates stated. The limiting velocity through the racks had been more or less arbitrarily established, as a matter of experience, and the effort had been made to so proportion the water passages between the upstream faces of the intake, where the velocity was very low, and the cylindrical branches below, where it was relatively high, that the changes of mean velocities at successive cross sections would not be abrupt. Plotting the mean velocities as abscissas against distances along the centre line of the passages as ordinates, a line was obtained consisting of a curve at each end, connected by a nearly straight inclined line, and the tangents at the points of beginning and ending of the curves were horizontal.

With regard to the enquiry of Professor Angus, the author stated that the purpose of the model tests had been to determine: first, whether the rates of flow through the four branches of the intake would be substantially alike in each, and if not, what changes of form or dimensions would accomplish this result; second, whether considerable differences would occur between the velocity of the water at any point in the plane of the racks or screens and the mean velocity at this plane; third, the total head losses between the upstream face of the intake structure and the point of beginning of the 25-foot diameter tube.

During the first series of tests which had been made, there was a small difference between the volumes of water flowing through the two outer and two inner branches of the model, and there were points in the plane of the racks at which the velocities departed considerably from the mean velocity.

The form of the outer branches of the model had then been modified by reducing to some extent the swell or bulge of the outside contour, which occurred just above the cylindrical portion of the branches. Slight changes had also been made in the shape of the noses of the division walls at the upper face of the intake.

A second series of test runs had showed that the changes resulted in obtaining very nearly equal volumes of flow through the four branches, and that variations of the velocities at the plane of the racks had been greatly reduced.

The design of the intake had then been changed, and the structure built to conform to the modified form of the model.

The tests indicated that the total loss of head between the points mentioned would be about 1.05 feet, excluding that caused by the racks themselves, when the flow through the intake was at the maximum rate of 7,500 second-feet. The difference between the losses which occurred before and after the changes in the model were made, proved to be practically negligible.

Several preliminary designs of the intake had been partly worked out, among them one which embodied features similar to those suggested by Professor Angus. No models of these had been made, and what the corresponding head losses would have been were consequently unknown.

The adopted design had been selected because estimates of the cost of constructing the intake according to the several designs considered, indicated that it was less expensive, and structurally the problems presented were simpler.

Ordinarily, the rate of discharge through the intake would be less than 6,000 second-feet, and the head losses would be less than 0.60 feet or about 0.3 per cent of the effective head at the turbines. It was considered that any probable reduction of head losses which would be obtained by adopting another design was not justified by the extra cost of the structure.

Discussion on "The Central Heating Plant of The Toronto Terminals Railway Company, Toronto"

Paper by J. A. Shaw, M.E.I.C.[1]

J. A. Shaw, M.E.I.C.[2]

The author on the conclusion of his paper observed that the installation of a combined central heating plant in Toronto was exceptionally interesting as an example of what could be done in view of our present railway problems in Canada, by proper co-ordination. The plan had worked out to the advantage of all concerned through lower initial and annual costs, and to the city, through the diminution of smoke. In the preparation of the plant, considerable difficulty was encountered in obtaining exact information as to what load should be provided for. It was suggested that a large section of the downtown district should be served, from Yonge street to York street and as far north as King street. It was eventually decided to confine operations to the terminal buildings only. Due to the Post Office having been previously served upon a request from Ottawa, it was decided to extend the service to the new Customs House. There were also other terminal buildings which no doubt would be developed in the near future when conditions improved.

The original estimate called for 2,000 h.p. for supplying the Royal York hotel, but after construction had been in progress on the hotel for some time, it was decided to put in a newly developed system of automatic modulated heat control. This was done, with the result that the steam demand was considerably reduced. Then, shortly after the hotel was opened, a further extension to the building was made. Therefore, it would be appreciated that reliable data as to the load were not obtainable in advance and it was necessary to make allowances for contingencies.

E. A. Ryan, M.E.I.C.[3]

Mr. Ryan stated that he had read with much interest Mr. Shaw's excellent contribution to the Proceedings of The Institute, which described one of the outstanding engineering projects of the last few years in Canada.

The paper, together with the work described, was worthy of study by the members and the public generally, as it indicated the progress that was being made in Canada along the lines of economic development in respect of railway terminals.

The speed with which the project had been pushed to completion reflected great credit on those associated with it—for it would be noted that preliminary load surveys were made late in 1927, and steam was delivered to the various buildings in August 1929.

He would appreciate further information on certain features that on first sight were not clear—and which might have given similar impressions to others.

The number of boilers installed was such as would undoubtedly make for great flexibility, but it would appear as if the capacity of the plant—both rated and actual—was well in excess of the probable known load. Perhaps it was the intention to extend the services to other buildings in the vicinity?

The arrangement of the main steam header in a loop around the basement of the boiler room seemed unusual. Was the loop provided with sectionalizing valves, or was there an auxiliary loop? Judging by the provisions made against shut-down by duplication of main steam services out of the plant he would assume that the main steam header would be similarly guarded—particularly as it appeared to be of flanged construction—but there was no reference to this in the text or illustrations.

The pipe supports shown were interesting and he could quite appreciate the value of the comment in support of the method. Generally the unnecessary waste that occurred around an uncovered flange or piece of large pipe was not realized until an analysis had been made. The arrangement illustrated showed a method of minimizing the losses usually occurring from this source.

The reason for the absence of economizers as part of the plant equipment—particularly in view of the large quantity of fresh water "make-up" referred to on page 71—would be of interest.

He presumed that the principle of "steaming" the locomotives from a central plant was an innovation. It should certainly effect very material savings in fuel and time, particularly—in addition to the other advantages cited in the paper.

H. H. Angus[4]

Mr. Angus considered that the description of the plant was of interest as giving information regarding a central plant for use in railroad work.

The plant installed, however, did not appear to be the economical solution of the problem involved. Figs. 2 and 3 gave the total steam generated per month and the maximum demand per hour. From these curves it would be seen that the maximum peak load was 5,000 h.p., and the average peak about 4,200 h.p. for five months, and 2,500 h.p. for the rest of the year. The average load was about 2,800 h.p. during the winter months and 1,400 h.p. during the summer months.

It was common practice at the present time to operate boilers in large plants at from 400 to 600 per cent of normal rating, and in smaller plants from 250 to 300 per cent,

(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and appeared in the February, 1932, issue of The Engineering Journal.

(2) General Electrical Engineer, Canadian Pacific Railway Company, Montreal.

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especially where the load fluctuated, as it did in the plant under discussion, and the peak occurred only for a short time during the winter. When operating at not over 300 per cent rating it had been found that properly designed and operated boilers were out of commission for repairs less than 15 per cent of the time. The author had chosen for use, boilers having a nominal rating of 819 h.p. These boilers would each produce 2,000 h.p. at 250 per cent rating, and 2,500 h.p. at 300 per cent rating. During the winter months, two of these boilers would ordinarily carry the load, and in real cold weather three boilers would carry the peaks at a maximum of less than 200 per cent capacity with a fourth boiler installed as a reserve. During the spring, summer and fall, one or two boilers would be used. This plant of four boilers would have a surplus of over 1,000 h.p. for future additions. There seemed to be no object in installing the four 550 h.p. boilers described in the paper.

For economical operation and saving in repairs, the boilers should have been equipped with a rear water wall, an economizer and induced and forced draught fans. With this equipment, most manufacturers would guarantee an efficiency of between 83 and 85 per cent at any load between full load and 300 per cent overload, and would have resulted in a yearly operating efficiency of around 80 per cent, which was considerably higher than the figure of 72 per cent given in the paper. Steel stacks supported from the roof of the boiler house would have been much cheaper than the brick chimneys used, and if painted at reasonable intervals would have lasted indefinitely.

For a plant of this size and in its location, storage capacity of 1,350 tons in an overhead bunker was excessive, as this was close to seven days supply at peak load.

Regarding the pipe lines to the various users of steam, a considerable saving could have been made by using velocities of around 15,000 feet per minute, which were not considered high in central station heating systems. If this velocity had been used, the 14-inch pipe line would have been reduced to 8 inches, and other lines in the same proportion. This would have resulted in a saving of initial capital cost as well as reducing the loss due to radiation. To do this would have required an increased pressure at the boilers, but would have caused a very slight increase in the coal bills. In central heating plants a boiler pressure of 250 pounds per square inch was commonly used in order to reduce the loss in the distribution mains.

W. H. Bonus[5]

Mr. Bonus believed that there were certain phases of particular interest; for instance, no mention had been made of height of the boiler settings or furnace volumes and it would be interesting if the author would give this information.

While there were two distribution lines for the steam there was apparently only one header at the rear of the boilers. In order to insure continuity of service in a plant with a load of this nature, it would seem advisable to have had a duplicate header.

In the general layout of the plant, had consideration been given to generating steam at higher pressures, i.e., 300-350 pounds per square inch, with ratings of 250 to 300 per cent, and, by means of bleeder turbines, deliver some of the steam into the tunnel mains at the desired pressure, and use the power so generated for the Toronto Terminals Company instead of using all purchased power?

The turbo-generator set referred to was he believed an emergency unit, and he would like to know what use was made of the exhaust.

The author had referred to one elevator to handle both coal and ashes, both operations taking place at the one time. Had experience shown that it was good practice to depend on one combined ash and coal handling unit or should there be separate, or duplicate, units?

Reference had been made to the fact that only 40 per cent in winter and 60 per cent in summer of the condensate was returned to the plant, and that it had not been found economical to install sufficient return lines to carry back as much of the condensate as was possible. Referring to the log sheet of daily and monthly operation, 40 per cent return during the month of January 1931 meant a loss of 60 per cent of 63,000,000 pounds of water, or 38 million pounds of raw water at 51 degrees F. to be added in place of the same amount at 160 degrees or, for easy computation, a temperature difference of 100 degrees. With 72 per cent efficiency and a coal assumed to be 13,500 B.t.u. per pound, this indicated a loss, due to additional fuel required, of approximately 200 tons of coal during the month of January 1931.

The plant apparently distributed about 86 per cent of the steam generated and this appeared to be low. But, assuming that this percentage existed on an average during 1931, when an estimated total of steam generated amounted to 500,000,000 pounds, there would then be distributed 430,000,000 pounds of steam. It was fair to assume that a yearly average of returns would be 50 per cent although probably lower than that, as 40 per cent was during the winter when quantities were large and 60 per cent in summer when the quantities were small. However, assuming 50 per cent., the total yearly make up would therefore be at least 215,000,000 pounds of water at 51 degrees F. The condensate average temperature at the plant in winter was 160 degrees F. dropping to 140 degrees F. in the summer. So it would be fair to assume the average temperature throughout the year to be approximately 150 degrees, or about 100 degrees F. difference in temperature between condensate and city water.

Additional coal required during the year to heat this raw water:—

$$\frac{215,000,000 \times 100 \times 100}{2,000 \times 13,500 \times 72} = 1,100 \text{ tons}$$

Assuming coal to be \$5 per ton, loss = \$5,500 per year.

With an allowance of 10 per cent covering depreciation and interest, it appeared that an expenditure of about \$50,000 would be justified.

In addition to the cost of the estimated amount of 1,100 tons for the season there was the cost of the water taken from the city to supply the make-up. This, in itself, was no small item, being 215,000,000 pounds at 13¾ cents per 1,000 gallons, or a total cost of \$2,956.25 per year.

L. M. Arkley, M.E.I.C.[6]

Professor Arkley remarked that he had the pleasure of inspecting the plant several times, and the same impression was received when it was seen as when listening to the paper, and this impression was of a plant which had been built with the minimum of cost to do certain work and still give a good efficiency. Water-cooled walls, and many other things which were expensive had not been used and he thought that perhaps it was largely a matter of cost.

If one was so inclined all kinds of money could be spent in making a plant a little more efficient, but it was a question whether the increase in efficiency justified the extra cost involved. The author was not ashamed of the analysis of the flue gas, and anyone passing through could make an analysis for himself. He had done so and found the CO_2 a little over twelve per cent, which was very fair.

Again with regard to the second last line on page 71 of the paper, where the author spoke of the total cost of distribution steam, the cost had not been given. If this could be done it would be one of the most interesting points in connection with the paper.

[5] University of Toronto, Toronto, Ont.

[6] Professor of Mechanical Engineering, Queen's University, Kingston, Ont.

J. R. W. Ambrose, m.e.i.c.[7]

Mr. Ambrose observed that the author had mentioned that perhaps the capacity of the plant might appear larger than required. This was intentional as when the estimate was prepared, anticipated demands were in a nebulous state, for instance, the Canadian Pacific Railway had not finally decided on a direct steaming system. The Custom House load was not contemplated and enquiries were being received from other parties for steam service. With this in view, it had seemed good practice to reserve a certain amount for future requirements, especially in view of the fact that the amounts of steam asked for by the two railway companies were only an estimate and might be exceeded by as much as 30 per cent.

The author had been very modest in telling of the efficiency of this plant. When the plant was up to its capacity he thought the results would be agreeably surprising. There was one thing which the author did not mention, however, and it would be very interesting to hear why powdered coal had not been used as he believed a study of this type of fuel had been made.

M. Barry Watson, a.m.e.i.c.[8]

Mr. Watson stated that in connection with the special pipe roller and pipe supports which were used, this appeared a very minor item, but nevertheless an added expense might have been saved by replacing the small wheels and axle in each pipe support with a straight roller under each pipe bracket rolling on a flat plate, making both the pipe bracket and bottom plate long enough to prevent overrunning. He saw no objection to this simpler and cheaper mechanism, but probably the author had gone thoroughly into the question and had had some good reason for not using it.

A. K. Spotton[9]

Mr. Spotton remarked that he would like to know what consideration had been given to the use of a higher steam pressure, the generation of power and the use of the exhaust steam.

J. A. Shaw, m.e.i.c.

The author in reply remarked that the installation of four 550-h.p. and four 819-h.p. boilers was mainly influenced by the fact that the Terminal Company were in possession of four 550-h.p. units which had only been in service a comparatively short period. Up to the present time the full demand had not yet been required due to the programme of construction not being complete. A maximum demand of 7,500 h.p. had been supplied indicating that the boiler capacity installed would be closely proportioned for the ultimate demand.

With regard to Mr. Angus' comments, as mentioned previously arriving at a total load was an extremely difficult matter and in Canada both railways had found that the steam plants which were built were never too large. As Mr. Ambrose mentioned there was every reason to err on the large size and from what was known today, it would appear that, inside the next three years, the plant would be used to capacity.

Already some consideration had been given to extending the hotel, in addition to the extension already made. The addition of a large storage warehouse for terminal needs was also quite within the realm of probability. The load of such a building would increase the demand by 800 h.p.

With reference to operation at higher ratings, this had been considered in the calculations, and it was decided that reliability was the first consideration and that operating to 150 per cent of rating was advisable. Also this rating permitted the elimination of water walls, which reduced the initial cost. The use of units on hand restricted the size of units to be purchased and if a higher pressure had been adopted the boilers on hand would have had to be scrapped.

It was considered that the initial outlay for economizers was not warranted. Steel stacks had been used in railway practice to within the last five or six years but in 1926 and 1927, when the railways were able to lay aside a small surplus, one of the first expenses authorized was the elimination of steel stacks, as they continually required attention such as painting, repairing or renewals. Therefore, the introduction of a permanent form of stack was decided to be preferable.

Considering the ultimate capacity of the plant, it was estimated from 300 to 400 tons of coal would be burnt daily, therefore, the capacity of 1,200 tons for the coal bunker was not excessive when the winter interference with traffic was also considered. On more than one occasion in recent years, there had been very irregular movements of coal into Toronto. Tie-ups occurred usually in Buffalo, and the coal supply had run short for a day or two and then acceptance of three or four times the normal amount of coal ordered had been expected; with extra capacity it was possible to prevent charges for demurrage or placing the coal in storage dumps. The capacity of the bunkers had received every consideration from both operating and fuel officials.

Mr. Angus had referred to the size of the steam lines. The changes he suggested would have meant increasing the steam pressure of the generating unit and as this was held down to 200 pounds, a higher outlay would immediately have been incurred by such action. A larger distribution line with 200 pounds pressure was decided on as a conservative design.

In reply to Mr. Bonus' inquiry the boilers were set 14 feet from the boiler room floor, that is to the bottom of the headers. The furnace volume of the 550-h.p. boilers was 1,135 and of the 819-h.p. boilers 1,730 cubic feet and they were arranged to operate continuously at 150 per cent boiler rating and at an emergency rating of 200 per cent.

The use of one header only instead of installing an auxiliary loop or header was also considered including cost and it was decided that as the size of the header was 16 inches, and the best form of construction in the way of flange connections had been used, there was very little if any risk involved in using the single header, as a complete tie-up would only occur if a breakdown occurred at the back of the smaller units.

The question of bleeder turbines for developing power had not been considered as the electric service locally was reliable and the railway companies did not wish to go to anyone other than the Ontario Hydro-Electric Commission for electrical current, as the rate offered was reasonable. Installing turbines would have required expensive additional accomodation and possibly a condenser with a special water supply.

No provision had been made for the use of the exhaust from the steam generating set, as it was installed purely for emergencies.

The capacity of the coal bunker provided against any serious interference through breakdown of the only coal and ash elevator. Further, the maker of the hoisting equipment was within one-half mile of the plant.

Sufficient superheat was provided in the boilers to ensure the delivery of dry steam with a reduction in condensation troubles. At the hotel steam was received at 40 degrees superheat which was close to that desired for operating unaflow and high speed Belliss and Morcom engines. With the comparatively long delivery line to the Canadian National yards steam was delivered with from 3 to 4 degrees of superheat.

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(7) Chief Engineer, Toronto Terminals Railway Company, Toronto, Ont.

(8) Angus and Watson, Consulting Engineers, Toronto, Ont.

(9) Babcock-Wilcox and Goldie-McCulloch, Ltd., Galt, Ont.

Relative to the return of condensate, as indicated in the paper, in both the Canadian Pacific and Canadian National yards the larger quantity of steam was used for coach heating, the condensate of which could not be saved. This left only steam used for heating buildings, as the condensate of the steam used for direct steaming in the Canadian Pacific Railway roundhouse remained in the locomotive boilers. Therefore, taking into consideration the comparatively small amount of condensate and the length of the return it was not thought economical to bring it back. Where the condensate could be used to economical advantage as in the case of the hotel and station, both of which used steam in summer as well as winter, return lines had been provided.

Mr. Arkley had brought up the point of efficiency. The statement referred to might have been more clearly expressed. It was desired to point out that taking the total water evaporated, divided by the pounds of coal burned, and its thermal efficiency, together with the temperature of the boiler feed, gave an evaporative efficiency of 72 per cent for the year's operation, which might be considered a satisfactory showing and indicated maintained alertness on the part of the operating staff.

As regards the use of pulverized coal, this had been gone into thoroughly. There was the difficulty of overcoming fly dust from the stacks, which was a serious matter in view of the fact that the prevailing wind tended to carry any dust over to the front of the hotel and the city and any danger from that point must be eliminated. Then, again, the difficulty of dealing with a variable load was a more serious one when pulverized coal was considered. Also, from the standpoint of reliability and first cost, the estimates were in favour of the stoker installation.

Although the question of pipe supports seemed to be a small detail to touch on, it was well worth while in order to overcome the continuous loss by radiation as well as to keep down the temperature in the various tunnels. In the past, experience showed that after a period of four or five years, the amount of bare pipe exposed above the pipe supports became important and for that reason a little more thought than usual was given to trying to overcome the loss.

Mr. Spotton had mentioned higher pressures. This had been touched on, also the development of power, however the policy of the railroads was not to develop power where power was already available on a fair basis.

Regarding the comments on the fuel used, advice was received that the most economical would be American slack, so that the plant was designed to burn the cheapest form of slack obtainable in Toronto.

Discussion on "The New Pumping and Filtration Plant at Niagara Falls, Canada"

Paper by H. G. Acres, M.E.I.C., and S. W. Andrews[1]

Wm. Gore, m.e.i.c.[2]

Mr. Gore observed that the plant described seemed to have been well designed and carried out, and formed a very interesting example of modern waterworks practice. In the pretreatment of the water the filter alum was added in the suction well of the low lift pumps, which ensured a thorough mixing of the chemical with the water in the passing through the pumps. The treated water then passed through a series of spiral flow tanks which served to coagulate the precipitate created by the reaction between the alum and the water. From the coagulation tanks the water passed into settling tanks where the precipitate settled out leaving the water relatively clear so that subsequent filtration might proceed without putting too great a load on the filters. The slow stirring of treated water after thorough mixing was now known to be of considerable assistance in securing precipitation. It had to be carried out with considerable care, as the floc readily broke up again if the stirring was too vigorous. The first coagulation stirrers of which he was acquainted were introduced by Mr. Baylis of Chicago and many experiments using mechanical devices were made by him.

The application of the spiral flow tanks to the same end was largely developed under his direction by the city of Ottawa, where it was found they were superior to mechanical stirrers. They had since been found to be very effective with the water of the city of St. Thomas and the city of Belleville, and they were being applied to the much larger plants of the cities of Toronto and Calgary. The tangential entry spiral flow system was showing itself to be a very effective one in preparing water for filtration, provided it was carried out for a sufficient length of time.

He had been wondering what kind of shocks in the delivery mains were experienced by the use of the stop and check valves, and whether it was really desirable in cases of long mains to put in air vessels. At Belleville stop and check valves were used where the delivery main was only 24 feet long, and it was found that the valves could be closed just quickly enough to prevent reversal of the pumps, and of course shocks were not experienced by reason of the short length of mains involved.

A. G. Riddell, a.m.e.i.c.[3]

Mr. Riddell asked if there was any question involved in removing the water from the Chippewa river for water supply purposes, and did the Ontario Hydro Commission have any objection to this removal? It was a very small amount.

H. W. B. Swabey, m.e.i.c.[4]

Mr. Swabey inquired whether Bonna reinforced pipe had been used and if it had been made in Canada.

N. J. Howard[5]

Mr. Howard remarked that he would like to know whether the author was satisfied that when the extension of the Niagara Falls plant was made the mechanical mixing time period, which he understood from Mr. Andrews was reduced from 40 to 20 minutes, would be of sufficient duration to handle the artificial system of precipitation for which that process was developed. Generally speaking he had found that 30 to 40 minutes was almost the minimum time that would produce an effective floc, and he had understood Mr. Andrews to say when the plant was extended up to 40,000,000 gallons capacity the 40-minute period would be reduced.

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(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th, 1932, and published in the March, 1932, issue of The Engineering Journal.

(2) Gore, Nasmith and Storrie, consulting engineers, Toronto, Ont.

(3) Superintendent, Bernard H. and Fred Prack, architects and engineers, Hamilton, Ont.

(4) Director and Manager, Inspection Department, J. T. Donald and Co. Ltd., Montreal.

(5) Toronto Island Filtration Plant, Toronto, Ont.

A. U. Sanderson, M.E.I.C.[(6)]

Mr. Sanderson stated that he had listened to a very comprehensive description of this modern plant, which embodied many special features, and he thought all were interested in the results of its operation. If sufficient data were available at this time he should like to know what the highest turbidity was that had been recorded, and what was the maximum amount of alum required to produce proper coagulation and settlement, also the size of filter sand, and the minimum filter runs during the season of the year when the micro-organisms were present in great numbers in the raw water.

J. L. Stanley[(7)]

Mr. Stanley, in reply to Mr. Sanderson's query, stated that the plant had been put into operation on September fourth last, with one new high pressure pump, and the additional pumping equipment had had to be brought up from the old station, and installed in the new. As a result of this change over the plant records were not as complete as they might be. Also the plant had been in operation for such a short period that there had not been time to make a complete study of the turbidities, alum dosage, filter hours, etc., and he would not care to give any definite figures at the present time.

A. F. Macallum, M.E.I.C.[(8)]

Mr. Macallum inquired whether there had been any chemical analysis made of the river water at the plant. Mr. Sanderson had already touched upon the length of run. The only criticism he had to make was the lack of figures on the construction cost. For instance, he had found difficulty in making estimates in getting correct figures on what the cost of a filter plant would be, that was say, a unit of cost per million gallons. He had estimated one of 34,000,000 gallons and had found it would work out very closely, for the northern waters from the Laurentian district. In a plant at Ottawa there had been a rock excavation costing $90,000. That, of course, would be variable, for different foundations. For instance, sub-structure and super-structure was the principal cost in filtration plants, and he had found that to be about 65 per cent of the total cost. Rock excavation was 8 per cent, or $90,000 as given above, the filter equipment 10 per cent, the pumping equipment 4 per cent, the chemical filter ran about 4 or 5 per cent, all things like automatic gate checks, valves, sluices, etc., 3 per cent, and the conveying equipment and chlorine 3 per cent. He thought that if figures like that were given in connection with the plant it would give a very good idea of whether the cost did exceed proportionally what other plants had cost. There was one other detail which he might criticize, and that was the pipe gallery which appeared rather small in the photograph. Nearly all pipe galleries on older plants were too small. They were either too small or one could not, if anything went wrong with the equipment of these pipe galleries, handle them. The worst one he had observed was at Cambridge, near Boston. It was so small that it was necessary to crawl along the pipes to get at any place in the pipe gallery, and if a valve had to be removed it was necessary to tear away the floor above.

Dr. H. G. Acres, M.E.I.C.[(9)]

In answer to Mr. Gore's last remarks the author observed that it was of course true that the reaction from a cessation of power supply was liable to occur more rapidly on short mains than on long ones, because the long mains have more of a tendency to be dead-beat, but inasmuch as the maximum reaction was a joint function of the culminating velocity in the pipe and the length of the water column, the reaction to be anticipated was likely to be more serious in longer pipes than in short and as mentioned in the paper it was found that under a certain set condition either a direct or reflected pressure wave having maximum intensity of about 385 pounds per square inch at the pump might be expected.

That was the theoretical pressure, and one way to absorb the shock was to use the ordinary check-valve in conjunction with air chambers, but a more positive and dependable expedient was to partially synchronize the period of valve closure with the time element of the pressure wave. That could be done easily and effectively if stop-valves of the floating plunger type were used, as was done in this particular instance. The automatic mechanism attached to the Johnson valves could be adjusted to insure any necessary degree of absorption and flattening of the pressure wave.

In reply to Mr. Riddell the author stated that the amount of diverted water was so infinitesimal compared with the total volume of flow that he did not think it was seriously considered. As a matter of fact, the enabling negotiations were with the Federal Department of Public Works, and the agreement with the Hydro was more or less of a formality. The intake volume of the canal was about 18,000 cubic feet per second, so that waterworks diversion would work out to less than a fraction of one per cent.

The author in answer to Mr. Swabey observed that Bonna reinforced pipe was used, but at the time the pipe was ordered there was no manufacturing agency located here and the pipe was shipped direct from Belgium.

In answer to Mr. Howard he remarked that it was largely a matter for future determination. Every plant was of course a law unto itself. There was only one thing known at the present time and that was, that the 40-minute period that was now used was amply sufficient for the floc formation necessary to get efficient precipitation in the settling basin. It would be a good many years, perhaps, before that period of time would necessarily be reduced to the 20 minutes that Mr. Andrews mentioned, and before that there would be ample opportunity to study the quality of the water and test its behaviour under actual operating conditions. If the investigations that Mr. Stanley, the superintendent in the plant, makes during that period were such as to prove definitely that 20 minutes were not enough, then it would be necessary to provide more mixing chambers.

With regard to Mr. McCallum's allusion to cost. He usually did not like to put costs in a paper for general consumption, because while the basic conditions might be more or less standard, there were always certain ancillary conditions which had vital effect on cost, and sometimes one even forgot to mention them. For instance, in the case of the plant under discussion, he could give from memory approximately what the cost of that plant would be divided by its 10,000,000 gallons of present capacity, but that would not mean anything at all because part of the plant was built for 20,000,000 gallons, part for 40,000,000 gallons, and part for 10,000,000 gallons, and furthermore 12,000 feet of reinforced pressure pipe was included in the total capital cost. As actually built, the following approximate percentages of capital cost applied to the major elements of the installation, after deducting engineering costs, excess labour costs due to unemployment relief and landscaping, etc.

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(6) Assistant mechanical and electrical engineer, Department of Works, City of Toronto, Ont.

(7) Manager, Board of Water Commissioners, Niagara Falls, Ont.

(8) 612 Bank Street, Ottawa, Ont.

(9) H. G. Acres and Company, Ltd., Niagara Falls, Ont.

Item	Capacity-M.G.D.	Approximate Cost	Cost per M.G.D.
Pumping Station	40	$ 86,000.00	$ 2,150.00
Filter Building and Reservoir	10	180,000.00	18,000.00
Mechanical Equipment	10	92,000.00	9,200.00
Pumps and Connections	10	22,000.00	2,200.00
Electrical Control	40	35,000.00	875.00
Outdoor Substation	40	32,000.00	800.00
Intake	20	33,000.00	1,650.00
Sewer	40		
		$480,000.00	$34,875.00

Cost per M.G.D. installed — $48,000.00

Now, with regard to the tendency to crowd pipe in a filter gallery. It was rather unfortunate that Mr. Andrews did not have time to explain the details of the filter piping. He could quite understand that glancing at the pictures shown in the printed paper many might get the idea that the filter gallery was rather congested, but there was one element in the design and fitting up of the filter gallery that in his opinion had entirely offset that presumed disability, and that was the use of victaulic joints throughout practically the whole of the pipe installation. The result was that there were no overlapping or enmeshed bell and spigot joints in any of those lines of pipe, nor were there any tight-fitting gasket joints where pipe had to be pried at to get it loose. Any pipe in that gallery, after taking off the collar and removing the flexible rubber seal-ring, had a clearance at each end from the adjacent pipe of 3/16ths of an inch.

So that if any section of pipe had to be taken out, the collars and seal-rings at each end were removed and the pipe was quite loose and could be lifted out. The floor grating over the pipe gallery was arranged with removable sections, so that the filter gallery crane could drop over any section of pipe and lift it out without any trouble at all. It might be necessary sometime to take out a section of the influent to get at the effluent main, but the procedure was so simple with the victaulic joints that he did not consider that a disadvantage. The victaulic joints had been found so far entirely free from leakage.

As to raw-water analysis, no independent tests were made because it was not considered necessary. There was no alternative source of supply, and a multiplicity of analyses taken over a long term of years by the cities of Buffalo and Niagara Falls, N.Y., were available, the latter intake being in the same reach of river.

Although a fact of no particular significance, it was at least an interesting coincidence that the raw-water tests made by the International Joint Commission showed that the water in the vicinity of the mouth of the Welland river, and close to the main shore, had a greater degree of purity than at any other point on the Niagara river.

Discussion on "Reconstruction of Wharf at Kaslo, B.C."

Paper by P. E. Doncaster, M.E.I.C.(1)

J. M. Begg, M.E.I.C.(2)

Mr. Begg stated there was no need to apologize for a paper dealing with a comparatively small job. A paper dealing in complete detail with a little job or a limited portion of a large one was of more use to the engineer than a superficial paper on a larger project.

He was in entire agreement with the author on the value of a more open confession of difficulties encountered. A frank revelation and description of difficulties, misfortunes or failures would be of great benefit to fellow engineers engaged in similar work. Such candour always inspired respect.

H. W. Frith, M.E.I.C.(3)

Mr. Frith stated he had listened with a great deal of interest to the paper presented and he believed there was an economic saving in using treated timber and pointed out that all present untreated structures when the time came for renewal were being replaced by treated timber.

K. W. Hicks, S.E.I.C.(4)

Mr. Hicks remarked that special attention was given the incising process before the pressure treatment in order to secure the proper penetration.

W. G. Swan, M.E.I.C.(5)

Mr. Swan stated that he believed semi-permanent or permanent work a good investment and was glad to see the government department was at last beginning to recognize the fact.

He was considerably surprised at the shape of the structure as he was under the impression wharves were built on straight lines, but it possibly suited local conditions in this case.

The field treatment of the piling suggested also surprised him as the creosoting companies in general seemed to discredit it, whereas in this case, if he understood correctly, they were recommending it. He thought forty years for the economic life of the structure too long.

Further, he believed more consideration should be given by engineers to cedar piling in fresh water. These can now be obtained up to 60 feet. However in 1926, 27, 28 and 29 the price was high and so therefore this might have been a deterrent.

The use of a black top surface was quite in line with his own idea. He suggested using a laminated floor beneath the traffic surface for greater stiffness, less working and better bond. He thought if cold mix black top pavement was cheaper much more of it would be used.

It might be well if the author stated why he hadn't used creosoted piling and what condition the piling of the old structure was in when removed.

P. E. Doncaster, M.E.I.C.(6)

The author referred Mr. Swan to the arguments in the paper regarding the discussion on creosoted piling. He pointed out that in the appendix a log of the survey of all the old piles was attached. With few exceptions the old piling was rotted at the top and around the drift bolts.

G. E. Herrman, Affil.E.I.C.(7)

Mr. Herrman stated he believed the reason for not having creosoted piles was a matter of finance, in other words, making the suit fit the cloth. He did not think forty years too long for the estimated economic life of the structure, because in this case there were no unexposed parts in the timber, even the nail holes for the decking were prebored.

Further, he pointed out, after years of effort, this project showed the feasibility of preframing and preboring, the same method as used in steel construction. Everything went together perfectly in the field as the author had already stated.

C. J. Fox, A.M.E.I.C.(8)

Mr. Fox stated he could not see the force of the author's economic argument for the forty-year economic life. He wished to know if the capacity of the wharf was sufficient for future growth in that time.

(1) This paper was presented before the Vancouver Branch of The Institute in November 1931, and published in the May, 1932 issue of The Engineering Journal.
(2) Chief Engineer, Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver.
(3) Chief Engineer, Vancouver Harbour Commissioners, Vancouver, B.C.
(4) Canada Creosoting Company, Vancouver, B.C.
(5) Consulting Engineer, Vancouver, B.C.
(6) District Engineer, Department of Public Works, Canada, Nelson, B.C.
(7) Canada Creosoting Company, Vancouver, B.C.
(8) Vancouver, B.C.

The Installation of Radial Air-Cooled Engines

A. H. Marshall,
The Pratt & Whitney Aircraft Company, Hartford, Conn.

Paper presented on October 30th, 1931, before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada (Ottawa Section, Royal Aeronautical Society).

SUMMARY.—This paper deals with a number of the features upon which the successful operation of a radial air-cooled engine depends. The general principles governing the installation of cowling are discussed and other topics dealt with include valve temperatures, exhaust manifolds, means of regulating oil temperature, fuel supply systems, air intakes and the effect of rigidity or vibration of the engine mounting upon engine operation and reliability.

The installation of radial air-cooled engines has gradually changed from what was first a comparatively simple problem to one which is now highly complicated by the number of accessories necessarily added to meet service requirements. In view of the fact that fundamental specifications on installation details have not changed to any extent, this paper will confine its discussion to the latest developments in installation accessories and designs. It will refer to these developments from the viewpoint of the aeroplane operator, who, after all, is most affected by them, and who eventually influences all installation changes.

The operator in purchasing his equipment is reasonably sure that his choice includes a reliable aeroplane and a dependable engine. He must, however, make a careful analysis of the things which can possibly impair the dependability of these units, and insofar as they pertain to engine operation, see to what degree they can be affected by the engine installation. An experienced operator, who has confined his aviation activities to a specific locality, undoubtedly knows his requirements for satisfactory operation under his local atmospheric conditions, but he, or an inexperienced operator, would be entirely at sea in formulating requirements for operations in a locality having directly opposed climatic conditions. His natural impulse, then, is to question every detail of a new installation with which he is not entirely familiar, and which he naturally feels may be unnecessary for his particular service. Let us see, then, how the engine manufacturers and the aeroplane manufacturers are co-operating to satisfy requirements of all operators for dependable operation under any climatic conditions.

It is granted that the operator has chosen a reliable engine. It must also be granted that the operator will utilize a suitable fuel for his engines, will supply the proper grade of oil, and will service the engines carefully at necessary intervals. In this analysis, we must grant too, that the aeroplane manufacturer has provided ample support for the engine, has eliminated vibratory tendencies in its mounting structure, has installed reliable fuel and oil lines and has provided trustworthy controls. The installation problem is then reduced to the requirement of providing adequate means for regulating engine operating conditions within the limits available to the engine manufacturer for testing and proving his product. By engine operating conditions, we mean cylinder temperatures, valve temperatures, oil temperatures, oil pressure, fuel pressure, fuel line temperature and induction charge pressure and temperature. All of these conditions must be regulated within figures definitely imposed by the engine manufacturer in order that his guarantees on performances and reliability may be assured.

Engine cowling is usually thought of as a means by which aeroplane manufacturers stream-line the engine. From the standpoint of the engine manufacturer and the aeroplane operator, cowling has a more important function. It is one of the means employed to regulate engine operating conditions. Nose cowling on radial air-cooled engines must be capable of regulating the amount of cooling air to the cylinder barrels. Inter-cylinder cowling must prevent leakage of air to the cylinders and into the accessory compartment. The accessory compartment cowling must protect the accessories, permitting at the same time through suitable exits, the escape of air which has been directed into this compartment by some regulatory device controlled by the pilot.

The requirements for a satisfactory nose cowling are plainly outlined in describing its function. Its purpose is to regulate cylinder barrel temperatures and crankcase temperatures. It must, therefore, contain openings through which a flow of cooling air may be obtained, and regulated, by means of an adjustable shutter. The openings must be large enough to permit satisfactory cylinder cooling in the heat of summer. To obtain best cooling efficiency and a more even temperature gradient around cylinder barrels, the openings should be located between cylinders rather than in front of cylinders as perceived when looking at the front of the engine. Shutters, controlling the size of the openings in the nose cowl, should be capable of closing off entirely the flow of cooling air to the barrels. To obtain this feature requires accurately and closely fitted cowling, in front of the cylinders, between the cylinders, behind the cylinders and around the oil sump. Only when this has been accomplished may cylinder temperatures be regulated within reasonable limits, and in like manner, may the crankcase be kept at temperatures which will have no detrimental effect on oil temperatures. It is quite apparent that nose cowling of proper design is essential on modern air-cooled radial engine installations.

Fig. 1—Wasp Jr. Standard Engine Cowl and Exhaust Collector.

We have all noticed with interest the development of the N.A.C.A. and Townend types of ring cowling which have materially increased aeroplane performance. What effect has their use had on temperature control? We find that the N.A.C.A. cowling increases the cooling problem considerably. Because of its effectiveness in increasing aeroplane performance it could not be rejected from the cooling standpoint. Instead, deflectors were developed which directed the limited supply of cooling air to the parts of the engine most in need of it, and thus, satisfactory cooling was obtained. Because of this deflector development, it was possible to retain the advantages of both the nose cowling and the N.A.C.A. type of cowling.

Fig. 2—Parkins' Pusher Engine Ring Cowling and Rocker Box Deflectors.

Townend types of ring cowling do not affect cooling to any great extent. The shorter the chord of the cowling, the better the cooling. However, where ring cowls are installed on installations not originally so equipped, it is a good precaution to use deflectors to direct air to the rear of the cylinders. In fact, deflectors are now being used as standard equipment on many new installations not only to maintain cylinder temperatures well below maximum permissible operating limits but also to help even the front and rear barrel temperatures. Deflectors have been invaluable in the development of supercharged and geared engine installations for relatively slow speed planes, even those equipped with our present conventional cowling.

The operator is interested in these developments insofar as they increase the performance of his aeroplanes and assure the reliability of his engines; but, these features must be obtainable without any unreasonable sacrifice in accessibility. Aeroplane designers have, therefore, put great effort into manufacturing durable cowling which may readily be removed for inspection purposes, and for servicing any parts of the installation requiring periodic attention. Due to the fact that most N.A.C.A. cowlings have been impractical in this respect, we see few of them used in Commercial service. Yet, the Stearman Aircraft Company has developed an N.A.C.A. cowling which permits rather easy access to the engine through hinged sections, held in place simply by trunk latches. In like manner the Curtiss Aeroplane and Motor Company has offered to the industry a ring cowl held in place by means of only two turnbuckles which, when tightened, draw the ring down on the heads of all the rocker boxes. No additional supports are required, this cowling being retained in a fixed position by caps, lined with felt padding, into which the heads of the rocker boxes fit. These developments illustrate the trend of aeroplane designers' efforts towards retaining accessibility while improving aeroplane performance.

Valve temperatures are not controllable, but may be seriously affected by installation features. This may interest the aeroplane operator from the viewpoint of valve temperatures influence valve stem wear and valve stretching. Excessive heat is conducive to excessive stem wear by permitting rapid use of the grease placed in the rocker boxes. Excessive heat naturally reduces the strength of the valves and contributes toward their stretching. Excessive stem wear and stretch necessitate frequent replacement of valves with attendant increased maintenance cost.

Impairment of rocker box cooling is one cause of overheating valves. Inadvertently, operators may utilize ring cowls or N.A.C.A. cowls which prevent cooling air from reaching the fins on the cylinder heads and rocker boxes. Although this is normally a condition which is corrected at the time of checking a new installation, it is something to beware of. Removal of the cooling obstacle or effecting the necessary cooling by suitable deflectors are the means of rectifying this trouble.

High exhaust back pressure is the second and probably the most common cause of high valve temperatures. Here, again, we have a problem which should not concern the operator of a new machine. He rightfully may demand a guarantee from the aeroplane manufacturer, or the engine manufacturer, that this condition shall not exist. But, it is not at all uncommon for operators to add to, or to replace, original exhaust systems on their aeroplanes. Here, then, is where care must be observed. Restrictions of any sort, throughout the exhaust manifold, and in the tail pipe, must be avoided. Mufflers, containing small outlet areas, should not be used. Air heating flues must not be installed inside of exhaust pipes if they, in any way, decrease the area through which the exhaust gases flow. In all cases, the operator should ascertain that the static pressure, at any point, in the exhaust system, does not exceed five inches of water. This can easily be measured by drilling small holes at points in the manifold where the flow of gases is surely parallel to the surface of the exhaust pipe,

Fig. 3—Accessibility Obtained with Hinged Sections in N.A.C.A. Cowl.

and connecting to these holes, tubes, which are led to a differential gauge containing water.

Exhaust collector development by engine manufacturers has been greatly retarded by the inadaptability of any one design to the majority of installations. Locating the exhaust manifold in front of the cylinders of a radial air-cooled engine cannot help but impair cooling efficiency.

A location of the ring to the rear of the cylinders is, therefore, more satisfactory from the cooling standpoint, but the question of adaptability of one design to all installations, immediately arises. A ring of large overall diameter, will avoid all interference with accessory compartment cowling, and can be made in such manner as to form part of a ring cowling. This is the form of the Wasp Jr. manifold.

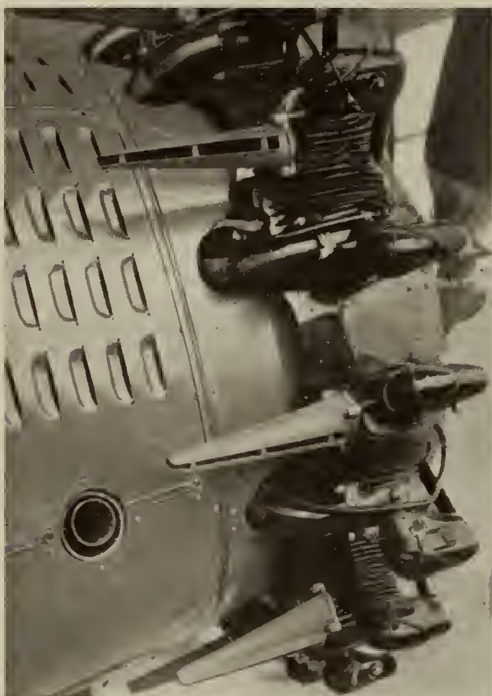

Fig. 4—Inter-Cylinder Deflectors to Improve Cooling on Supercharged Engine.

Objection may arise to the large diameter collector ring should it interfere with vision where the engine is located directly in front of the pilot. In such cases, it is expedient for the aeroplane manufacturer to design an exhaust ring of small diameter, permitting the outer periphery of the collector to form a section of the accessory compartment cowl. A protective cowling, which will prevent heat radiation to any of the accessories, must be installed about two inches below the exhaust ring, leaving an air space for cooling air circulation. The outlet for the cooling air will appear as a peripheral slot just at the rear of the collector. This is the form of exhaust manifold which is used on the Fokker, Ford and Boeing planes.

It is well to bring to attention at this point that any exhaust manifold requires cooling. Cooling of the collector is the safeguard against fire hazard. Bearing this in mind, no design, which completely isolates the collector from cooling air flow, should be accepted.

Another point of interest is that stainless steel is displacing all other materials for exhaust collectors. Its advantage lies in the fact that it does not rust or flake, thus eliminating the potential fire hazard of incandescent particles alighting on inflammable parts of the aeroplane.

All operators are concerned with oil temperature regulation. Here is a subject upon which more controversial discussion has been expended than almost any other installation governed feature. For some reason or other, engine manufacturers have been loth to recommend the use of oil coolers on their engines until every other means of obtaining satisfactory cooling in the oil lines, and oil tank, had first been tried. An oil cooler was considered a reflection upon the operating efficiency of the engine, or the efficiency of the installation. Consequently, oil tank cooling has been developed to quite a satisfactory state, but, in extreme cases, where peculiar shaped oil tanks had to be used, due to limitation of space, or where larger sized engines were employed, oil tank cooling was obtainable only by complicated forms of air ducts and flues. The ultimate installation was expensive and in most cases extremely heavy, and, furthermore, would not be as effective as a well designed oil radiator. The aeroplane manufacturer, in the end, was more willing to accept a small increase in drag, by placing in the slip-stream a small efficient radiator, than to resort to intensive research on oil tank cooling.

The engine manufacturer has taken a big step forward in developing, as an integral part of the engine, a unit which gives oil temperature control within wide limits. The new Pratt and Whitney oil regulator is located in the induction passage above the carburetor. Here, the cooling medium is a mixture of gasoline and air, available at a rather wide range of temperatures, which may be varied from 30 degrees F. to 60 degrees F. below outside air temperature, to possibly 75 degrees above outside air temperature. Heat of vaporization is given up by the air in the carburetor as it absorbs gasoline, thus producing a much lower temperature than that of the air induced into the carburetor. Yet, a high temperature is available when intake air is preheated, and also, when exhaust gases are directed through the hot spot pipe, which passes directly under the oil cooling unit in this device. Some preheaters are capable of raising intake air temperatures 75 degrees before it enters the carburetor, which gives a mixture temperature, above the carburetor, of about half this rise. As six square feet of radiating surface are presented to this variable temperature cooling medium, oil temperature regulation can well be assured. The regulation is obtained not only by controlling the temperature of the mixture, but by varying the flow of oil through the unit. A spring loaded by-pass valve, which is also controllable by the pilot, is built into the unit for this purpose.

The use of the oil temperature regulator will probably change present requirements of oil tank installations. The fact that no cooling should be required in the external oil system will permit complete isolation of the oil tank. High oil temperature may thereby be obtained in cold weather without lagging the entire oil system. Ultimately, this control over oil temperature regulation should permit the use of the same grade of oil for winter and summer operation, a real boon to the operator.

Fig. 5—Use of Streamline Shape Intercylinder Deflectors under N.A.C.A. Cowling. Wasp Jr. Engine in Stearman Mail Plane.

Improvements in fuel systems on large aeroplanes have been confined for the most part to a gradual standardization on fuel pump feed. Gravity systems, disapproved of by military units on most planes, are, from the engine manufacturer's viewpoint, thankfully being displaced by pressure feed systems on commercial planes. As long as carburetors require a rather narrow range of float valve pressures for metering accurately the fuel, so that fuel consumption may be guaranteed within reasonable limits, it is sensible to avoid the expensive determination of the actual hydrostatic fuel head in an aeroplane, the proper carburetor float valve seats for this head, the proper graduation of fuel line sizes throughout the aeroplane, the fear of fuel flow variation due to the adaptation of improper replacement service parts in the system, and the fear of vapour locks, when gravity head is relied upon. Furthermore, the operator is saved the expense of maintaining carburetors actually suitable for only a particular model of engine for which the float valve size has been determined.

Fig. 6—Tandem Installation—Note Clean Cowl Lines Around Front Engine.

The present recommended fuel system includes the use of fuel pump, by-pass and relief valves, a hand operated emergency and starting pump, an efficient strainer, a suitable selector type fuel cock, approved type compression fittings, and fuel lines incapable of becoming broken through inadequate support or insufficient flexibility. All units should be located in front of the fire wall, remote controls from the cockpit being furnished where required. All fuel lines must be located to permit easy inspection and ready replacement. Flexible metal hose, such as Titeflex, must be supported against possible movement in the manner employed for support of copper tubing. Copper tubing must contain flexible connections wherever two parts of the tubing may be vibrated by opposing forces. To avoid vapour lock, all parts of the fuel system must be located well away from exhaust pipes, and from other sources of heat. Naturally, where the fuel tank level is below the fuel pump, a high lift pump must be utilized.

It will interest the operator to know that inexpensive high lift fuel pumps are being perfected for aeroplane use. The necessary valves and, wherever possible, extraneous fuel lines are being built into compact units. It is quite certain that in the near future, fuel line installations for pressure feed systems, including those with low tank installations, will be quite as simple as the gravity feed system.

The induction system on an engine is one feature of the installation which has suffered from lack of intelligent thought on the part of aeroplane designers and, in some cases, on the part of the operator. Entrances to intake ducts have been located in all sorts of places without any regard to the effect on power loss or the induction into the carburetor of dirt or water. Many forms of scoops, preheaters and oil coolers have been deftly installed in front of the carburetor intake in such manner as to restrict, rather obviously, the flow of air to the carburetor. While such conditions favour the engine, by decreasing the available power, the engine manufacturer cannot help but criticize such installations and point out to the operators that they are not obtaining full value from their engines.

Wherever there is any doubt about intake ducts being free from restriction, it is now good practice to measure, by the same method that exhaust back pressures are measured, the static pressure in the carburetor adapter. The pressure at this point should be about equal to atmospheric pressure, but there is no harm in having available at this point a slightly positive pressure. Then the guaranteed power output of the engine will be obtainable and the fuel consumption should more nearly follow specified figures.

There is no doubt that the induction system on radial air-cooled engines is rather complicated. But, by virtue of its function in regulating engine operating conditions, and because it is the controlling factor in permitting the relatively high horsepower output in radial air-cooled engines, it certainly deserves some attention. Despite the efforts of the engine manufacturer to provide adequate control of induction charge condition, much criticism has been directed at the developments of induction system accessories. Let us review this subject and then form our opinions on the basis of an analysis of requirements fulfilled by the latest refinements in this line.

Overhead air intakes, to eliminate the induction of dust, during warm-up and take-off on land planes, and water, in the case of sea planes, have been developed and are performing these functions very satisfactorily. Care must be observed in determining the proper area of the air ducts. As a precaution, it is prudent to provide throughout the intake duct an area about 25 per cent greater than the area of the bottom carburetor flange. The adapter at the bottom of the carburetor, into which the overhead duct directs the air, should contain a friendly curvature towards reversing the direction of air flow without undue disturb-

Fig. 7—Overhead Carburetor Air Intake System to Eliminate Dust and Water.

ance. It is desirable that a spring loaded back-fire flap valve be installed in the bottom of the adapter to discharge, when opened, outside the accessory compartment cowling. Otherwise, the overhead duct must be well supported throughout its length, and all joints must be firmly secured to prevent any leakage of flame into the accessory compartment when a back fire occurs. The entrance to the overhead air duct should be placed at an angle to the slip-stream in order to obtain a zero or positive pressure at the carburetor adapter. To avoid the possibility of large foreign matter or small engine parts entering the duct, a screen of about 4 mesh should be installed over the intake entrance.

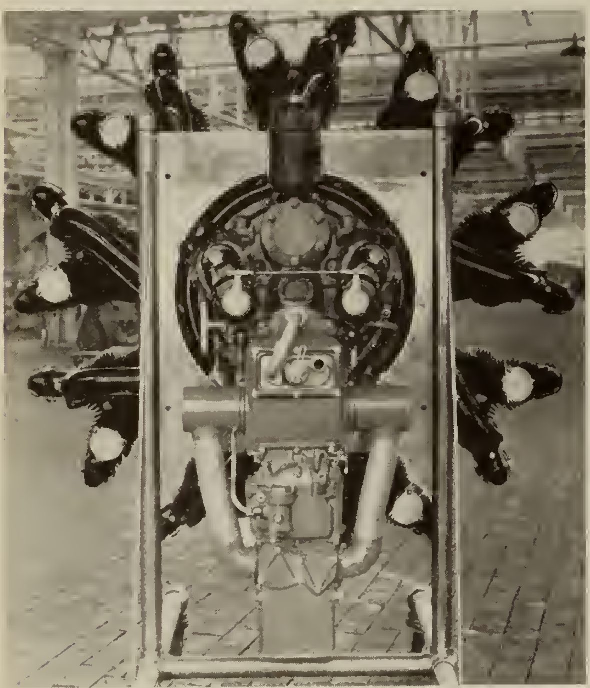

Fig. 8—Hot Spot and Oil Temperature Regulator Assembled on Engine.

Preheater pipes, from whatever source of preheating utilized, should be led either into the carburetor adapter or into the overhead intake duct at a point near the carburetor. Heat control is very easily obtained by installing a butterfly valve in the cold air duct at any point above the preheated air entrance. No shut off need be provided for the hot air, especially if the cold air intake scoop faces the slip-stream, as the pressure existing in the duct when the cold air valve is opened, will probably cause a reversal of flow through the preheater system.

The hot spot is still considered one of the most important parts of the induction system. Unless preheating of intake air to about 150 degrees F. above outside air temperatures can be secured, the hot spot is necessary for aiding distribution in extremely cold weather. The use of a hot spot eliminates the complication of a very bulky preheating system, as preheating is only necessary for prevention of ice formation in the carburetor. It is true that most preheaters, when used in conjunction with the hot spot, are designed for service in moderately cold weather relative to the severe low temperatures encountered in Canada and the Arctic region. Additional preheating for extremely cold weather conditions can quite easily be obtained by extending present forms of preheater ducts into suitable fairings strapped to the exhaust collector. Restrictions must be avoided as in the case of the cold air intake, but a small reduction in power must be accepted when hot air, instead of cold air, is directed into the carburetor, due to the loss in volumetric efficiency. It is interesting, in connection with power loss, that the hot spot will effect the same improvement in distribution with a much smaller loss, than will preheating. Preheating reduces the weight of the charge while the action of the hot spot is merely to vaporize the wet portions of the fuel.

This paper cannot rightfully be concluded without making some mention of engine mount structures. The developments in this line are mostly concerned with elimination of vibration. Experience has proved many times that a heavy structure embodying rigidity as its main feature, and careful alignment and bearing of all bolted surfaces as its next important feature, will dampen vibratory tendencies to a remarkable extent. Although rubber mounting supports have been successful in many installations, their use has in some cases been the main cause of severe vibration. If vibration can be eliminated without recourse to rubber dampeners, the installations will be safeguarded from possible fuel line and oil line failures, which will surely occur, unless extremely flexible connections are used between parts of the structure separated by rubber.

Monocoque engine mounts are making an appearance in both military and commercial aircraft. This type of construction, which appears as either a frustum of a cone, or a section of a cylinder, has proved very successful for some purposes and very grievous for others. Naturally, this form of mount adapts itself well towards resisting torque reaction, and torque impulses, of the engine, but from the accessibility standpoint, monocoque mounts are not usually as acceptable as those made of welded steel tubes or structural shapes of aluminum. Unless the engine accessories are easily reached through a completely removable fire wall, the monocoque form must obstruct accessibility. Small inspection doors are not satisfactory to the operator who must have the assurance of periodic inspection and periodic servicing being faithfully performed. No matter how proficient the organization, laggards will be present who will avoid, or at least slight, difficult work. Accessibility is without doubt of paramount importance for dependable and faithful servicing of engines.

In conclusion it may be well to outline briefly the method of co-operating with the aeroplane builder to insure satisfactory installation. Upon receiving information on the sale of an engine for a new aeroplane project, the installation department is required to consult at once with the purchaser of the engine. Installation details are discussed with reference to a more or less standard code outlined in an installation hand book. Previous experience with numerous other installations suggests such deviations from the standard code as are necessitated by the specific duties of the aeroplane, or are required by radical changes in construction and arrangement of parts. Upon completion of the aeroplane, the installation department, where it deems necessary, supplies complete testing equipment and personnel for checking the installation. Cylinder temperatures, exhaust back pressures, intake pressures and temperature and intake manifold pressure are carefully measured under all flight conditions and must be satisfactory under the worst loading to which the engine will ever be subjected. The effect of the preheater, the hot spot, the nose shutters and other regulatory devices are carefully determined under the prevailing atmospheric conditions and allowance is made for satisfactory operation under other atmospheric conditions in analyzing the efficiency of these units. The installation is released when all service requirements have been satisfied. The results of such efforts may only be recognized in the general standardization of installation details and the willingness of operators to accept standard equipped aeroplanes for their particular service without requiring numerous installation changes and additions.

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Our Members and Unemployment

No apology is needed at this time for bringing up the subject of unemployment, and the extent to which it is now affecting our membership. Judging from the records of The Institute's Employment Bureau it appears that this aspect of unemployment requires more serious consideration than it has yet received. The number of members registered with the Bureau for positions did not show a very rapid growth during 1930 and the early part of 1931, but for the past nine months a steady increase has been taking place and still continues. It seems certain that these registrations do not give a complete picture as regards The Institute as a whole, for in many cases members are deterred from registering by their distance from Headquarters, or because they prefer to rely on their own efforts; there are no doubt some who shrink from making their needs known although possibly in real need of assistance. Our experience as to this increase in the number of men looking for positions is similar to that of other organizations dealing with technically trained men, like the Technical Service Council in Toronto, and its seems evident that the time has come in Canada for an organized and determined effort to prepare for the difficult conditions which are likely to exist in the coming fall and winter.

Recognizing this situation, Council, at its last meeting, appointed a standing Committee on Unemployment whose first task will be to make a general survey as to the needs of the case as it affects our membership generally. The Institute's Branch organization, extending all over Canada, affords, in Council's opinion, a sound basis for such an enquiry and for building up an organization for the assistance of unemployed members, should this unfortunately prove to be necessary. In carrying out this duty the committee is asking for, and expects to receive, the active help of all our Branch executive committees, which it is felt will be willingly accorded.

By the time this article is in the hands of readers of The Journal all members of The Institute will have received from Headquarters a brief questionnaire asking for individual information as to their own cases, whether unemployed or not. Members are urged to act promptly by filling in the forms as requested and forwarding them to their respective Branch secretaries. On receipt of these it will be possible to judge the situation, first, as to each Branch district, and next, as to The Institute membership as a whole. When the returns are analysed it will be possible to consider what further steps or organization will be found desirable. Actually, in order that valuable time may not be lost, The Institute's Committee on Unemployment is engaged in framing recommendations outlining a scheme for providing relief and assistance in necessitous cases, supposing the survey shows a real need. In doing so, the committee has been guided to some extent by the experience of similar bodies in New York, Boston, Cleveland, and other cities in the United States, where for some time past conditions have been even more serious than they appear to be at present in Canada. Some of our larger Branches have already taken steps to deal with the problem locally, but so far their efforts have not been co-ordinated, and it is felt that results will follow more promptly and effectively if co-operation can be secured by the joint efforts of our Branches and Headquarters.

In work of this character experience has shown that success can only be attained if in each centre there are men who will take an active interest in the work and will sacrifice the time required to undertake the necessary interviews and inquiries. Questionnaires and forms are needed to begin with, but personal contact has been found the only satisfactory method of dealing later with the cases where members are reluctant even to apply for assistance. Personal action is also needed in the earlier stages of the inquiry, for without effort of this kind it is impossible to get reliable information as to the number of cases of unemployment now existing, the extent to which there is real need, or an estimate of the situation likely to exist six months hence.

The Institute Committee on Unemployment appeals for the active co-operation of our individual members in the work now being undertaken, and is confident that this co-operation and the assistance of our Branches and their officers can be relied on to the fullest extent.

Canadian Meetings of Sister Societies

Many distinguished visitors are travelling to Canada this summer and among them will be two parties of engineers who deserve and will receive a special welcome from The Institute. One of these comes from Great Britain, the other from the United States, for the Institution of Mechanical Engineers and the American Society of Mechanical Engineers are each holding a Summer Meeting in Canada this year.

On June 27th the American Society of Mechanical Engineers will arrive in Toronto, journeying thence to Bigwin Inn, Lake of Bays, where a four day professional and social meeting will take place. The programme for the Bigwin meeting includes more than twenty professional papers, and has been prepared with the co-operation of The Institute. Our American friends do not believe in "all work and no play" on these occasions, and may be relied on to take advantage of the opportunities for recreation and relaxation which their Canadian trip will provide. The visit to Ontario will be followed by a voyage on the St. Lawrence to Montreal, Quebec and the Saguenay.

It is pleasant to have another opportunity of cementing those cordial relations of The Institute with the American Society of Mechanical Engineers which have so long existed, for this is not the first time the Society has met in

Canada, and many of our members will recollect the very successful meeting which the A.S.M.E. held in Montreal in 1923; everyone will expect that the 1932 meeting will have equally good results.

The British party, composed of members of the Institution of Mechanical Engineers, will land at Quebec at the end of August, will visit Montreal and Ottawa, and will then proceed to Toronto, where their meetings will be held from August 31st to September 2nd. After a visit to Hamilton and the Niagara Peninsula they will pass through Rochester and Schenectady en route to New York. Detailed arrangements for their Canadian tour are being completed with the assistance of local committees of Institute and Institution members in Montreal and Toronto, and our Branches in all the centres visited will aid in making the trip enjoyable. A series of visits to representative industrial plants is being arranged, and it may be noted that the party will be in Ottawa while the Imperial Economic Conference will probably still be in session. Their stay in Toronto will give them an opportunity of attending the Canadian National Exhibition, and their varied programme will show them many sides of Canadian activity.

The Institution of Mechanical Engineers is one of the oldest and most prominent of the British engineering organizations and its representatives will be heartily welcome, particularly since their trans-Atlantic journey is taken at a time when such important inter-Empire relations are pending.

In the case of both societies their tour will afford occasion for the formation or renewal of many personal contacts, and those exchanges of views which do more to clear away cobwebs than reams of correspondence, and are such a powerful influence in promoting goodwill and effective co-operation in the difficult tasks confronting the engineering profession.

Amendment to By-laws is Carried

The report of the scrutineers on the vote regarding the amendment proposed to Section 37 of the By-laws, which closed on May 2nd, 1932, has been presented to Council, and states that the proposed amendment was carried by a very large majority.

This amendment provides for the removal from The Institute's membership list of the names of members in arrears for one year or more, this action being taken only after the member has received two separate notifications. Under the new By-law Council is empowered to extend the time for payment in special cases where sufficient cause is shown.

The full text of Section 37 as amended follows:

Arrears—Exemptions—Life Membership List.

Section 37.—The secretary shall notify any member whose fees become in arrears. No member shall be considered in arrears for any year until after the thirtieth day of June of that year. A member who is in arrears shall not have the right to vote, he shall not receive the publications of The Institute, nor shall he be eligible for office in The Institute or any of its Branches.

Should his fees still be in arrears on the first day of October, he shall again be notified in form prescribed by the council, and if still in arrears on the first day of January of the year following, he shall forfeit his connection with The Institute and shall be so notified by the secretary.

The council, however, may for cause deemed by it sufficient, extend the time for payment and for the application of these penalties.

Further the council may for sufficient cause temporarily excuse from payment of annual fees any member who from ill health, advanced age, or other good reason assigned, is unable to pay such fees, and the council may remit the whole or part of fees in arrears.

The council, at its discretion, may as a privilege exempt from further payment of annual fees any corporate member who has reached the age of sixty-five, or who has been a corporate member for thirty years, or who has rendered signal service to The Institute. The names of such members shall be placed on a Life Membership List.

Results of May Examinations of The Institute

The report of the Board of Examiners, presented at the meeting of Council held on May 20th, 1932, 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:

Schedules B and C. For admission to Associate Membership:

W. R. Caron	Quebec, Que.

Schedule C. For admission to Associate Membership:

J. M. Kilkenny	Beauharnois, Que.
Seraphin Cyr, Jr.E.I.C.	Montreal, Que.

Schedule B. For admission as Junior

W. I. Shuttleworth	Montreal, Que.
P. Varley	Montreal, Que.

Meeting of Council

A meeting of Council was held at Headquarters on Friday, May 20th, 1932, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and eight other members of Council present.

The report of the scrutineers appointed to canvass the ballot for the amendment to Section 37 of the By-laws, closing on May 2nd, 1932, was received, showing a very large majority in favour of the amendment. Discussion followed as to the procedure to be adopted in putting this amendment into effect, and it was pointed out that the terms of the amendment itself left in the hands of Council ample power to deal with any special cases of hardship or difficulty which may arise in regard to members' arrears of fees.

A report was presented as to progress made in connection with the E.I.C. Engineering Catalogue, from which it was noted that the undertaking had been well received and that satisfactory participation on the part of industrial firms seemed assured.

The Committee on Unemployment appointed at the last meeting of Council, under the chairmanship of Mr. Tennant, presented a report making recommendations as to the possibility of assisting unemployed members during the coming winter. Council directed that a copy of this report be forwarded to the various Branches, with a circular letter inviting their participation in a general survey of the situation with a view of further action, the whole with as little delay as possible. A standing Committee on Unemployment was appointed to deal with this matter, the committee consisting of Messrs. D. C. Tennant, M.E.I.C., chairman, A. Duperron, M.E.I.C., and R. J. Durley, M.E.I.C., with power to add to its number.

The resignation of W. C. Adams, M.E.I.C., as Treasurer of The Institute, due to ill health, was accepted with great regret, and it was unanimously resolved that P. L. Pratley, M.E.I.C., be appointed Treasurer to replace him. J. A. McCrory, M.E.I.C., was appointed a member of the Finance committee to replace Mr. Adams on that committee.

Past-President A. R. Decary, M.E.I.C., and F. A. Combe, M.E.I.C., were appointed members of the Committee on Development.

In view of the statement of revenue and expenditure for the first four months of the year, as shown by a report from the Finance committee, it was decided, on the recommendation of that committee, that a further reduction of ten per cent be made in the pay of The Institute's staff, to take effect on July 1st, 1932.

The report of the examiners regarding the examinations of The Institute held on May 3rd, 1932, was received, from which it was noted that of the six candidates examined all had passed.

Thirty-seven resignations were accepted, fourteen members were placed on the Suspended List, one Life Membership was granted, and a number of special cases were considered.

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

Elections		*Transfers*	
Member	1	Junior to Member	1
Assoc. Members	4	Junior to Assoc. Member	3
Juniors	4	Student to Assoc. Member	1
Students admitted	13	Student to Junior	2

The Council rose at eleven forty-five p.m.

OBITUARIES

James Penrose Anglin, M.E.I.C.

Widespread regret will be felt at the death of James Penrose Anglin, M.E.I.C., which occurred at Montreal on May 15th, 1932.

Mr. Anglin was born at Kingston, Ont., on February 20th, 1876, where he received his early education. He then attended Queen's University and later McGill University, graduating from the latter institution in 1906.

Coming to Montreal in 1897, Mr. Anglin received his first real architectural training under Robert Findlay. In 1902 he supervised the rebuilding of the Bank of Montreal head office for the firm of McKim, Mead and White, and afterwards remained in charge of the architectural department of the bank, designing numerous branch buildings throughout Canada. In 1908 he resigned from that position to enter the building business, and in 1913, Mr. Anglin, in conjunction with G. B. Allison, organized Anglin's Limited, general contractors. In 1919 the firm of Anglin-Norcross Limited was organized, Mr. Anglin becoming president of the new firm. Among the many buildings constructed by this company are the Royal York hotel, Toronto, the Insurance Exchange building, Montreal, Bank of Montreal,

J. P. ANGLIN, M.E.I.C.

Ottawa, McGill University Engineering Building, Loyola College, Montreal, the Bell Telephone building and other notable structures throughout Canada.

Mr. Anglin was a member of the council of the Montreal Board of Trade, a past president of the Montreal Builders' Exchange, the Association of Canadian Building and Construction Industries, and a vice-president of the Montreal Financial Corporation. His clubs included the Montreal Club, the Engineers' Club, the Royal St. Lawrence Yacht Club, the Rotary Club of Montreal, the Royal Montreal Golf Club and the Islemere Golf Club.

Mr. Anglin became a Member of The Institute on July 20th, 1920.

Harold Frederick Guild Barnjum, A.M.E.I.C.

Members of The Institute will learn with regret of the death of Harold Frederick Guild Barnjum, M.E.I.C., which occurred on July 16th, 1931, at Richmond, Va.

Mr. Barnjum was born at Montreal, Que., on June 19th, 1880, and was educated at the High School in that city.

Mr. Barnjum entered railway service on the Grand Trunk Pacific Railway (now part of the Canadian National Railways) in 1906, continuing with that company until 1916, when he went overseas with the Third Canadian Railway Troops, being mentioned in despatches. Following demobilization in 1919, Mr. Barnjum returned to the Grand Trunk Pacific Railway, and was stationed at Prince Rupert, B.C. From 1919 to 1925 he was connected with the Montana Highway Commission, and for six months in 1925 was with the Pennsylvania Highway Department. In the same year Mr. Barnjum became draughtsman in the office of the chief engineer of the Chesapeake and Ohio Railway Company at Richmond, Va., which position he held until the time of his death.

Mr. Barnjum was a member of the American Railway Engineering Association, and joined The Engineering Institute of Canada as an Associate Member on October 28th, 1919.

Everett Thomas Cain, A.M.E.I.C.

Regret is expressed in recording the death of Everett Thomas Cain, A.M.E.I.C., which occurred at Moncton, N.B., on May 4th.

Mr. Cain was born at Zephyr, Ont., on November 3rd, 1882, and graduated from the University of Toronto in 1913, with the degree of B.A.Sc.

Following graduation he was employed until November 1913 in the structural draughting office of the Dominion Bridge Company, at Lachine, Que., on detailing and checking steel bridges, buildings, etc. Mr. Cain then entered the service of the Canadian National Railways, in which he remained until his death. For a time he was in the bridge department, and later was in the assistant engineer's office and the chief engineer's office, respectively, at Moncton. At the time of his death, Mr. Cain was assistant engineer at Moncton, N.B.

Mr. Cain became an Associate Member of The Institute on March 22nd, 1921.

Victor Frederick William Forneret, M.E.I.C.

Deep regret is expressed in announcing the death of Victor Frederick William Forneret, M.E.I.C., which occurred in Toronto, Ont., on April 19th, 1932.

Mr. Forneret was born at Berthier-en-haut, Que., on August 17th, 1863, and graduated from McGill University in 1887 with the degree of B.A.Sc.

Following graduation, Mr. Forneret was until 1891 assistant engineer on the River St. Lawrence Ship Channel for the Montreal Harbour Commissioners and the Department of Public Works. In 1892 he was assistant engineer on a survey of the Galops rapids for the Department of Railways and Canals. Following this he was for three years engaged in private practice as a civil engineer, and in 1896 became assistant engineer for the Department of Public Works, being first assistant to the superintending engineer, River St. Lawrence Ship Channel, Department of Public Works and Department of Marine and Fisheries.

In 1908 Mr. Forneret was appointed superintending engineer of the St. Lawrence Ship Channel for the Department of Marine and Fisheries, becoming subsequently superintending engineer and engineer in charge, which position he held at the time of his retirement.

Mr. Forneret was a member of The Institute of long standing, having joined the then Canadian Society of Civil Engineers as a Student on January 25th, 1887. He then transferred to the grade of Associate Member on December 9th, 1897, and became a full Member on January 8th, 1910.

John Laing Weller, M.E.I.C.

Widespread regret will be felt at the death of John Laing Weller, M.E.I.C., which occurred at Hamilton, Ont., on May 24th, 1932, closing a long and distinguished career.

Born at Cobourg, Ont., on February 13th, 1862, Mr. Weller graduated with honours at the Royal Military College, Kingston, in 1883. He then entered the government service in the Department of Railways and Canals, and from that time until 1888 was engaged on the construction of the Trent and Murray canals, and later was appointed principal assistant engineer on the enlargement of the Ontario-St. Lawrence canals. In 1900 Mr. Weller became engineer in charge of the Port Colborne improvements, and at the end of the year superintending engineer of the Welland canal. In 1912 the government reached a decision on the necessity of enlarging the Welland Ship canal and Mr. Weller was selected as engineer-in-charge of surveys, design and construction of that new waterway. Owing to war conditions the construction work was completely closed down in the spring of 1917, and on its resumption in 1919 he was appointed consulting engineer for the Welland canal development.

Mr. Weller's resourcefulness and ingenuity were exemplified in the methods he adopted whenever emergencies occurred on the works under his charge. His success in 1908 in repairing in record time a serious break in the south bank of the Cornwall canal, will be long remembered.

He was a leader in a number of developments which are now matters of ordinary practice, for example in 1904 he obtained patents on reinforced concrete poles for electric transmission lines, and several miles of lines were so constructed, and in 1910 he built a reinforced concrete deck scow for canal maintenance work.

His principal achievement was, of course, the planning and organization necessary for the construction of the Welland Ship canal, an undertaking unprecedented in magnitude as far as Canada is concerned.

Mr. Weller was a senior member of The Institute, having joined the then Canadian Society of Civil Engineers as a Member on October 12th, 1899. On April 15th, 1932, he was made a Life Member. In spite of the demands made on him by his arduous professional life, Mr. Weller found time to take an active interest in Institute affairs, and was a member of Council in 1915, 1916 and 1917.

PERSONALS

A. Ross Robertson, A.M.E.I.C., was re-elected president of the Canadian Institute of Steel Construction at the annual meeting of that organization which was held recently. Mr. Robertson is manager of the Ontario division of the Dominion Bridge Company and is located in Toronto.

Dr. John Stephens, M.E.I.C., professor of Mechanical Engineering, University of New Brunswick, Fredericton, N.B., has been appointed to the membership of the National Research Council, Ottawa, Ont.

John K. Davidson, Jr.E.I.C., has joined the staff of the Electric Reduction Company at Buckingham, Que. Mr. Davidson is a graduate of the University of St. Andrews, Dundee, Scotland, of the year 1926, and following his arrival in Canada, was connected until 1930 with the Dominion Bridge Company, He was later engaged as resident engineer on the construction of a filtration and pumping station for the Water Commissioners of Brantford, Ont.

E. A. Earl, M.E.I.C., has been appointed location engineer with the Public Works Department at Lusaka, Northern Rhodesia. Prior to the War, Mr. Earl was in private practice in Vancouver, B.C., and from 1914 to 1918 was overseas, retiring with the rank of captain. In 1919, he went to the Gold Coast as assistant engineer in charge of a section of construction of the Gold Coast Government Railway, and in 1922 became district engineer in charge of a district on the construction of the railway. In 1927 Mr. Earl was assistant engineer on railway surveys with the Nigerian Railway, at Ebute Metta, Nigeria.

A. E. MacRae, A.M.E.I.C., has severed his connection with Messrs. Marks and Clerk, Ottawa, and will continue in practice as consulting engineer and solicitor in patent, trade mark and design causes in the same city. Mr. MacRae, who is a graduate of Queen's University in chemical and metallurgical engineering, was for nine years examiner of the chemical and metallurgical division of the Canadian Patent Office, and for several years practised as a patent solicitor in Ottawa. Prior to entering the Federal government service in 1914, he had considerable practical experience with the Mond Nickel Company at Coniston and with the Canadian Copper Company at Copper Cliff, Ont. Mr. MacRae is a Fellow of the Canadian Institute of Chemistry.

A. C. Fleischmann, A.M.E.I.C., and S. Farquharson, A.M.E.I.C., have formed the firm of Fleischmann and Farquharson, engineers, Montreal. Mr. Fleischmann, who is a graduate of the Cluny School of Engineering and the Artillery School of Fontainebleau (France), was for a time in the Technical Service of the city of Montreal, and since 1930 has been in private practice as an engineer.

Mr. Farquharson came to Canada from New Zealand in 1923, having served with the New Zealand Mounted Rifles in Palestine and studied civil engineering at Canterbury University College, Christchurch, New Zealand. Later he was connected with the B.C. Electric Railway Company in Vancouver, the Power Corporation of Canada, Ltd., in Montreal, the Shipshaw development of the Aluminum Company of Canada at Arvida, Que., and recently has been practising industrial engineering in Montreal.

John W. Seens, A.M.E.I.C., president and general manager of the Canadian Bridge Company at Walkerville, Ont., has been named president of the Canadian Steel Corporation, Ltd., the Canadian subsidiary of the United States Steel Corporation. Mr. Seens graduated from the University of Michigan in 1901 with the degree of B.S., and subsequently joined the staff of the Canadian Bridge Company as draughtsman, but in October, 1905, returned to Grand Rapids, Mich., where he was engaged on engineering work with the city engineer. In 1906 he returned to Canada, and once more entered the employ of the Canadian Bridge Company. In 1911 he was appointed manager of the Structural Steel Company, Montreal, and in 1918 he rejoined the staff of the Canadian Bridge Company, as manager of sales with headquarters at Montreal. Since that date he has remained with the same company, being elected a director of the company in 1922, vice-president in 1926, and president and general manager in 1927.

John McLeish, M.E.I.C., director of the Mines Branch, Dominion Department of Mines, is a member of the Administration Board recently set up by the province of Alberta to regulate the production of gas in the Turner Valley field. The new legislation, which is already in effect, provides for the supervision and control of the field's resources by the three members of the Board. Mr. McLeish, who is a graduate of the University of Toronto, is

JOHN McLEISH, M.E.I.C.

an active member and past-chairman of the Ottawa Branch of The Institute, being the Branch representative on Council for the current year.

ELECTIONS AND TRANSFERS

At the meeting of Council held on May 20th, 1932, the following elections and transfers were effected:

Member

FLAHERTY, Benjamin Guy, B.S. (E.E.), (Univ. of Wash.), chief engr., Consolidated Marine Companies, Ltd., Montreal, Que.

Associate Members

*CARON, William Robert, elect'l. supt., Quebec Harbour Commission, Quebec, Que.

*KILKENNY, John Murray, (Univ. of Toronto), Beauharnois, Que.

MacDONALD, Walter Elwood, (Ottawa Coll. Inst.), city water works engr., Ottawa, Ont.

ROBINSON, Denis Owen, B.Sc., (Queen's Univ.), sales engr., Canada Cement Company, Toronto, Ont.

Juniors

BEAMENT, George Edwin, B.A.Sc., (Univ. of Toronto), c/o McPherson & Co., 171 Yonge St., Toronto, Ont.

MILNE, James Ramsay Burt, (H.M. Dockyard School), engr. and dftsman., Price Bros. & Co. Ltd., Kenogami, Que.

*SHUTTLEWORTH, Wilbur Irvin, (Ottawa Collegiate), 2188 Dorchester St. West, Montreal, Que.

*VARLEY, Percy, elect'l. dftsman., Canadian Industries Limited, Montreal, Que.

Transferred from the class of Junior to that of Member

BALL, Spencer, B.Sc., (Univ. of Sask.), asst. professor of civil engrg., Nova Scotia Technical College, Halifax, N.S.

Transferred from the class of Junior to that of Associate Member

DION, Joseph Edgar, B.Sc., (McGill Univ.), 467 Mount Stephen Ave., Westmount, Que.

RINFRET, Guy Raoul, B.Sc., (McGill Univ.), res. engr., Rapide Blanc Devel't., Shawinigan Engineering Company, Montreal, Que.

TOUPIN, Valerien, B.A.Sc., C.E., (Ecole Polytech.), office manager, St. George Construction Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

BURNSIDE, Robert John, B.A.Sc., (Univ. of Toronto), res. engr., James, Proctor & Redfern, Ltd., Toronto, Ont.

Transferred from the class of Student to that of Junior

BROWNELL, Harold Ross, B.Sc., (McGill Univ.), sales service engr., Bailey Meter Co. Ltd., Winnipeg, Man.

STEWART, Leslie Baxter, B.Sc., (McGill Univ.), elect'l. tester, Shawinigan Water & Power Company, Shawinigan Falls, Que.

Students Admitted

BEDFORD-JONES, Charles Edward, (Univ. of Toronto), 210 Somerset St. West, Ottawa, Ont.

BOUCHER, Raymond, (Ecole Polytechnique), 3774 St. Hubert St., Montreal, Que.

CHIPMAN, Robert A., B.Sc., (Univ. of Man.), 132 Montrose St., Winnipeg, Man.

CRAIN, Harold Fowler, B.Sc., (Queen's Univ.), 998 Bronson Ave., Ottawa, Ont.

EWENS, Frank Gordon, (Univ. of Toronto), 374 Huron St., Toronto, Ont.

FORD, Wilson Harlow, (N.S. Tech. Coll.), 87 Morris St., Halifax, N.S.

MICKLETHWAITE, William E., (Univ. of Toronto), 886 Ossington Ave., Toronto, Ont.

MILLER, George Grant Boundy, B.Sc., (Univ. of N.B.), DeBec, N.B.

McINTOSH, Douglas Elliott, (Grad. R.M.C.), (McGill Univ.), Lieut., R.C.S., Camp Borden, Ont.

McKAY, Robert Donald, B.Sc., (Dalhousie), (N.S. Tech. Coll.), 165 Oxford St., Halifax, N.S.

RAUE, Alfred George, (R.M.C.), 12062-104th Ave., Edmonton, Alta.

SOUTHMAYD, Charles Goodrich, Jr., (Univ. of Toronto), Aurora, Ont.

WARREN, Pierre, (Ecole Polytechnique), Pointe-au-Pic, Que.

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*Has passed Institute's examinations.

BOOK REVIEW

First Report of the Steel Structures Research Committee

Reviewed by P. L. Pratley, M.E.I.C.*

Department of Scientific and Industrial Research, Great Britain. Published by H.M. Stationery Office, London, 1931, paper, 6 x 9¾ in., 276 pp., figs., tables, 5/- net.

The "First Report of the Steel Structures Research Committee" is a document of almost 300 pages and covers a very wide scope of inquiry ranging from surveys of present practice in different parts of the world to details of experimental and laboratory research and tests of full-sized frameworks. It is divided into six sections with the following general headings:—

(1) Investigations into present practice.
(2) The testing of building frames for deformation and strain.
(3) Determination of stresses in building frames.
(4) Materials: specifications, and tests.
(5) Struts: formulae for their design.
(6) Welding.

Each of these sections is still further divided into a number of individual reports by special investigators, technical officials of the Department, professors at the universities, engineers in practice, etc., and at the end of the report a tentative summary of the findings and suggestions is embodied in a series of recommendations for a code of practice in the design of structural steel work.

Viewed generally, the report is a splendid tribute to the thoroughness with which the engineers, manufacturers, and educational authorities in Great Britain have been awakened to the need of a joint effort, based on sound and scientific principles, toward modernizing and standardizing the practice of structural engineering, and at the same time it is indicative of the wealth of resource which the interested parties in the Old Country can bring to bear on such problems when the need is realized. The Committee opens its report with the statement that they were appointed in August 1929 for the following purposes:—

"(*a*) To review present methods and regulations for the design of steel structures, including bridges."

"(*b*) To investigate the application of modern theory of structures to the design of steel structures, including bridges, and to make recommendations for the translation to practice of such of the results as would appear to lead to more efficient and economical design."

and, while a great deal has been accomplished, they are the first to admit that they are only just starting on what may be a long, an arduous, and most certainly a very important course of inquiry.

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*Monsarrat & Pratley, Consulting Engineers, Montreal, Que.

The various sections and sub-sections of the Report being written, as they are, by different individuals, very naturally express different viewpoints and direct attention to different aspects of the question and are couched in very different terms. In some places one is tempted to criticize the text as being somewhat laboured and cumbersome, and to feel that the writers have lost sight of the fact that the only people interested, or likely to be interested, in their work are those to whom the general principles of structural engineering are familiar, who are engaged professionally and practically in the design and construction of steel framing, and who do not stand in need of so much elementary analysis of the problem as is presented on some of these pages. There appears sometimes to be a little tendency to despise the methods at present in existence for proportioning materials and applying the principles of design to the actual problems encountered. As an example, it would hardly appear necessary or vital to the purposes of the Committee to make the statement that "floor loads" are little more than constants in an empirical formula of design. There would appear to be no particular disgrace in using "floor loads" as definite quantities in arriving at the sizes and disposition of materials to support them and it is difficult to see that their inclusion as a direct factor can be regarded as merely empirical. Also the accompanying discussion on the existing conceptions of a frame structure seems to suggest that it is only by accident that our existing buildings stand up and carry the loads. The introduction, on page 12, of a reference to reinforced concrete as an example of a structure where the designer has no assurance that the material is what he intends it to be, other than from supervision during erection, is rather regrettable because such assurance is normally quite satisfactory when coupled, as it is, with much experimentation upon which the actual design has been based. On page 13 reference is made to the need for a revolution in the methods of stress analysis and the effect of this need on the amount of revision that can be recommended at present in building codes. While it is very gratifying to read that the results of the research may most likely lead to the removal of many restrictions which have proved to be onerous it would rather seem that attention should be directed, not to revolutionary analysis, but to the revision of assumptions and a better understanding of the actual properties and duties of the materials.

The comparison of regulations, covering the design of steel frame buildings, selected from various foreign countries, from the Dominions, and from towns in Great Britain outside of London, and the general comparison of these with the London County Council Regulations constitutes a very instructive and informative section of the Report. Canadian readers will be pleased to see the constant references to the Canadian Engineering Standards Association Specifications for Steel Structures and will not be disappointed at the relative position which they hold in this comparison. It is rather surprising that so many of the large British towns are so poorly off for building codes and one is tempted to hope that the reason lies in the fact that competent engineers are engaged to design the structures so that restrictive specifications are not so essential. In summarizing the differences between the various by-laws quoted and compared, the compilor of this section states that "these differences are rather more easily seen than the reasons for them" and adds that "good practice in steel frame construction is not a variable dependent on geographical position." It might perhaps have added to the value of the Report had some effort been made to analyze these reasons, or at least to state some of them. For example, the variation in governing legislation or regulations regarding professional practice and the engaging of competent engineers to design such steel construction quite conceivably constitutes one reason for the variation in the codes. Also, the rigidity of inspection of materials, the capacity of the workshops and the development of workmanship must vary under different conditions and the codes would naturally reflect these variations. It is quite well understood in Canada, for instance, that our specifications have progressively changed with the control of design, with the reliability of material and with the improved shop practice.

The survey of office live loads is also a most interesting and a well presented section of the Report. Very fair judgment and very capable appraisal is shown in dealing with these figures and this aspect of the general problem. One very obvious outcome of the study is that, generally, standard specifications can only apply to the very ordinary and well established type of structure and that for the buildings erected for specific purposes the engineers should be permitted and expected to furnish individual study and consideration.

Some very interesting remarks on strain gauges are incorporated in the chapter on strains in buildings, and the proposed testing of columns and beams in the new Geological Museum in South Kensington should prove most instructive. Similarly the buckling tests on webs of heavy beams which are presented in the section on "Stresses in Building Frames" are very valuable and suggestive and the continuation of such work is bound to be of great importance to the Committee and to the engineering profession at large. Some space is given later to the discussion of riveted joints and the distribution of stress between the rivets. The McGill experiments conducted by Professor Batho are referred to and are supplemented by a number of further investigations carried out by the same enquirer at the University of Birmingham. Our old friend the "slope deflection nightmare" appears on pages 179 to 182 where a discussion is also presented regarding an attempt to allow for non-rigidity of beam connections. Some interesting figures follow on the arithmetical effect of different methods of considering the eccentricity of loading in building frames and no one can avoid agreeing with the writer who says that "it is evident that there is a wide field for research in this particular problem." The Committee is arranging to have an experimental full-size frame of columns and beams erected at the Building Research Station for the purpose of studying eccentric connections and the resulting distribution of stresses. Special loading devices are being installed whereby the weight of tanks of water can be applied at selected points in a multitude of different combinations in order to simulate the effect of dead and live loads. It is intended that the connections in this experimental framework shall be successively bolted, riveted, and welded so that the comparative rigidity of these types of connections may also be studied. There can be no doubt but that research of this type will be productive of much useful and practical information. On page 197, in the chapter on "Materials and their Testing," some reference is made to the distinction between the limit of proportionality, the elastic limit, and the yield point of steel specimens and a new definition for elastic limit is produced. From the various diagrams introduced into the text it is rather difficult to appreciate how the limit of proportionality is arrived at as the stress-strain lines very often seem to be straight and of constant slope for distances beyond the points indicated. The information gathered from the use of very small test specimens, carefully machined, is apparently of considerable importance and the conclusions stated by Professor Robertson, on page 208, are worthy of close attention.

Section 5, on Struts, is naturally of consuming interest to anyone who has been concerned with the preparation of column formulae in standard specifications. One is somewhat taken aback at the introductory sentence which states that "stress analysis shows that the vertical members in a steel building frame are subjected to such bending moments that they should be considered rather as beams than as struts." It would almost seem that this is magnifying the quantitative importance of eccentricity of loading. The only two formulae discussed by the writer are the extremely elaborate ones of Moncrieff and Perry, the latter of which is reproduced in the recommended code of practice. No reference at all is made to the simpler formulae which at present govern the various specifications but the statement is made by Professor Robertson, on page 231, that he "does not think it matters much what formula is used as long as the designer is given the table of values, and that the curvature, or Perry, formula has a better theoretical basis than the others and can be used directly for eccentric loading." This would seem to be a very reasonable point of view but at the same time for ordinary purposes it is a question whether the values derived by a good theoretical formula such as is suggested could not be very closely expressed by a simple formula which would remain in the mind of the designer when his tabulated values were inaccessible. This, it would appear, is really at the basis of the present practice of using simplified formulae. No one suggests that the simplified formula, such as the straight line, has any particular theoretical basis which establishes it as preferable, but it is usually believed that some simple formula can be derived which presents in an easily remembered form a means of arriving at values very close to those which were established by the more complex formulae. Professor Robertson probably has some similar idea in his mind when he states that he "makes a clear distinction between a formula derived from results of laboratory tests and a formula proposed for design purposes." He also expresses a strong opposition to the method of plotting on diagrams the obtainable results of compression tests on steel columns and obtaining a formula suggested by the lower limit of the constellation of points. One does not doubt but that the profession would welcome an improvement upon this method but the suggested improvement would need to be presented with some convincing recommendation as to its superiority and inclusiveness and also with evidence that its resulting values are not too conservative in their consideration of modern materials, uniformity of product, and advancing workshop practice. One is surprised, in a document characterized on a whole by such admirable language, to find, on page 232, near the bottom, the expression "as large, if not larger, than...." instead of "as large as, if not larger, than...."

The section on Welding is a very informative survey of the practice in Europe and America and of a large number of tests made under various auspices. Extended reference is made to research work being carried out in different countries and to the optical, electrical, and magnetic examination of welds, of electrodes, and of the actual operation of fusion. Some exceedingly interesting features are revealed in these investigations and the suggested programme of future work which the Committee may possibly undertake appears to be well conceived and should undoubtedly produce still further valuable information regarding this particular feature of construction.

The "Code of Practice for the use of Structural Steel" concerns itself with masonry, brick work, concrete, fire-proofing, and other similar features, as well as the purely steel framework. In general, the loadings and units recommended for the steel construction are very much in line with our own Canadian Standard practice as exemplified in the C.E.S.A. Specifications. The column formula, of course, is distinctly different in form but would not produce very different results within the usual range of stiffness ratio. Beyond an $\frac{L}{r}$ of 70 the proposed formula falls very rapidly compared to the straight line formula, $17,000 - 60 \frac{L}{r}$ until at the value of 100 the permissible average stress is only 8,500 lbs./sq. in. instead of 11,000 lbs./sq. in. Special clauses are introduced regarding the effective length of columns and the provision for eccentric loading and the combination of bending stress with axial stress and the Code closes with a reference to pressures upon various types of foundations.

A tremendous amount of work is represented in this First Report and if nothing more is accomplished than the adoption of the Recommended Code instead of the present London County Council Regulations, a great forward step will have been taken. The future work of the Committee will be studied with consuming interest by engineers all over the Empire and there lies in the future the possibility that a British Standard practice may result sufficiently general in its principal features to be applicable to steel building construction in every corner of the Commonwealth.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Electrical Engineers: Transactions, Vol. 51, No. 1, March, 1932.
American Society of Mechanical Engineers: Transactions, Vol. 53, 1931.
American Society for Testing Materials: Index to Proceedings, Vols. 26-30 (1926-1930).

Reports, etc.

Dept. of Mines, Canada:
Report for the Fiscal Year Ending March 31, 1931.

Dept. of Mines, Geological Survey, Canada:
Memoir 169: Geology and Mineral Deposits of a Part of Southeastern Manitoba.
Summary Report, 1930, Part D.
1931, Part B.

Dept. of Mines, Mines Branch, Canada:
Investigations in Ore Dressing and Metallurgy, 1930.
The Canadian Mineral Industry in 1931.

Dept. of Mines, Explosives Division, Canada:
Annual Report for the Calendar Year 1931.

Dept. of the Interior, Topographical Survey, Canada:
[Map of] Great Bear Lake, Northwest Territories, 1932.
[Map of] Rainy Lake, Ontario, 1931.

Forest Products Laboratories of Canada:
Red Stain in Jack Pine.

City of Winnipeg, Hydro-Electric System:
Twentieth Annual Report, December 31st, 1931.

Port of Vancouver, British Columbia:
Report of Harbour Commissioners, 1931.

Canadian Airways, Limited:
Annual Report, 1931.

McGill University:
Annual Report of the Corporation, 1930-31.

Air Ministry, Aeronautical Research Committee, Great Britain:
Reports and Memoranda:
1413: Wind Tunnel Experiments on the Cowling of Air Cooled Engines.
1436: Torsional Loading on Stripped Aeroplane Wings.
1438: Wind Tunnel Experiments on High Tip Speed Air-Screws.

Geological Survey, United States:
Water-Supply Papers:
662: Surface Water Supply of the United States, 1928. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins.
688: Surface Water Supply of the United States, 1928. Part 8: Western Gulf of Mexico Basins.
690: Surface Water Supply of the United States, 1929. Part 10: The Great Basin.
Bulletin 827: A Geologic Reconnaissance of the Dennison Fork District, Alaska.
830-A: Copper Deposits near Keating, Oregon.
Professional Paper 170-B: The Upper Cretaceous Ammonite Genus Barroisiceras in the United States.
170-D: Pliocene Fossils from Limestone in Southern Florida.

Bureau of Standards, United States:
Commercial Standard CS33-32: Knit Underwear (exclusive of Rayon).
Mis. Pub'n No. 136: Bibliography on Standardization.

Bureau of Mines, United States:
Talc and Soapstone in 1930.
Sand and Gravel in 1930.
Cement in 1930.
Natural Gas in 1930.
Bulletin 304: Ochers and Mineral Pigments of the Pacific Northwest.
348: Paraffin and Congealing-Oil Problems.
349: Liquid Oxygen Explosives.
352: Safety Practices in California Gold Dredging.
Technical Paper 511: Carbonizing Properties of Davis Bed Coal from Garrett County, Md., and of Mixtures with Pittsburgh Bed Coal.

National Electric Light Association:
Purchasing and Storeroom Committee, Accounting National Section: Public Utility Salvage Accounting.
Hand Posted Stock Records.
Stores Statistics.
Hydraulic Power Committee, Eng'g National Section: Mechanical Reliability of Hydro-Electric Units, 1930.
Prime Movers Committee, Eng'g National Section: Station Piping.

The John Crerar Library:
Thirty-Seventh Annual Report for the Year 1931.

Westchester County Sanitary Sewer Commission:
Report, 1931.

Technical Books, etc.

Presented by Fraser Publishing Company:
Fraser's Metal Products Directory, 1932.

Presented by British Steel Export Association:
Great Britain, Dept. of Scientific and Industrial Research: First Report of the Steel Structures Research Committee, 1931.

Presented by Iron and Steel Institutes:
Fourth Report on the Heterogeneity of Steel Ingots, 1932.

Presented by the Asphalt Institute:
Manual No. 1: Road-Mix Types, 2nd. ed., rev. 1932.

Presented by Universal Oil Products Company:
The Cracking of California Gas Oil and Fuel Oil. [24 pp.]—Reprinted from Oil and Gas Journal, March 13, 1930.
Needs of Automobile Engines Dictate Design of Refinery Equipment. [8 pp.]—Reprinted from World Petroleum, Jan. 1932.

Presented by Combustion Engineering Corporation:
Tangential Firing of Gaseous and Liquid Fuels. [6 pp.]—Reprinted from Combustion, October, 1931.
Corner Firing of Blast Furnace Gas. [6 pp.]—Reprinted from Combustion, Jan. 1932.
Modernizing the Old Boiler Plant. [7 pp.]—Reprinted from Steam Plant Engineering, February, 1932.
Combination Burning of Blast Furnace Gas and Pulverized Fuel. [5 pp.]—Reprinted from Combustion, March, 1932.

Presented by Gale & Polden, Ltd.:
An Introduction to Aeronautical Engineering, Vol. 1: Mechanics of Flight, by A. C. Kermode. 1932.
Metal Aircraft Construction, by M. Langley. 1932.

Presented by Charles Griffin & Co. Ltd.:
Water Analysis for Sanitary and Technical Purposes, 2nd ed., by Herbert B. Stocks. 1932.

Presented by The Harbour Commissioners of Montreal:
Facts of Interest in Relation to the Harbour of Montreal, 1928.

Purchased:
American Society of Civil Engineers, Manuals of Engineering Practice.—No. 7-1931: Government Services Available to Civil Engineers.

Catalogues

The Garlock Packing Company:
Garlock Transmission Belting.]19 pp.].

Canadian Steel Piling Company, Ltd.:
Steel Sheet Piling. [72 pp.].

Canadian Junkers, Ltd.:
The Junkers Aeroplanes in the Service of the Guinea Airways, Ltd. [8 pp.].

Foster Wheeler Corporation:
Bulletin B-32-3: Boilers. [47 pp.].

The Tenth Annual Symposium on Colloid Chemistry will be held in Ottawa, Canada, June 16-17-18. About 200 specialists in this comparatively new field of science are expected to attend this meeting and eight of the 27 papers listed in the preliminary programme will be presented by Canadians. The sessions will be held in the newly constructed National Research Laboratories.

Dr. Emil Hatschek, Fellow of the Institute of Physics and lecturer on colloids at the Sir John Cass Technical Institute in London, will read a technical paper and will also give an evening lecture which will be illustrated by experiments.

Papers will be presented on the colloid chemical aspects of such diverse subjects as the constitution of rubber; diphtheria toxins and antitoxins; asphalts; studies in cellulose; colloidal arsenic; gelatin; resins, and cane wax in raw and refined sugar .

Eight annual meetings of colloid chemists have been held in the United States. The sixth symposium was held in Toronto in 1928; the tenth and second to be held in Canada is to assemble in the Canadian capital this year.

BRANCH NEWS

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

Joint Meeting with the A.I.E.E.

The annual joint meeting of the Hamilton Branch of The Institute and the Toronto Section A.I.E.E. was held in the Westinghouse auditorium on April 22nd, with an attendance of over two hundred. In the absence of the chairman and vice-chairman, the meeting was called to order by W. F. McLaren, M.E.I.C., past chairman of the Hamilton Branch, who welcomed the Toronto visitors and handed the meeting over to Mr. T. W. Eadie, chairman of the Toronto Section A.I.E.E. Mr. Eadie expressed his pleasure at this annual meeting, which has become such an institution in the activities of the two organizations, and then introduced the speaker, Mr. A. L. Atherton of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Mercury Arc Rectifiers

Mr. Atherton's subject was "New Utility Given Mercury Arc Rectifiers by Sectionalizing." An approach to an understanding of the problems such as mercury arc rectifiers present, was well explained by by the speaker. As various electrical subjects get more and more specialized, the wide divergences of knowledge become more and more apparent. Unknown functions appear. The rectifier is essentially a gas discharge device. It consists of a pool of mercury and a solid electrode and the pool is made to emit electrons. In its development, a new factor, namely, the control of conductivity, has arisen, a facility which did not exist before. Many interesting facts have been established regarding the characteristics of conductivity in mercury vapour.

The development of mercury arc rectifiers goes back to the year 1902. Since then there has been a great deal of research and experiment to establish designs which would produce a satisfactory piece of apparatus.

One of the most baffling problems that has presented itself is that of "arc back," which seems to be a loss of fluxion of insulation. The device might operate 215,000 times satisfactorily and then miss. What causes this lapse—foreign gas, the density of mercury vapour?

Physicists declare that it might be a chance combination of many small things. The search has been unremitting. The mercury vapour travels at the rate of 20,000 miles per hour, and the irregularity of the shape of the chamber and the varied density may possibly produce a favourable condition. It has been noted that when pressures are low there is a comparative freedom from arc back. The control of the mercury vapour is the most important feature.

The second stage in the development of mercury arc rectifiers, whereby refinements must come, has now been reached. Devices have been developed to offset certain conditions, but each one while increasing the efficiency, increases the internal losses (which amount to 5 to 10 volts). Dr. Slepian has calculated that theoretically the internal loss can be cut down to a fraction of a volt.

Years of study, research and development finally produced a mercury rectifier as reliable in service as a synchronous converter when the capacity was held down to 500 kilowatts, according to Mr. Atherton, but when size is increased to get larger output capacity, the reliability decreases many times faster than the capacity is increased.

Since the best performance is obtained only in the smaller sizes, the advantages of efficiency, dependability, economy and flexibility of both use and application are fundamental, therefore permanent, in the smaller units, said the paper, and the author mentioned books, bars of soap and lead pencils as familiar illustrations of the same principle.

Mr. Atherton explained that multiple installations of small units would be impracticable but said subdivisions of a large capacity, in which the structure is built in sections but installed as a whole had proven a feasible project. This plan makes all the desirable qualities of the small rectifier for larger capacities while the disadvantages of sectionalizing were negligible.

Expressed in terms of cost four 750 kilowatt sections installed as a whole, with ordinary load factors and rates for power, will operate at a power cost of from $1,000 to $3,000 a year less than a single tank of 3,000 kilowatt rating, Mr. Atherton said.

Space economy, convenience of installation and maintenance, the fact that any damage is likely to be limited to a relatively small part of the total structure and cause correspondingly short periods of interruption to service, as well as the increased reliability, greater flexibility in application and use, improvement in manufacturing requirements and an efficiency advantage of one per cent or more all indicate the preference for the sectionalized rectifier, said the engineer.

Consequently he closed his paper with the prediction that "as we understand more more of the behaviour of the rectifier and in view of the intensive research activity being devoted to the project, further improvement will be made in respect to both efficiency and size. As this progress occurs the development will be along the lines of sectional structures."

An interesting discussion took place following Mr. Atherton's talk, to which a large number of those present contributed. A vote of thanks to the speaker was moved by Mr. W. F. Sutherland of the Toronto Section A.I.E.E. and seconded by W. L. McFaul, M.E.I.C.

A vote of thanks to the Canadian Westinghouse Company Limited for the use of the auditorium and for the refreshments provided was moved by Mr. Morley Wood, Toronto Section A.I.E.E., seconded by Guy Marston, A.M.E.I.C. H. U. Hart, M.E.I.C., replied on behalf of the Canadian Westinghouse Company.

Kingston Branch

L. F. Grant, M.E.I.C., Secretary-Treasurer.

On March 1st, following a dinner at the Badminton Club, a paper on "Locomotive Design" was read by William Casey, M.E.I.C., vice-president of the Canadian Locomotive Company, Kingston. A synopsis follows.

Locomotive Design

Design of locomotives is governed by certain fixed restrictions, which are, in the order of their importance, gauge, tunnel clearances, weight on rails and turntable lengths. Certain other restrictions such as grades and curvature may exist in particular cases. Although it is over a century since the appearance of the first locomotive there has been more progress in design in the last ten years than in the preceding fifty.

Broadly speaking, on main line operation we find passenger, manifest and drag freight, transfer, switching, and suburban services, and locomotives must be designed for the particular service in question.

The first step in design is the determination of the tractive power necessary to haul a train of a given weight at a given speed, the maximum grade and curvature of the railway division being known. The tractive power which a locomotive can develop is given by the familiar equation.

$$T.P. = \frac{d^2S\ .\ 85\ P}{W}$$

in which d is the cylinder diameter, S the length of stroke, P the boiler pressure and W the driving wheel diameter. The tractive power necessary to move the train at the required speed may be estimated by allowing 6 pounds train resistance per ton weight, plus the amount for the engine and tender. From this and from the equation above, and assuming a rail adhesion factor of four, the necessary weight of the locomotive can be determined, and hence the number of axles necessary to keep the axle load below the maximum allowed for the particular railway, which in Canada is about 60,000 pounds. The diameter of driving wheels may be determined by experience, and this combined with the common boiler pressure of 200 pounds gives the cylinder dimensions. A piston speed of 1,000 feet enables a calculation of cylinder horse power to be made.

The next calculation is for boiler capacity, from which in turn the grate area can be computed. The size of fire-box necessary to give this grate area may necessitate the addition of a trailing truck.

The type and main dimensions being now settled, it is necessary to check weights including those of the various items of auxiliary equipment which a railway usually specifies. Such items are superheaters, feed water heaters, etc. In the last few years the use of alloy and high strength steels has increased, giving lighter parts.

Following the determination of weights, the position of the centre of gravity is calculated.

A few of the American railways have recently experimented with higher steam pressures in order to obtain greater thermal efficiency. To utilize these, radical changes were necessary in boiler design, bringing about the water-tube firebox. A few engines have been built in the United States with pressures up to 450 pounds per square inch.

In Germany a great deal of pioneering in radical locomotive design has been done along four different lines, namely high pressure steam; high pressure steam turbine; Diesel electric; and Diesel locomotive with mechanical drive.

The Diesel locomotives show the much greater efficiency that can be obtained by this cycle, and have set a mark in fuel economy that can be approached only by the higher steam pressures.

The more recent development of high pressure steam locomotives was pioneered in Germany by the Prussian State Railways, who, in collaboration with the Superheater Company developed a locomotive commonly described as the three pressure type. This development was brought to America last year, and at present there have been about eight of this type built, notably the C.P.R. 8000, which has the greatest tractive power of any locomotive in the British Empire to-day. In this locomotive the firebox is of the water-tube type, connected through headers with a series of small tubes nested in a forged steel header. This is an entirely closed circuit, and theoretically there is no evaporation. The pressure developed is from 1,400 to 1,600 pounds per square inch. The latent heat of steam at this pressure is such that when water is introduced into the drum containing these tubes a heat transfer takes place and a pressure of about 850 pounds is built up in the drum. While the locomotive is usually described as a three-pressure, only two pressures are utilized. The pressure in the drum (850 pounds) is the high pressure, and is applied at the centre cylinder, all locomotives of this type having three cylinders. The boiler, apart from the water-tube firebox and drum arrangements, follows conventional design, and the firebox gases pass through a fire tube boiler of standard construction maintaining a pressure of 225 pounds per square inch. The high pressure cylinder exhausts at 225 pounds, and this exhaust is combined with the main steam from the standard boiler to feed the two outside cylinders. An economy of 20 per cent is claimed for this type.

All of these departures from the conventional are interesting, but the saving in many instances is not sufficient to warrant the greater capital cost involved; in fact such overhead charges are created that twenty-four hour operation would be necessary to show interest on the investment.

London Branch

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

The regular monthly meeting of the Branch was held on March 24th in the City Hall auditorium, the speaker being E. T. Sterne, consulting chemical engineer. His address was entitled "Chemistry in Engineering."

D. M. Bright, A.M.E.I.C., chairman of the Branch, presided and after disposing of the usual preliminaries he called upon Mr. Murray Dillon to introduce the speaker.

Chemistry in Engineering

Mr. Sterne's address, while not of a technical nature, was interesting as showing the advances made in engineering achievements by the aid of chemical investigations of materials and consequent betterment.

In speaking of concrete mixtures he informed his audience that by a recent development in the chemical control of the ingredients in the manufacture of Portland cement, a cement can now be produced which will withstand the alkali corrosion which is encountered in the west.

He also referred to the chemical control of the correct proportions of different kinds of limestone, and proper burning and grinding in the manufacture of cement, and to the control of concrete mixtures and the chemical reaction in the setting.

Regarding steel he spoke of the advances made in the introduction and chemical control of new steel alloys and the consequent production of a metal much harder and stronger.

In the field of electrical engineering he instanced many improvements brought about by the aid of chemistry, amongst them being the drawing of tungsten wire for electric lamps to replace the old carbon filament, the introduction of gas filled lamps and of neon gas filled tubes for signs; and the control of the permeability of copper for electric wires. Also, the discovery that long distance transmission of electric current was made easier by the use of light weight aluminum wires together with the use of transformers with chemically controlled transformer oils. Regarding mechanical engineering particular reference was made to the advances made in the introduction and control of new steel alloys used in the production of cutting steels for use in the making of tools and cutting machinery generally, such as lathes, etc. Mass production was entirely dependent on these new alloys and he gave as an instance the production of the Ford cars.

He also referred to the high efficiency now attained in boilers which was made possible by water softeners evolved by chemical processes.

Speaking generally he gave examples of the value of chemical analysis of samples of materials used in engineering such as oils, coal, etc., and mentioned one instance that came under his personal notice. Out of thirteen or fourteen samples of road oil submitted with tenders and chemically examined, only three or four were found to be of such quality as to justify considering the accompanying tenders. In another case one oil broker delivered oil so much below his sample that the whole shipment was rejected.

About forty members and guests were present including Professor Gunton and a number of students in chemistry from the University of Western Ontario.

Engineering Triumphs of the Ancient Egyptians

The regular monthly meeting was held on the 21st of April, 1932, in the County building, Ridout street, and the speaker of the evening was Mr. F. H. Coates, lecturer in Bio-chemistry, University of Western Ontario. The title of his address was "Engineering Triumphs of the Ancient Egyptians."

D. M. Bright, A.M.E.I.C., chairman of the Branch, presided and called upon Mr. Williams, B.A.Sc., chemical engineer, to introduce the speaker.

Mr. Coates' lecture was illustrated by many beautiful views (including close-ups) of temples, monuments, etc., not the least important of which were the pyramids and the sphinx. He showed views of temples and other buildings erected in the city, now called Cairo, all built of the marble slabs which had originally formed the covering of the pyramids. When these buildings fall into ruin or are demolished much important information concerning the history and building of the pyramids should be brought to light; for it was known that these slabs were covered with hieroglyphics on what had been the outside in their original position but now on the inside and thus hidden. The pyramids date back to 4,000 years B.C. and the slabs had been removed and used by the Romans for the above purpose about 800 A.D. Also another piece of vandalism practised by them was the burning of tons of papyrus for heating purposes—thus, valuable information recorded on this was irretrievably lost.

Reference was made to the wonderful precision used in the erection of the pyramids and which pointed to the fact that accurate instruments of some kind must have been used. The centre of the Cheops pyramid lay exactly on the 30th latitude, it was a perfect square on plan, one of the passages in it was so inclined that the star Polarius always shone down it and the sides of the pyramid were built at an exact inclination to the horizontal of 52 degrees. The Sphinx, supposedly built as a temple, dates back to approximately 8,000 years B.C. and is fashioned with the body of a lion and the head of a human being, thus indicating strength with intelligence.

Views were shown of the temple of Karnak, which took 1,000 years to build, various units being added during the reigns of successive kings. The speaker cited the benefits derived from the increased fertility of the land by the periodical flooding of the surrounding areas made possible by the operation of the Assouan dam on the Nile. There was, however, the partial submerging of ancient temples and relics in the areas affected and unless something was done many of these relics would be entirely destroyed. Although they had withstood the ravages of time and weather it could hardly be expected they would survive periodical submersion of the foundations and damage had already been done to some of them.

Speaking of the method of erecting obelisks and large shafts of stone up to 90 feet long, he said traces had been found showing that the multiple pulley was known and that it was probably used to some extent, but the evidence pointed to the building of banks of burnt clay under the obelisks and gradually raising them by that means until they were sufficiently near the vertical to enable them to be pulled into their upright position.

Many questions were asked the speaker and amongst these was a query as to the feeding and housing of the large gangs of men employed for long periods of time on this laborious work. The answer was that each man received a bowl of rice and a bowl of water per day and as to housing they probably built huts for themselves using bricks made from the Nile clay. They received no pay as mostly criminals and slaves were employed on the work.

A hearty vote of thanks was proposed by W. C. Miller, M.E.I.C., and seconded by E. V. Buchanan, M.E.I.C., who complimented Mr. Coates on the clarity and beauty of his coloured views most of which, he understood, had been taken by him in his travels.

The motion was unanimously carried by the thirty members and guests, who were present.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.
F. V. Dowd, A.M.E.I.C., Branch News Editor.

Photo Elasticity

At the regular meeting of the Montreal Branch of The Institute held on April 14th, 1932, C. Michael Morssen, M.E.I.C., gave a very interesting lecture on "Photo Elasticity as Applied to the Investigation of Stresses in Structural Elements and Machinery." The chairman for the evening was R. E. Jamieson, A.M.E.I.C.

The speaker was very familiar with his subject, having visited the testing laboratories of Paris, Zurich and Brussels where he made special studies of photo elasticity as used in research work.

Mr. Morssen explained that the tests are based on the optical and mechanical properties of the material of which the model used for testing is made.

Small scale models are used at the present time and are generally made of a transparent substance such as glass, cellophane, etc.

What is sought is the connection between the optical and mechanical properties of transparent bodies when subjected to compression or tension, therefore a mechanical strain will develop at each point of principal stress. The stresses in a transparent model will affect the optical properties of the model so that a polarised light giving through a point of investigation will be divided into two beams, vibrating parallel to the principal stresses and permits the circulation of the intensity of same.

Photo elasticity is a development which gives a practical way to determine for each point in a model the two principal stresses their direction, intensity and nature (compression or tension) and this solving the problem of elasticity for the model.

A vote of thanks was tendered the speaker by C. J. Desbaillets, M.E.I.C.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

Dinner Dance

A pleasant and quite successful dinner dance was given by the Branch on March 31st at the Welland House, St. Catharines.

About one hundred and twenty-five members and guests attended, some of them coming from points as far distant as Buffalo and Hamilton. At this particular function no head table was provided, nor were there any speeches, and the experiment appeared to be favourably received.

ELECTORAL MEETING

The electoral meeting was held this year at the H.E.P. Administration Building at Niagara Falls on May 6th. The nominating officers and scrutineers present were: past chairman E. P. Johnson, A.M.E.I.C., C. H. Scheman, M.E.I.C., and E. G. Cameron, A.M.E.I.C., and chairman Walter Jackson, M.E.I.C. They reported that the three newly elected members of the Executive committee were Messrs. P. E. Buss, A.M.E.I.C., from Thorold; W. D. Bracken, S.E.I.C., from Niagara Falls; and J. C. Street, M.E.I.C., from Welland.

Ottawa Branch

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

At the noon luncheon at the Chateau Laurier on April 14th the speaker was Grote Stirling, M.E.I.C., member of the Federal Parliament for Kelowna constituency. C. McL. Pitts, A.M.E.I.C., chairman of the local Branch, presided, and in addition to the chairman and speaker, the head table guests included Hon. H. H. Stevens, Hon. A. K. MacLean, Hon. Martin Burrell, W. G. Ernst, J. A. Rodd, J. H. Campbell, Thos. L. Richard. F. A. Acland, Dr. Charles Camsell, M.E.I.C., President of The Institute, and G. J. Desbarats, C.M.G., M.E.I.C.

THE INGENIOUS ONES

Mr. Stirling took as the title to his address "The Ingenious Ones," by which expression he characterized those who had been responsible for engineering progress down through the ages. Primitive peoples, stated the speaker, at first distinctly individual, gradually formed themselves into communities, in each of which there would be one or more noted for their ingenuity, for their capacity for making use of the materials at hand and their facility for solving problems brought to them. Through the exercise of this ingenuity progress began to evidence itself.

In time, primitive routes of travel for the carrying on of commerce became established, which routes at times had perforce to lead across rivers, creeks and deep ravines. In crossing creeks the first idea, apart from the use of boats, was to use a fallen tree. Such a tree in time would rot and to the ingenious one the thought occurred to place a prop beneath the centre to give greater stability. Later, the idea would occur to introduce a number of props and in some such manner as this the first bridges were evolved.

It is probable, explained the speaker, that the Romans developed a forerunner to our present surveyors' level which consisted of a mounted tube without lenses, the level being obtained by the holding of water within it.

The speaker then traced the course of engineering progress further down through the Dark Ages when the priest and magic-worker held sway, coming finally to modern times.

One item of particular interest to the engineer was the gradual evolution of the surveyors' theodolite. This probably had its origin in the Dark Ages through the habit of the priests and magicians, in their efforts to invest their practices with mysticism, of consulting and studying the stars. At the end of the 18th century it began to take on some of its modern characteristics; the instrument of today follows as a result of a host of inventions and developments that have gone before.

Toward the close of his address the speaker devoted a few minutes to the place in the engineering profession of such organizations as The Engineering Institute of Canada, showing that they were all patterned closely after the original parent organization, the Institution of Civil Engineers of Great Britain. He remarked that the standards set for admission into such organizations as The Engineering Institute of Canada might reasonably be taken into consideration by the Civil Service Commission in filling positions of an engineering character. He also put forward the thought that if the opinions of engineers had been held in greater regard, a tremendous amount of money would have been saved to this country and to every other country.

Previous to the address, the chairman referred feelingly to the sudden death of one of the oldest members of the local Branch, C. H. Keefer, M.E.I.C., and as a tribute to his memory the members rose and stood for a few moments in silence.

The luncheon on April 28th, which was held at the Chateau Laurier under the chairmanship of the local chairman, C. McL. Pitts, A.M.E.I.C., was attended by a large number of engineers and others, the head table guests including, in addition to the chairman and speaker: Sir William Clark, Hon. H. H. Stevens, Dr. H. M. Tory, Dr. Charles Camsell, M.E.I.C., Gordon Gale, M.E.I.C., J. F. Gillies, President of the Canadian Lumbermens' Association, J. G. Parmalee, R. L. Sargeant, John Murphy M.E.I.C., R. H. Coates, B. Stuart McKenzie, M.E.I.C., T. A. McElhanney, A.M.E.I.C., and Group Captain E. W. Stedman, M.E.I.C.

STANDARDIZATION FOR EMPIRE TRADE

"The possible ramifications of industrial standardization are as vast as industry itself," stated Charles D. leMaistre, C.B.E., of London, England, British industrial expert and director and secretary of the British Standards Institution. Specifications leading to this standardization throughout the British Empire which are being brought about largely through the efforts of the institution with which he is connected will "in no way interfere with invention and design, and are arrived at by the general consent of all parties concerned. They do much for the safety of the workers by producing a reasonable quality of material, so tending to prevent accidents. They also help to stabilize unemployment by enabling producers to stock during slack times."

Efforts at the national standardization of industrial products were begun by engineers in the Old Country some thirty years ago, stated the speaker. To be successful they should be based upon a community of interest on the part of the manufacturer and the purchaser, and the findings should be arrived at through the common consent of all parties interested, co-operation being obtained from all of them from the very start. The British Engineering Standards Association, through which these efforts were largely fostered, has extended the scope of its activities to such an extent that it has recently taken in other branches of work on equal terms with engineering such as chemical, building, and textile activities, receiving a new charter therefor under the name of the British Standards Institution.

At the last Imperial Conference in London in 1930 it was recommended "that the standardizing bodies in the various parts of the British Commonwealth of Nations should keep in regular and systematic consultation with a view to the establishment of uniform standard specifications so far as is practicable in their common interest," thus extending the scope of the movement. It was found that such efforts would tend to eliminate the almost insuperable barriers to inter-Empire trade which result sometimes from the distances apart, the varying local conditions and the different habits of the peoples in various parts of the Commonwealth.

Mr. le Maistre had come to Canada to discuss empire standards with the National Research Council, the Canadian Engineering Standards Association and others, after spending two months in Australia and New Zealand where, he stated, he found the governments and trade generally very sympathetic to his mission. While passing through British Columbia he spent a week there interviewing lumbermen and other industrialists where he found every desire to co-operate to the full in the work of inter Empire standardization.

The thanks of the meeting were conveyed to the speaker by Sir William Clark, British High Commissioner, who stated that Mr. le Maistre's mission was one of particular importance now when all are not only talking, but thinking, of the development of further trade within the Empire. He characterized that mission as one dealing with the removal of practical obstacles to the extension of that trade whereby unnecessary competition among ourselves would be avoided.

Peterborough Branch

W. F. Auld, Jr.E.I.C., Secretary.
A. R. Jones, Jr.E.I.C., Branch News Editor.

The annual meeting of the Branch was held on May 12th, previous to which a dinner was held in the Y.M.C.A. banquet rooms. The reports of the retiring Executive were given by the various committee heads, following which, the results of the election for next year's officers were announced. The most notable feature of the reports was that, in this period of general decline in memberships, the Branch showed a membership list and an attendance record at meetings practically equal to the previous year. During the year twelve technical papers were presented.

Among the members of this year's Executive who were re-elected were H. R. Sills, Jr.E.I.C., chairman of the Meetings and Papers committee, whose work has been greatly appreciated by the Executive, and W. F. Auld, Jr.E.I.C., who was also the recipient of much praise for his efficient work.

THE FERRANTI SURGE ABSORBER

The April 28th meeting was featured by an address from J. M. Thomson, designing engineer with the Ferranti Electric Company. Mr. Thomson described the design and operation of the Ferranti surge absorber. This latest method of lightning protection was developed in England and has only recently been applied to any extent in this country. The chief advantage over the usual types of protection is the ability of the absorber to smooth down the front of an incoming wave as well as reducing its peak value. In transformers this is not so important since the space for insulation is fairly large and the insulation on the first section of turns can be built up to protect against the voltage which is built up in these turns when the wave is steep. In rotating machines, on the other hand, the space for insulation is extremely limited. Consequently when generators or motors are connected directly to transmission lines, it is important that the wave front be smoothed down.

Mr. Thomson had slides showing the appearance and method of construction of these absorbers.

Quebec Branch

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

RESSOURCES FORESTIERES CANADIENNES

Lundi le 7 mars, au Château Frontenac, la Section de Québec réunissait ses membres à un déjeuner-causerie. L'invité d'honneur, Mr. K. G. Fensom, Gérant du Canadian Hardwood Bureau à Ottawa, avait choisi comme titre de sa causerie: "The Utilization of Canadian Forest Resources."

Présenté par Hector Cimon, M.E.I.C., Président de la Section de Québec, le conférencier démontra que nos importations de bois étrangers nuisaient considérablement au développement de nos produits canadiens. Un tableau, comparant les caractéristiques et les propriétés de nos bois canadiens avec les bois importés démontra que l'érable dur et le bouleau canadien peuvent rivaliser en tout temps avec les bois importés. Nos bois canadiens gagnent à se faire connaître, et le Canadian Hardwood Bureau a grandement contribué à préconiser l'usage de nos bois durs en remplacement des bois importés. Le conférencier s'étendit ensuite sur le sujet du traitement des bois et sur les progrès réalisés dans ce domaine.

G. C. Piché, A.M.E.I.C., Chef du Service Forestier de la Province, remercia le conférencier: "Les bois qui ont grandi dans notre sol, sous notre climat ne sauraient faire autrement que de résister aux conditions climatériques de notre pays, au moins aussi bien que les bois étrangers."

Alexandre Larivière, A.M.E.I.C., Membre de la Commission des Services Publics de Québec seconda le vote de remerciements. Le conférencier fut vivement applaudi.

On remarquait à la table d'honneur, outre Mr. Fensom et Mr. Cimon: MM. A. R. Decary, M.E.I.C., A. B. MacAllister, J. A. Duchastel, M.E.I.C., A. B. Normandin, A.M.E.I.C., G. C. Piché, A.M.E.I.C., Alex. Larivière, A.M.E.I.C., A. G. Sabourin, A.M.E.I.C., et T. C. Dennis, A.M.E.I.C.

POSSIBILITIES AND PROBLEMS OF HYDRO-ELECTRIC POWER INDUSTRY

On March 21st, 1932, a luncheon meeting was held at the Chateau Frontenac, with an attendance of 65 members and guest representatives of the Quebec Board of Trade.

The speaker, G. Gordon Gale, M.Sc., M.E.I.C., vice-president and general manager of the Gatineau Power Company, was introduced by Hector Cimon, M.E.I.C., Branch chairman, and addressed the meeting on "Possibilities and Problems of Hydro-Electric Power Industry."

He stated that Canada, had a wonderful heritage in its water power and was one of the leaders in hydro-electric development among the nations of the world and the progressive development of these great natural resources in a sane, timely and economic manner was a responsibility which each must share.

Mr. Gale dealt at length with difficulties of water power development in Canada, particularly on the Gatineau river, and also explained to the meeting why electricity could not be used to heat dwellings.

The cost of distribution of electricity in comparatively small quantities was quite frequently double the cost of the power when it left the plant; this was true in towns and villages and the ratio was still greater in the case of rural distribution.

The location of a power plant in respect of its market presented some interesting problems; with regard to power rates, it was pointed out that the cost of power at the power plant and coal at the pit head were by no means the largest part of the cost to the consumers. Cost of transmission and distribution of electricity and the cost of transportation of coal often represented the largest proportion of the cost to the ultimate consumer. Quantity required and distance from source of supply had a direct bearing on the price.

The speaker was thanked by W. G. Mitchell, M.E.I.C., who pointed out that business men in particular and the public in general were deeply interested in water power development, and the immense sums which had been spent on it.

The chairman welcomed many members of the Quebec Board of Trade and Major R. M. Watson, first vice-president of the Board, replied, pointing out that hydro-electric development had played an immense part in the progress of industries and expressed confidence that in spite of depression there was a still greater future ahead for the industry.

RADIO-ELECTRICITY

A luncheon meeting was held at the Chateau Frontenac on April 18th, 1932, with an attendance of over thirty-five members and a few guests, greatly interested in the subject.

The speaker, Alexandre Larivière, A.M.E.I.C., member of the Quebec Public Service Commission, was introduced by H. Cimon, M.E.I.C., Branch chairman, and addressed the meeting on "Radio Electricity."

When introducing the speaker, Mr. Cimon gave a brief story of the radio, showing the active part taken by Canadians in its development.

It was in 1883 that the famous English physicist, Clerk Maxwell, discovered the feasibility of the transmission of electric waves by the ether medium. All ether waves travel at approximately the same speed, 186,000 miles per second.

According to experiments and studies completed to date, it was admitted that the space in which electro-magnetic waves travelled was limited, in their inferiority by the surface of the earth, and in their superiority by the conductive zone known as Heaviside, so called after the man who first discovered its use.

Mr. Larivière said that the fundamental principles of radio-telegraph and radio telephone were exactly the same; he also explained how pictures were transmitted by television.

The development of radio electricity had also played an important part in the progress of marine and aerial navigation. It was now possible to hold a telephone conversation from a private residence with a person travelling in an airplane; and ships might be controlled at sea by radio.

At the conclusion of the address, C. H. Boisvert, A.M.E.I.C., of the Quebec Public Service Commission, and R. B. McDunnough, A.M.E.I.C., of the Quebec Power Company, moved a hearty vote of thanks to the speaker, which was carried with applause.

A Dry Development Photo Print Process

Compounds of the Diazo group have been in use in the aniline dye industry for over a century. These organic compounds are produced from comparatively simple substances contained in coal tar and possess the property of combining with other organic compounds and forming dyestuffs. The action of light, however, renders them unable to form these pigments, and this property, which is taken advantage of in photo printing (the diazotype process), was discovered in 1890 by Messrs. Green, Cross and Bevan. The use of the diazotype in photo printing has become more general however since the introduction of Ozalid paper in 1922, a development based on the work of Professor Koegel, who worked out the method of dry development by the use of ammonia.

This dry-developing process has seveial advantages. The image is positive, and the prints are true-to-scale and non-fading. Papers can be coated with different emulsions giving brown, black or blue lines. With the proper equipment, the slight odour of the ammonia used for developing is not objectionable. Special papers are also available for moist development, the dye-forming constituent being incorporated in the paper. With these papers, the developer is applied in a thin film, the paper thus being moistened on one side only. In order to obtain the best results, it is advisable to use special developing-machines for this process.

This process is called "Ozalid" and its development is of an importance which will be readily appreciated as by its means indelible tracings on cloth, or on paper, can be inexpensively produced from ink or pencil drawings. By this means duplicate tracings can now be effected with speed and economy, and being absolute replicas of the originals, take the place of the latter for all purposes. Valuable original drawings, not needed any longer for printing purposes, can be kept in a safe place and preserved. The Canadian manufacturers are the Kalle Manufacturing Company of Montreal and Winnipeg.

The Harland Engineering Company of Canada, Ltd., Montreal, have been appointed sole Canadian representatives for Messrs. W. H. Allen, Sons and Company, Ltd., of Queens Engineering works, Bedford, England. Messrs. Allens are well known in this country for the excellence of their products which cover five main departments. These include: Steam turbines of all descriptions, also vertical steam engines of the open and enclosed types; surface and jet condensers combined with reciprocating, kinetic rotary and steam jet air pumps; centrifugal pumps for all liquids and sands; Diesel engines of both the air and airless injection types and also heavy fuel oil engines; marine equipment such as main and auxiliary circulating pumps, bilge and ballast pumps, etc., also fans and engines, and air supply to boiler rooms.

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The Service is operated for the benefit of members of The Engineering Institute of Canada, and industrial and other organizations employing technically trained men—without charge to either party.

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PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. At present employed. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, B.A.Sc., C.E. of Toronto, P.E. of N.B., desires employment. Experience includes three years on highway pavements, six years on city pavements and bridges, as well as general municipal engineering, two years on railway construction, four years on mining, assaying and drainage work. At present near Saint John, but willing to go anywhere. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing or sales organization. Apply to Box No. 334-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., married, thirty years experience in municipal engineering, highway and pavement work, also qualified sanitary engineer. For the past twenty years engaged as construction engineer on large works, including buildings, sewerage and water systems. Experienced executive and up-to-date methods used. Permanent position desired as engineer or superientendent. Location immaterial. Available at once. Apply to Box No. 336-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available immediately. Qualified Captain in military engineering. Apply to Box No. 377-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and movable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 29, married; experience over the last nine and a half years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations of hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial, available at once. Apply to Box No. 477-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

Situations Wanted

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in design, manufacture, sales and installation of pulp and paper, also mining machinery, seeks association with firm as sales engineer. Apply to Box No. 633-V.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C., Experience: Installation staff Can. Gen. Elect.; student's test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years' experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, A.M.E.I.C., Canadian. Fifteen years experience since graduation, manufacturing, testing, erecting and operating electrical equipment of all kinds. Six years power house and substation design and layout. Thoroughly familiar with automatic and supervisory control equipments, and industrial control. Available immediately. Anywhere in Canada. Apply to Box No. 681-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available on short notice. Apply to Box No. 692-W.

ELECTRICAL ENGINEER, B.Sc. '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting expe-

Situations Wanted

rience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experienced in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc. (Univ. of Man. '31), age 22. Experience includes two months surveying and two summers draughting maps and treated timber bridges with highway department. Interested in manufacture of electrical equipment, water power engineering, radio and telephone, highway engineering. Available on one month's notice. Apply to Box No. 747-W.

MINING ENGINEER, university graduate '30. Experienced in surveying, mapping, assaying, examination of prospects, diamond drilling and a season on Dominion Geological Survey. Employed at present but available on short notice. Apply to Box No. 748-W.

SALES ENGINEER, BSc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available shortly. Apply to Box No. 749-W.

CIVIL ENGINEER, M.A. (Cantab.), A.M.Inst. C.E., A.M.E.I.C. Age 27. Unmarried. Three years experience on hydro-electric construction, tunnels, dams, penstocks, etc., geodetic and general surveying. Three years experience on design of hydro-electric structures and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 751-W.

CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.), D. and S.L.S. Age 28. Available May 15th to September 15th. Will consider any offer for above period. Ten years experience in highway, drainage and railroad engineering; surveying of all types; sewerage and waterworks design; sales and newspaper work. Owns a car and has a thorough knowledge of prairie provinces. Apply to Box No. 760-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box 770-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monumental and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

ELECTRICAL ENGINEER AND AVIATION PILOT, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

SALES REPRESENTATIVE. Electrical engineer with ten years experience in power field interested in representing established firm for electrical or mechanical product in Montreal territory. Excellent connections. Apply to Box No. 795-W.

MECHANICAL ENGINEER, S.E.I.C., B.Sc. (Queen's '32). Age 23. Single. Three years as moulder's helper, machinist, etc., in foundries, machine shops and hydro-electric construction; also field and office draughting on power house construction. Good references. Available at once. Apply to Box No. 797-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc. (Univ. of Alberta '32). Single. Experience in surveying and draughting with Alberta Govt. Roads Dept.; also in electrolytic lead refinery. Available immediately. Location immaterial. Apply to Box No. 798-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in Municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

CIVIL ENGINEER, B.A. (Mech. Sc. Trip.): late mathematical scholar (Pet. Cambridge); Jr.E.I.C., age 28, graduated 1926. Extensive experience in all phases of hydro-electric development embracing design, field work, supervision, and contractor's office work, both in Britain and Canada. Also as resident engineer on large road contract in Scotland. Would work, and secure useful introductions, in any part of the world. Available June 15th. Apply to Box No. 801-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C. with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

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Engineering Education in Canada

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Introduction

"The ideal object of education," writes Dean Inge, "is that we should learn all that it concerns us to know, in order that thereby we may become all that it concerns us to be." If we admit the validity of this definition it is clear that, before we decide what we should learn, we must come to some measure of agreement as to what, in our profession, it concerns us to be. If we decide that our duty to ourselves and to the world at large is fulfilled if we become, primarily and solely, good engineers, then the problem as to the best means to be used to this end, though far from simple, will be immeasurably less difficult than if we admit a wider interpretation of our aims.

Let us suppose, in the latter case, that we adopt some such ideal as the following: "It concerns us, primarily, to be, and to see that those entrusted to our care become men of sound health and character, of broad sympathies and vision, with an intelligent interest in all that concerns human life and welfare, earning our rightful place in society by the practice of engineering and bending our surplus energies to the development of a healthier and a happier world." Should we, in whose hands the training of future engineers is placed, assume some responsibility in each part of this ideal programme? Or should we, as at present, concentrate on the purely vocational side and leave the rest, on which the future of civilization may depend, to the Goddess of Chance in the fond belief that all things are for the best in this best of all possible worlds?

Were our concentration on the vocational side to lead to no worse evils than a certain narrowness of life and usefulness in the engineering profession itself, this misfortune would be solely our own affair and would not leave us open to reproach from mankind at large. Unfortunately, such is the increasing influence of applied science of all kinds in the lives of men, with tremendous potentialities for both good and evil, that if the engineer remains absorbed in his craft with the result that he is the unwitting tool of unscrupulous opportunists, his great powers, which should be bent to the service and welfare of mankind, will inevitably result in the destruction of civilization itself.

Such is the great capacity of man for living in the present, coupled with his natural self-interest, and mental laziness where large issues are concerned, that anyone stressing the dangers of present tendencies is apt to be classed as unduly pessimistic and alarmist. Short though our memories be, we are yet too close to the tragedy of the War for any thinking man to dismiss these dangers lightly. However much delight the militarist may find in visions of whole enemy cities wiped out by bombs and gas (his own cities will undoubtedly be treated in the same way), he can do nothing without the help and service of the engineer: on the point of view and place in society of the latter the future peace and happiness of the world depend.

Of all professions that of scientific engineering is the youngest: when we compare the short duration of the industrial age with the centuries during which the soldier, the Church, and the lawyer have ruled the world we are filled with amazement at what Applied Science has done. And since this latest phase is so recent, the engineer is of necessity absorbed in putting his own house in order: while he is trying to develop the best technique for his training he has continually to adjust his curricula to include an ever-increasing volume of knowledge; little wonder, then that he is too absorbed in his work to realize and prepare for his ultimate status in society.

Canada, though a comparatively new country, by virtue of her geographical position, natural resources, and the qualities of her people, is destined to a great future, and with that future will come great opportunities and responsibilities for guiding the future of mankind. At present, naturally and rightly, she too is concentrating on putting her own house in order, and the chief work of our engineers is in developing those natural resources and the resulting growing industries which will be the foundation, but not the whole structure, of our maturity.

The great responsibility for anticipating and preparing for the future of the engineering profession in Canada naturally lies with our universities and all who co-operate in the education of engineers: one must remember that we are not preparing men for present conditions so much as for those of twenty or thirty years ahead, and consequently our chief responsibility is to posterity.

Present Engineering Education in Canada

Engineering differs from other human activities, such as law and medicine, in which an extensive training is necessary, in the great variety of work which it embraces. It can be roughly divided into two groups: the professional group which requires a thorough theoretical training, and whose activities range from pure scientific research on the one hand to pure business on the other; and the sub-professional group, including the purely practical man and the craftsman. On this continent engineering education has concentrated largely on the training of the first group to the comparative neglect of the second, with the result that large numbers of skilled workmen have been imported from time to time from older countries. In this connection it is relevant to quote from the Preliminary Report of the Investigation of Engineering Education, carried out by the Society for the Promotion of Engineering Education some five years ago:

> "That the present structure of American technical education is top-heavy and unbalanced seems plain by every test. We have concentrated by far the greater part of our facilities in degree-granting colleges, designed primarily to fit men for planning, investigative and advisory services of professional grade. We provide most meagrely for craft and trade training and for systems of apprenticeship and foreman training in industry. Training for the lesser technical positions not permanently attractive to college men is wholly inadequate. For the line, or operating type of activity, we give little distinctive training of any type."

This of course refers to conditions in the United States, but there is little reason to suppose that the state of affairs is much better in this country. It is true that we have the Ontario Apprenticeship Act and that we are not troubled, as are our friends to the south, by the continual multiplication of degree-granting institutions of low grade, but that our system is sadly unbalanced is very evident.

At the present time a large number of students who enter Applied Science courses in our universities never graduate; it may be true that the general cultural benefits derived from their association with the colleges and the certain amount of knowledge that they are bound to obtain do not make these cases a total loss, but at the same time it must be admitted that these students attempt a programme which is too ambitious for them, and that they suffer throughout life from a sense of failure. If their capabilities were more accurately determined before embarking on a degree course, so that they could take work more suited to their true vocation in other institutions such as technical schools or properly organized apprenticeship courses, they would afterwards live much more satisfying lives and would fill the needs of industry more satisfactorily. "Many a promising mechanic," to quote Sir J. D. McClure, "has been spoiled by the ill-considered attempts to make a passable engineer."

Canadian University Engineering Courses

As practically the whole of engineering education in Canada is in the hands of the universities, it has been thought that it may be of interest to include in this essay a somewhat detailed analysis of the courses available in our colleges at the present time. It is hoped that the tables and diagrams in the appendix are self-explanatory, and that they are in a form suitable for comparison and criticism.

The general tendency is for the first two years of the four-year courses to be the same for all branches of engineering, with some differentiation in the second year at Alberta and Queen's. Toronto, however, is unique in differentiating the courses from the very start.

It may be seen from Table No. 1 that the five courses which are most common, and may therefore be judged to be most important to the country, are, in order of prevalence, Civil, Electrical, Mechanical, Mining, and Chemical. The last two years of all courses are definitely specialized, and may be termed the "professional years"; in the case of the above five, the programmes of these years have been analyzed separately, and an attempt has been made to study the varying tendency towards specialization in the different colleges.

One interesting fact emerges from this analysis: the great diversity in texture of the courses in different universities. In general there is marked evidence of agreement of the various fundamental principles involved, such as the recognition that a university degree does not make an engineer and that therefore the courses should be based on a thorough grounding in fundamentals, with differentiation between different branches only in the second half of the course. Again, the courses are entirely vocational, the test of any study during the four-year period apparently being "is it of use to the graduate as an engineer?" In the detailed application of these principles, however, there is a great deal of variation. Each course expresses, to a greater or less degree, and with a time-lag of perhaps several years, the educational ideas and theories of the head of the department which gives it. This is a healthy state of affairs, for uniformity would be a sign either of perfection or of indifference to experiment and progress: perfection can unfortunately be immediately dismissed, at the present time, as a possibility in anything so intricate and debatable as educational policy, so that any deviation from the mean in the foregoing analyses, far from showing the presence of grave mistakes and misguided ideas, may be accepted as a sign of active and creative evolution. The final perfect course, if we ever attain to it, will be the result, not of any one man's ideas, but of a long process of trial and error in the field of human experience.

It will be noticed that all colleges, with the exception of McGill, compel their students to attend prescribed lectures or perform practical work for thirty or more hours per week. If it is admitted that an engineering graduate will ultimately be of more use if, when he leaves college, he has a sound knowledge of fundamental scientific theory, some facility in applying it to engineering problems, a clear brain and a capacity for clear thinking, than if his head is stuffed full of a great deal of information which he cannot possibly have had time to analyze, then there is a clear case for maintaining that the time-tables are too crowded.

The five-year university course, with a pre-engineering year in arts, is practically universal except in Ontario. The adoption of this plan is evidence of one or both of two things: first of all its chief use may be to provide that cultural background which will protect our budding engineer from the danger of being a one-sided technician, or secondly, and there is unfortunately much argument in favour of this latter, the Applied Science faculties have found students insufficiently prepared by the schools to be initiated immediately into the engineering courses.

The inclusion of a detailed historical analysis of curricula is, unfortunately, beyond the limitations of this essay. It would, however, be a grave omission were no mention made of the general development of engineering education from its beginnings. In Bulletin No. 11 of the Investigation of Engineering Education (published by the Society for the Promotion of Engineering Education) it is shown in a very interesting manner that from 1870 until about 1915 engineering courses gradually became less general and cultural and more and more specialized and technical. In the early days the curricula, due to the very undeveloped state of engineering knowledge and literature, consisted largely of pure science, and with the advancement of technical knowledge and the accumulation of laboratory equipment this state of affairs was very properly rectified. In order to overcome the prejudice of industry against the college graduate, moreover, the colleges still further emphasized the practical side, and in consequence the natural momentum of the system caused it to overshoot the mark. A change of viewpoint on the part of employers and the rapid accumulation of technical knowledge now combined to stem the tide, and from 1915 onwards we find a steady decrease in the specialization of curricula. It has been previously mentioned that there is a necessary time-lag of several years which separates the consensus of opinion and the actual courses: it takes many years to evolve a sound university course. Consequently, the change of opinion which caused the decline of specialization actually took place a good many years before 1915, and in like manner the courses of today do not reflect the contemporary view. We can therefore expect, during the next few years, increasing emphasis on the importance of fundamental principles, with development of the idea of post-graduate specialization under the guidance of the large manufacturers.

The Place of the University in Education

The university, as the seat of higher education and learning, has gradually evolved through various stages. At first its function was the education of the clergy, who held a practical monopoly of knowledge. Following the renascence of learning in western Europe the universities gradually became the reserves of the upper classes, their object being the education of gentlemen. The third and last stage has been brought about by the remarkable increase in scientific knowledge and its applications during the last century; the practice of the professions requires a steadily increasing training and knowledge which is outside the scope of the schools and which necessitates the continuance of education into the early twenties. The old aristocratic idea of university education is therefore dying (its last stronghold is Oxford) in the face of the ideals of democracy, and the colleges are becoming more and more the training places for the professions.

This increasingly democratic role of the universities is one of the best signs that the world, by the gradual increase of intelligence and equality of opportunity, may yet cure itself of the evils which cause so much misery and suffering. At the same time there are two tendencies, on this continent at least, in the present movement which give cause for alarm. I refer to the decrease of pure learning and the idea that everyone should go to a university.

The marked vocational trend of professional courses is due chiefly to the demands of industry, which, built as it is on a strictly economic and material basis, cares much for the utilitarian qualities of its servants and little for their intellectual wealth and general happiness (except in so far as these things make them work better). The argument for a broader intellectual outlook is bound up with the fallacy of the idea of the university for all. There is no higher stage of organized education than the university; in it, therefore, provision should be made for the encouragement of the very highest social ideals and intellectual endeavour. The expenditure of money and effort on students of inferior quality will reduce the general efficiency and hinder the development of that minority of first-class minds on which, if on anything, the improvement of the world depends. The danger is in the "tendency to level down all superiorities in the name of equality and good fellowship."*

If the present vocational trend persists, there is the possibility of the superior intelligences of the world being divided into two camps: the scientific and the artistic. Instead of minds finely balanced in all the true values of knowledge and artistic perception, there will be two groups whose mutual understanding and sympathy will steadily decrease, to the obvious detriment of the commonweal. The only remedy for this tendency lies with the individual himself, encouraged by the spirit of the universities: it is here that we must act independently of, and, if necessary, contrary to, the demands of industry. After all, the use of industry should be, not the provision of large dividends for shareholders, but the universal development of that material welfare which is necessary before mankind can learn to appreciate the higher wealth of the intellect and the spirit: it should not so dominate our educational policy as to hinder the growth of the latter. "If pure learning is to survive as one of the purposes of universities, it will have to be brought into relation with the life of the community as a whole, not only with the refined delights of a few gentlemen of leisure. I regard disinterested learning as a matter of great importance, and I should wish to see its place in academic life increased, not diminished. Both in England and in America, the main force tending to its diminution has been the desire to get endowments from ignorant millionaires. The cure lies in the creation of an educated democracy, willing to spend public money on objects which our captains of industry are unable to appreciate. This is by no means impossible, but it demands a general raising of the intellectual level."†

No one with best interests of the country at heart could be in favour of denying university education to a proportion of those who, under our present system, obtain it, without providing for them a training equally as good, and probably better fitted for them, elsewhere. The need for adequate training and education of craftsmen and practical men, who may have great and valuable talents but who are not the possessors of first-class brains, is being more and more realized; the actual provision of institutions suited to this purpose is bound, sooner or later, to follow this growth of opinion, and with the movement should be coupled a broader and higher conception of the function of the university.

The Applied Science courses of the future would then contain just as sound a grounding in general science (especially mathematics, for, in addition to the necessity of this subject as a tool in engineering theory and design, there is no better training for accurate and systematic thought) and of fundamental engineering theory as at present, but the method of instruction would include more private reading, essay and paper writing and critical discussions with professors, and fewer lectures. English literature would be studied under the guidance of men whose love for the subject would be sufficient to plant in the students a like enthusiasm, and the aim of this study would be the appreciation and criticism of social and aesthetic ideas rather than the learning of a few rules of grammar and style to be observed in the writing of "technical" English. Frequent essays would be required on topics of general interest. One foreign language at least would be taken with the object, not of its use in reading technical literature (such a use is limited to research men, who would be prepared accordingly) but of developing a sense of internationalism and a broad outlook. Political economy, general economics and law would prepare the student for that place in the world of affairs and finance to which his other properties would fit him. Active participation in the running of student engineering societies, and in general university debating, would give him that fluency of speech and facility for expressing himself that is so necessary in a position of importance. After graduation he would continue his studies in a more specialized way, preparing him more definitely for the type of work for which he is peculiarly fitted. In the case of those entering industry this specialized study would be supervised by the industrial concern in which the graduate is obtaining his practical training. Finally, by the aid of travelling scholarships he would spend a year abroad, getting perspective and breadth of view both in his own subject and in his ideas in general.

Such a programme is not too ambitious: first of all only those of sufficient intellectual endowment would be admitted, and secondly they would have the help of professors keenly alive to the objects in view, enthusiastic in their work and able, by being freed from long hours of lecturing and by sufficient remuneration, to keep in touch

*Dean Inge.

†Bertrand Russell, in "Education and the Good Life."

both by literature, personal research, and travel, with the best work that is being done in their subject in all parts of the world.

In order to develop to the greatest extent the value of the university to society, the whole structure of general education would have to be organized in an integral way. Many of the qualities required in the university student belong to earlier years, and the only control the university would have in such matters would be in the qualifications for entrance. The training of character is now recognized as belonging to the very earliest years, while the questions of health, good manners, honesty and fair play must be dealt with in the home and at school. The essential structure of democracy depends, not on the highest training for everybody, but on absolute equality of opportunity. Everybody should have the education for which they are naturally fitted, quite independently of their parents' financial resources. If this is to be realized, it will be necessary to spend much more public money on scholarships than at present, and education must cease to be looked upon as a necessary evil to be conducted as cheaply as possible.

In such an ideal system those students who wished to have an engineering training, who had the necessary natural ability required in the rank and file of the profession, but who were not of that high standard necessary for admission to the universities, would be trained in high-class technical schools. The courses given in these institutions would aim at just as sound a technical training as in the universities, but the standard of intelligence required would naturally be lower and there would be more specialization with a view to fitting men for particular types of work in industry. These schools would naturally take most of those who now fall by the wayside at the university, and in addition many who actually obtain degrees under the present system. Such an arrangement would result in a great increase of efficiency: those of superior intelligence and broad mental capacity would be able to develop their powers under conditions specially designed for them, unhindered as at present by the necessity of fitting courses to the lower standard of the majority. These latter, no longer struggling with courses beyond their capacity, would gain tremendously in self-confidence and usefulness. The error of the present system lies in setting up one standard of intelligence for the whole profession.

The great obstacle in the way of such a development is the problem of cost. The total number of full-time students enrolled in Applied Science faculties in Canadian universities (including Nova Scotia Technical College) during the session 1928-29 was less than three thousand. Even with the present system the cost of engineering education is high; should this small group of students be further split up, the duplication of apparatus and the reduction of the number of students in each institution would require a great increase in expenditure per student. Such a programme will not be possible until the number of engineering students has considerably increased, or until the public realizes the universal benefits which will ultimately result from a more liberal attitude towards education.

The only way of improving conditions at present would be a differentiation of courses within the universities themselves, but in this there are several dangers. If two standards of university degrees are adopted there will naturally be confusion in the minds of those not properly informed, while there would be a great danger of the general university standard being lowered. If the university degree is to be, as it should be, a sign of real intellectual achievement, any lowering of standard, even if accompanied by higher requirements for a select few, would inevitably result in a decline in the prestige of our universities in the eyes of the world.

Essentials in Technical Education

This essay has so far been limited to a discussion of the general principles of engineering education as related to the welfare of the profession and of mankind at large; let us now consider the objects and methods of the purely technical part of the programme.

It is now universally admitted that the university can only commence the complete education of an engineer. The details of practice and the wealth of experience necessary belong to later years, and the function of the university is to develop, as far as possible, those qualities of mind which will help most in successful later development, based on a background of sound scientific knowledge and general engineering theory. When a consensus of opinion as to the ideal qualities of an engineer is obtained, the usual result is such a collection of necessary talents as would require some race of supermen to fulfil. The mental qualities most needed, however, are not beyond the limitations of human nature; intellectual honesty, a critical attitude towards knowledge and methods, imagination, ingenuity and courage, all tempered by strict habits of accuracy and thoroughness. The development of these habits of mind is of much greater importance than the acquirement of great knowledge. It has been rightly said that education consists of tilling the ground and sowing the seed—the seed must grow of itself.

The main study which should provide the food for the growth of these qualities should be the application of pure science to engineering: the building up of engineering theory on fundamental laws and assumptions. This necessitates in the first place a sound grounding in the natural sciences, and especially in mathematics, the tool by which engineering theory is built up from fundamentals. In these early studies the prime object should be the development of accuracy, with just enough descriptive information about advanced work to fire the imagination and stimulate the interest.

If the general opinion of engineering graduates were obtained as to that subject which proved the greatest obstacle in their university work, mathematics would almost certainly head the poll. The result of a study of failures in Applied Science courses will inevitably show an almost universal weakness in this subject. The obvious remedy would seem to be greater opportunities for its study in the schools and a marked emphasis on it in the pre-engineering year: it seems a sad weakness that a student may enter the university without any knowledge of trigonometry and the haziest notions as to algebra and geometry, but such would seem to be the case. With the present standards it seems that only those who show marked ability in mathematics of school grade have any hope of graduating in applied science.

Assuming, and it is a very optimistic assumption, that the student has a sound knowledge of the natural sciences and of mathematics (including the calculus, the greatest tool of all), he can now be introduced to applied science proper, and here it is possible to formulate a principle of supreme importance. It can perhaps be best illustrated by the statement that, in any case where theory leads to a definite result which is applicable to an engineering problem, it is more important, in a university course at any rate, that the student should thoroughly understand the fundamental laws or assumptions, and their limitations, on which the theory is built up, than that he should remember the final formula. There may be some who would criticize this view on the ground that it will lead to a too theoretical outlook, and that an engineer in practice will have more faith in a few well-tried formulae and a comfortable factor of safety than in fundamental principles. This may be very true for those whose work is largely routine and based on precedent, but in the university we are hoping to train men who will be leaders and pioneers in their profession, men who will have the courage and self-confidence to apply their knowledge to new problems. The rapidly increasing reliability and uniformity in materials makes the intelligent application of theory of more and more importance in work of any magnitude.

Important as the understanding of theory may be, the realization of its limitations is quite as necessary; sometimes, especially in specialized courses, empirical formulae may have to be introduced, and in such cases an understanding of the limitations and scope of the work on which they are based is of prime importance. In developing the proper attitude towards formulae of all kinds a sound critical knowledge of fundamental principles is of greatest use.

The Laboratory

Side by side with these theoretical studies the student should be developing experimental skill and first-hand acquaintance with natural phenomena in the laboratory. Some of the greatest opportunities for gaining a true insight into his subject are to be found in this individual experimental work, and in such a case as electricity, where the average student has little or no familiarity with even the simplest concepts when starting the course, the theoretical work would be of little value divorced from the laboratory.

The class of experiment and apparatus should be within the scope of the student's knowledge; there has been a tendency on this continent to spend large sums of money on complicated apparatus of a far too specialized type for use in undergraduate laboratories. Again, the value of the work is destroyed if the students do not, as far as possible, choose and arrange the necessary apparatus themselves. Above all, the activities of the instructor should be limited to initial discussion and advice with a general supervision of apparatus and connections: he should avoid the danger of doing the experiment himself. Naturally, he should always be at hand to give advice or to straighten out difficulties, but the chief aim of the laboratory periods should be the development of some degree of experimental initiative in all the students.

The qualities which appear to be most necessary in laboratory work are an understanding of and a respect for the instruments used, observation, accuracy and patience. One disadvantage of the routine experiments usual in undergraduate work lies in the fact that the student knows (if he knows his theory) what he is looking for, and one of the most valuable habits of a true experimenter, ubiquitous observation, is not developed. In this lies the greatest difficulty, for the amount of ground to be covered, the limited time available, and the fact that a very small minority of the students have real genius, all combine to make it necessary that some knowledge of the theory should precede the experiment. The only possible purpose of the laboratory under these circumstances can therefore be the development of experimental skill, familiarity with standard machines and processes, and the practical realization of the fundamentals and results of theory. These, after all, are by no means unimportant achievements, and a born experimenter will soon become evident under such circumstances.

The proportion of time actually spent in the laboratory or on other practical work varies both with the course and at different colleges. For instance, the average time spent on practical chemical work in the courses of Chemical Engineering is 61.6 per cent in the junior year and 68.7 per cent in the senior year, of the total time spent on chemical subjects, while similar figures for Mechanical Engineering are only 51.0 per cent and 58.8 per cent (see Table No. 14). The average percentage of time spent on practical work (for the specialized engineering group) in the junior year is 38 per cent at McGill and 66.2 per cent at Toronto, while in the senior year the figures are 36 per cent for McGill and 78.7 per cent for Toronto (see Table No. 13). The average figures are 56.0 per cent for the junior year and 58.3 per cent for the senior year.

The Lecture System

The prevalence of a very full weekly time-table in our universities is readily seen from Table No. 11, and it has already been suggested that the demands on the student are too heavy. The conventional lecture itself has been much criticized of recent years, and there is much ground for this criticism. Though a good lecture is a stimulus and an inspiration, a bad lecture is a pure waste of time and the students would derive more benefit from sound sleep (a fact which many of them realize). Under the present system we compel the student to take down lecture notes all morning and to spend all afternoon in the laboratory or draughting room: little wonder that at the end of the day his brain is in no condition for further study. He develops no true appreciation of his work, and consequently rapidly forgets the superficial knowledge, crammed into his brain a few weeks before the examinations, for which we give him the dignity of a degree.

How can we improve these conditions? Let us, first of all, cut down the compulsory time-table hours to a maximum of twenty per week. Let us, in giving any course, give the students certain books to read, and let us suit the number and difficulty of these books to the capacity of the student. Lectures will be fewer than at present, and only good lecturers will be asked to give them (the other members of the staff will have plenty to do). Their purpose will be to survey the whole ground at a fairly rapid rate, concentrating on points of fundamental importance and the more difficult parts of theory. Once a week every student will be set a problem paper in each course, specially designed to bring out fundamental conceptions and to exercise his analytical and reasoning powers. Again, once a week every student will spend an hour with one of the staff, who will correct and criticize his papers. This "tutorial" should, if possible, include an hour for each main branch of his studies, and if each "tutor" takes a group of five or six students at a time this system would not necessitate any great increase in the number or the working load of the teaching staff. Even if the staff had to be increased, the superior efficiency of such a system would justify it.

This enormously increased contact between professor and student would remove many of the present weaknesses of the examination system. Supposing, for instance, that a student is under the observation of three or four tutors, these latter would be able to form a sound opinion of his ability and work, while the evils of personal prejudice or favouritism would be cancelled out. The annual examinations could then have a broader and more general scope than at present, designed to test the more permanent results of the course. The final standing of the student would depend on both these annual examinations and the consensus of opinion of his tutors.

Specialization

The rapidly increasing scope of engineering studies is making the inclusion of both a sound general training and specialization in limited fields more and more difficult of accomplishment in an undergraduate course; the scope of the general training is growing to such an extent that much specialization can only be achieved at the sacrifice of that broad outlook which should be the aim of university training. For example, the increasing importance of radio and of aeronautics calls for their fundamentals to be included in the general course, instead of being optional subjects. Further, specialization necessitates an increasing emphasis on the economical and practical side which can only be properly appreciated if the study is undertaken in close contact with industrial conditions.

The majority of universities have now adopted a distinct differentiation between the major branches of engineering, the tendency in Canada being to introduce this differentiation after the first two years of the four years' course. An interesting example of a perfectly general course is that given in Mechanical Sciences at Cambridge University (England), where the only specialization possible is in optional advanced subjects (which need not be taken at all) in the final year. Where a student has definitely decided on the branch of the art which he will finally adopt he will naturally provide his own specialization, but where no particular preference is shown it is felt that the complete generality of his training will enable him to make an unfettered choice at a time when he understands his own capabilities and possible opportunities much better than at the beginning of his university career. This system seems to work very well, though it has one or two inherent disadvantages. It is inevitable that one or more departments of the engineering school may become stronger than the rest, with the result that the course remains no longer perfectly balanced; further, such complete generality may prove a drawback in failing to provide a focus for the activities of a student who has no marked natural bent.

The practice of differentiating between the major branches at the end of two years would seem to be sound, provided that the subjects belonging to the chosen career do not swamp those of a more general nature. There is one grave danger in too early choice, and that is that the student will neglect those subjects not bearing directly on his specialty, and for this reason there are some advantages in deferring the choice until after three years.

The state of affairs in electrical engineering—on which the writer is most qualified to speak—is well summed up by Sir Thomas Purves, past-president of the Institution of Electrical Engineers:

> "A great responsibility rests to-day upon the teachers of scientific technology, whose task it is to equip the normal human brain, in a limited term of years, with the elements of knowledge which will best enable the coming generation to take up and carry forward the intellectual side of the world's constructive work. More and more has science become the basis of intellectual advancement, and more and more has it become essential to make a rigorously limited selection of the conceptions of nature's structure and law which can most helpfully be gathered together and impressed upon the mind of youth as a directive guide to well-balanced progress. No longer is it possible to turn out a finished student into the stream of life. We shall have to be content—and we may well be content—if the graduates of our science and engineering colleges are men with sound fundamental knowledge and with faculties trained to continue the process of absorption and assimilation; men who know what the tools of science and technology are and how they can be used, and who will be all the better if they have some general idea of the wonderful visions of ultimate things that the most advanced minds of the world are glimpsing today from mountain-tops that, to most of us, are still away in the far distance.
>
> "The need for specialization is, of course, greater than ever and will go on increasing, but the same may be said of the disadvantage of too early specialization. It is generally the hard and continuous specialist who 'delivers the goods,' but he can only do that after his college training has been supplemented by intimate contact with the problems of his profession.
>
> "The time is rapidly approaching—if, indeed, it has not already arrived—when the teaching of the detailed applications of technology to professional subjects, in full-time educational establishments, will have to be abandoned. The fundamental technique of electrical science and engineering, and its general applications, already furnish more than sufficient material for a full college course. The student will have to wait until he has left college, and has selected and entered his branch of the profession, before he can really begin to learn how his knowledge must be applied in practice. He will learn it then all the quicker, because he will be in touch with actual things and actual needs, in association with working experts and will have the continual stimulus of his natural desire to advance himself in his chosen career."

That conditions are very much the same on this continent may be evidenced by the practice of some of the large manufacturers in the United States of providing opportunities for their student engineers to pursue post-graduate studies at a neighbouring university. This would seem to be the best and most logical method of specialization, but for its successful operation it requires a combination of conditions not common in Canada. It requires, first of all, a manufacturing concern, employing recent graduates in "student courses," whose activities are of sufficient breadth to provide many avenues for the student; it further requires the close proximity of a university. Such a combination is not impossible at the present time in eastern Canada, but little can be done along these lines in the west for some time to come. The vital necessity for the organization of such post-graduate opportunities in the east is seen in the practice of sending our best students to partake of the advantages to be obtained in the United States—with the result that many of them never come back.

Advanced Degrees

It is the practice in most Canadian universities to grant the degree of M.Sc. in engineering on the satisfactory completion of a year of post-graduate study. The advantage of this to those hoping to enter the academic profession, or to those whose bent is nearer to scientific research than to practical engineering, is evident, but for those entering industrial work the system is not so attractive. The additional year of study delays the time when the graduate starts his acquaintance with practical life, and makes the necessary readjustment all the more difficult. It seems more and more evident that post-graduate engineering studies should be intimately connected with the practical experience obtained with the large manufacturers.

In the United States the degree of "engineer" has been adopted in many cases. In the best sense this is a professional degree, necessitating for its award that practical experience without which no engineer's education is complete. Unfortunately, the conditions under which these degrees are given are so varied, varying from the ordinary four-year undergraduate course with no extra experience to a requirement of seven years practice after graduation, that their universal value and prestige have been largely vitiated.

In view of this unsatisfactory state of affairs it would be unfortunate if our Canadian universities adopted this degree until, by energetic co-operation of all concerned, its status has been put on a uniform basis. Even if this were accomplished, it is a moot point as to whether it is a function of the university to grant professional status at all: this duty seems to belong more naturally to the professional engineering societies. In any one profession there should be but one standard and but one central authority whose duty it is to create, maintain, and enforce this standard. If each university is entitled to give professional degrees, it is obvious that there will be as many standards as there are universities. The natural solution of the problem would therefore seem to be in a universal recognition of the different functions of the university and the professional body: the university gives degrees, graduate or post-graduate, for strictly scientific and academic work and distinction, and it sets its own regulations. It may require certain general qualifications as to length of time spent on practical work for the first degree, but its chief duty is the maintenance of its degrees as a reward for strictly intellectual attainments. The duty of the professional body, on the other hand, is to create and maintain standards for definite professional status. It is in their power to attach much or little importance to a university degree, but it is in their hands, and in theirs alone, that the responsibility of full definition of professional status rests. The best professional qualification is corporate membership in an institution which maintains a very high and fair standard of entrance requirements.

Practical Experience

It is an old controversy as to whether the university man should obtain his practical experience before, during, or after his college career. The great argument for the first of these possibilities is that he will meet practical conditions at a more impressionable age, so that he will develop the faculty of co-operating with his fellow workers much more satisfactorily than he would after an experience which is apt to accentuate the difference between him and the ranks of labour. The trouble with this system, however, is that the habit of study, and a good deal of that knowledge which should be fresh in the student's mind on entering the university, are lost. By far the greatest proportion of engineering graduates now obtain their practical experience after their college careers, and in this too there are many drawbacks. A man of the age of twenty-one or two, after a successful university career, is naturally impatient, after his long education, to find scope for his abilities in creative work. He quickly finds, however, that he has still to undergo a very important part of his education, and if he is wise he will realize that the longer and more thorough his practical training is, the more fully will he be able to realize his ambitions in later life. It is at this time that he needs all the moral support and encouragement that older members of his profession can give him: at an age when he has little experience of life and consequently little true perspective, he is obliged to make a drastic change in his habits which may cause much mental unsettlement and depression.

It is important to note, at this point, the two main divisions into which the activities of engineering may be divided: field work and construction, and industrial work. It is in the latter division that the greatest provision has been made by manufacturers for the all-round practical training of graduates: in the former the young engineer has largely to make his own practical training, due to the fact that his employer will not, as a rule, be willing or able to give him a very broad experience. This is, after all, not a great disadvantage, since too much supervision is apt to destroy initiative and the sense of adventure. (This difference would seem to account for the higher degree of specialization in the Mining and Civil courses as shown by Table 12: the graduate in these fields must be better prepared to take a specific job.) In the case of industry the student engineer or apprenticeship course is becoming more and more the only satisfactory mode of entry into professional life: in this system the graduate spends a year or more in the shops, being moved from time to time through the different departments, and afterwards, if satisfactory, he will spend perhaps another year in the engineering offices before he finally obtains a permanent position. He is fortunate, on this continent, during these years in being able to obtain a good living wage: in Great Britain, for example, the degree man is lucky if he earns, for the first two or three years, enough to pay his board and lodging. At the same time, however, it must be admitted that some of the student courses on this side of the Atlantic would be much improved if they provided training of wider scope. For example, the average student course for an electrical engineer consists solely in experience in testing, whereas if he were taken for some months into the machine shop and the draughting room his efficiency as a prospective servant of the company would be considerably increased. Some experience in the production and costing departments would also increase his grasp of the industrial structure.

It is an obvious advantage if the student can obtain similar experience during the vacations while he is at the university. It will give him that intimate knowledge of industrial life which will enable him to make a wise choice after graduation, and will make the transition period less unpleasant. In this respect the eastern provinces have the advantage over those of the west, the students of which are practically debarred from vocational experience in industry due to the expenses of travelling. The wider experience of field work, such as in survey parties, which the latter obtain somewhat makes up for this disadvantage.

The second possibility, that of obtaining the whole of the necessary practical experience while attending college, is at present being developed in sixteen or more institutions in the United States. The system is called the "Co-operative Plan," and involves more or less equal periods spent alternately in college and in industry.* The periods of alternation vary between two weeks and four months, and the total time required for the bachelor's degree varies from four to five years. There is close co-ordination between the colleges and the industries participating in the plan, which appears to have distinct possibilities where the necessary industries are available close to the university. Its operation seems to depend, however, on the university being in a large industrialized area, and also on fairly prosperous industrial conditions.

What is most needed in Canada is increased co-operation between industrial concerns and the universities, with a view of providing sound post-graduate specialization consisting both of practical work and study. Only in this way can we hope to keep within our borders those superior students which we can ill afford to lose.

The Teaching Staff

"Teaching is the noblest of professions but the sorriest of trades." In this statement lies the secret of many of the faults and troubles of educational systems. There is in this country a most unfortunate tendency to look upon teaching as a stepping-stone to better things rather than as a life-long vocation. If mankind in general could be shaken out of its scramble for material wealth and power to a more disinterested anxiety for the happiness of the world at large, it would be realized that the greatest constructive power is that of education, and that on the point of view and quality of the teaching profession depends the future welfare of civilization.

Though this trouble is more evident in the schools than in the universities, it affects the efficiency of engineering education on account of the temptation presented to a first-class man by the superior financial possibilities of a commercial career. In the ideal teacher of applied science a peculiar balance of interests is necessary; he must be equally concerned with pure science and research, the application of these to industry, and human values. He must be a combination of a scientist and an engineer, and above all he must believe in the far-reaching importance of his teaching work.

Such an ideal man is by no means easy to find, and his qualities necessitate a very wide experience. When he is found he is apt to be rewarded with a salary which is quite insufficient to enable him to do justice to his capabilities. Instead of spending his spare time in private research and study, keeping in touch with those branches of industry and practice which concern him, or in visiting other countries in the interests of his work, he is often driven by economic necessity to take any vacation work he can find, regardless of its ultimate use in increasing his efficiency as a teacher. If he is fortunate enough to have private means, or if he has no family to support and educate, he may possibly hold his duty to mankind higher than material ambition, but if he does not do so he can hardly be blamed, and the whole profession suffers the loss.

In order that the primary interest of this essay, the improvement of the usefulness and status of the engineering

*For detailed accounts of the principles and practice of this plan see Bulletin No. 12 of the Investigation of Engineering Education, and also "Co-operative Courses—Their Development and Operating Principles," by K. L. Wildes, Vol. 49, Trans. A.I.E.E., p. 1086.

profession, may not run the danger of becoming tainted with the personal self-interest of a member of the teaching fraternity, it has been thought best to quote, at some length, some of the conclusions and recommendations of the Committee on Teaching Personnel of the Investigation of Engineering Education (Bulletin No. 4). Educational organizations in Canada and the United States are very similar, and the following statements are equally applicable to either.

"Are we drawing our younger teachers from among the highest level of those graduating year after year from our engineering schools as measured not alone by their scholastic records but by their character and all-round promise? Many of those in administrative positions feel that in general we are not doing so but that industry and practice are getting and holding these men, and that it is in just this way that industry is taking away the best talent from the teaching profession. To avoid a danger of this sort and to obtain the best possible material it will be necessary to render teaching positions so attractive that they will be eagerly competed for. If we can by any means whatsoever render the professorial position one generally recognized as of real prestige, to be gained and held only through severe competition and hard work, our problem is solved. Adequate salaries, larger opportunities to take part in engineering practice and research work, and a more careful scrutiny of candidates on the basis of all-round qualifications, will doubtless be the principal means toward the end desired."

"The teaching load for all ranks is uniformly heavy as compared with that borne in general by academic teachers. The average number of teaching hours (actually contact hours of fifty-five minutes each) is very close to eighteen and there is no great departure from this average for any rank (excluding deans). The general opinion seems to be that eighteen hours of actual teaching is too heavy a load since it certainly entails at least an equal amount of auxiliary work, preparation, marking of papers, etc., and that therefore the total amount of time and effort expended on the teaching duties alone leaves too small a margin of time for developing professional contacts, research, study, recreation, exercise, and in short general self-development."

"Taking all the available facts into consideration it must be concluded that in the engineering schools of the United States and Canada taken as a whole, by far the greater part of all the time and energy of the teachers is devoted to the work of undergraduate teaching.* The time seems to be ripe for lessening the burden on the individual teacher of the formal undergraduate teaching and for an increase in the time devoted to more advanced instruction, to engineering practice, research, and to whatever tends to enrich and develop the teacher as an engineer and a man."

"Turning now to the question of what can be done to secure and keep in the teaching ranks men possessed of the characteristics and ability deemed essential to the further progress of engineering education, we come at once to the question of financial remuneration. All will probably agree that this plays a most important part in securing and maintaining satisfactory teaching personnel. Whatever may be said regarding the other compensations which reward the teacher's career, in the last analysis the financial return will be found to be the most important single consideration. The proposition is difficult to state without offence to some of our cherished ideals and without laying ourselves open to the charge of a materialistic bias.

"Whatever the reasons may be that lead a young man to enter the teaching profession, one thing is certain; he will not stay in it, if he is a normal young man with ability and courage, unless he can be reasonably certain of making a satisfactory living as judged by the commonly accepted standards of the social order in which he finds himself. Moreover every graduating student knows about the small salaries paid to teachers and this knowledge, added to certain unfavourable impressions which he may have secured first-hand during his career as a student, leads him very often to avoid teaching.

"The data show clearly that engineering teachers' salaries even when supplemented by outside earnings are decidedly less than are the incomes of the most nearly comparable class, engineering graduates in practice. Teachers in some specially favoured institutions are better off than this, but even here, except for a very few specially favoured individuals, the total income does not exceed the median income of the practising engineer, and does not approach very closely even the lower limits of the income of the maximum twenty-five per cent of engineers in practice. To the young graduate looking forward to a career, the engineering teacher's prospects look at best like a decidedly second-rate chance so far as income is concerned.

*The general average time spent on research work for all ranks was found by the investigation to be only 1.3 hours per week.

"If salaries and total earned income of engineering teachers remain on the present basis it will doubtless be true in the future, as it has been in the past, that the teaching profession will continue to attract able men who are willing to face the smaller financial returns because of the opportunities for study and research, and for the relative freedom and permanency to be found in academic positions. Men in practice who have perhaps laid by a competence and have a taste for scholarly pursuits and an interest in education, and who perhaps have had all the experience in practical affairs they want, will from time to time join the ranks of the teachers. Possibly a permanent and not too strenuous berth with pleasant social accompaniments appeals to them. We shall, however, still continue to get too large a proportion of men who do not represent the highest type of our graduates, and who seem to gravitate toward teaching from negative rather than positive reasons. All administrative officers know how adhesive this type is. We should not lay too great weight on the fact as shown by the data that industry does not appear to be drawing away any considerable proportion of our teachers. Perhaps they take all they believe are of any particular value to them, and some of these may be the very men we need most to keep.

"If we are to raise the general standard of our teaching personnel above the present level (and this appears to be the essential and most obvious means of improving engineering education), we must, as remarked above, offer salaries which are at least the equivalent of the financial return which the engineering graduate may reasonably expect to receive in practice. To such a salary the ambitious, energetic, and capable teachers may add a fairly substantial amount by outside practice, but he will even then find himself, so far as income is concerned, in the ranks of the lower part of the upper twenty-five per cent of engineers. We cannot expect a young man of spirit and ability to enter or remain in the teaching ranks if he must occupy an inferior position as judged by the standards of the social order in which he lives in respect to the ordinary relations of life. We must raise our salary scale if we are to have our teaching positions desired and competed for by the kind of men we must have."

"It seems to be clear that it would be advantageous if all engineering schools not only encouraged their teachers to do a reasonable amount of outside professional work, but actually insisted on it and made a systematic and organized effort to promote it. Such action with reference to the younger teachers before they have become permanently settled in teaching positions would be most beneficial. Particular emphasis may be laid on the importance of such opportunities during vacations, for then is the most favourable time for a satisfactory and mutually advantageous co-operation with industry. The benefit is not confined to the teacher; the industry will profit by the services of men thoroughly masters of theory; the schools will render a correspondingly greater service to the community; the students will discover very quickly that their teachers are not merely teachers but doers, and will respect them accordingly."

"It is perhaps needless to qualify these statements by remarking that the character of the work should be such as to provide an experience which will react favourably on the academic work. Mere 'pot-boiling' jobs should be avoided.

"There will be little disagreement with the statement that the real problem before us is that of securing the right type of teachers for our engineering faculties—that this constitutes a major problem in engineering education. On it hangs the satisfactory solution of our most serious educational difficulties."

With regard to the heavy teaching loads which are prevalent, and the necessity of research work in universities, Bertrand Russell writes†:

"Every university teacher should be himself engaged in research, and should have sufficient leisure and energy to know what is being done in his subject in all countries. In university teaching, skill in pedagogy is no longer important; what is important is knowledge of one's subject and keenness about what is being done in it. This is impossible for a man who is overworked and nervously exhausted by teaching. His subject is likely to become distasteful to him, and his knowledge is almost sure to be confined to what he learnt in youth."

"Research is at least as important as education, when we are considering the functions of universities in the life of mankind. New knowledge is the chief cause of progress, and without it the world would soon become stationary. It could continue, for a time, to improve by the diffusion and wider use of existing knowledge, but this process, by itself, could not last long. And even the pursuit of knowledge, if it is utilitarian, is not self-sustaining. Utilitarian knowledge needs to be fructified by disinterested investigation, which has no motive beyond the desire to understand the world better. All the great advances are at first purely theoretical, and are only afterwards found to be capable of practical applications."

†Education and the Good Life."

A very commendable practice is now growing up, in the large manufacturing companies, of providing opportunities for engineering teachers to spend some time during the vacation in the factories, in order that they may keep in intimate contact with current practice and progress. Some such system is absolutely necessary if the teacher is to do justice to his position: pure concentration on remunerative work, which is unfortunately necessary in many cases for economic reasons, does not allow a man to obtain contact with the current practice of every branch of his subject. Before this practice becomes as common as it should be, it is clear that the average professor will have to be made more independent of outside remunerative work in obtaining a living. In taking advantage of these opportunities presented by industry, some colleges are very much more favourably situated than others. In the colleges of the west the high travelling expenses entailed make it quite impossible for the younger men, who most need the experience, to enter into the scheme. These out-of-the-way universities, if they hope to obtain the highest efficiency, might well do something to assist the younger teachers to obtain this very necessary and valuable experience.

An extension of this idea of the large firms to include opportunities and encouragement for engineering professors from other countries to spend some time in their works would undoubtedly, if reciprocated, do much to further the growth of international trade, international good-will, and the efficiency of the engineering profession. If universities in general recognized the value of such an interchange of ideas and knowledge and encouraged the same in a material way, they would do much to fulfil their great opportunities for promoting world peace.

It must not be thought that such innovations as recommended in the previous pages are to make teaching a well-paid soft job, with plenty of leisure and opportunities for globe-trotting. If the universities give more, they must certainly expect more in return. Under such a system there would be no excuse for continuing to employ those who do not repay, by the quality of their work, the privileges of their position. The main object in view is not the improvement of the teacher's lot, but the improvement of engineering education and the development of knowledge: these ideals depend for their fulfilment on obtaining and keeping the best men in the teaching profession, and any real improvement in education must be obtained by accomplishing this aim.

Conclusion

The future holds many things, all unknown, in store for the human race. The present state of civilization does not leave one with any great sense of satisfaction, and it may well be that many tragic and dark years will pass before mankind emerges into the sunlight. It may even be that man, by his own folly and misuse of the powers of nature, will pass into the darkness, destroyed by his own ambition. The great hope lies in the growth of good-will and intelligence that only rightly directed education can bring; human history, says Wells, becomes more and more a race between education and catastrophe. If catastrophe overtakes us it will be the engineer who must take the blame, for it is only by the misuse of the powers of nature that catastrophe can come. Little good will it be for him to say "I was employed by ignorant and self-seeking fools: I was so absorbed in the delights of my work that I did not see the road we were taking." Let him realize in time what he is doing, and let him take the share in guiding the actions of men and nations to which his knowledge fits him: not only his own interests demand it; the future of civilization itself demands it.

Never before in all the history of the human race did such a rich vista of ever-expanding knowledge spread out before the amazed eyes of man; rightly applied and directed by the engineer for the good of civilization this knowledge may yet enable us to emerge from the shackles of strife, ignorance, disease and drudgery which have hindered us for so long. Let him realize and prepare himself for his duty.

APPENDIX

Analysis of the Engineering Courses in the English-Speaking Universities and Colleges of Canada

Note:—The tables in the Appendix were compiled from the university calendars available at the time of writing this essay (early in 1931). The calendars for the current year show certain changes, the following being of sufficient importance to be noted:

Alberta: First Year Engineering. Students now take eight hours of graphics, making an average week of 30.5 hours.

Civil Engineering. The last two years of this course have been slightly changed.

Saskatchewan: Chemical Engineering. A complete four-year course is now given, the weekly time allotment being:

Third Year: Chemical subjects, 19.5 hours. Other engineering subjects, 14.5 hours.

Fourth Year: Chemical subjects, 15(?) hours. Other engineering subjects, 5 hours. Business, 1 hour.

Civil Engineering and *Mechanical Engineering:* These courses have been slightly changed.

The author wishes to apologize for any unintentional errors or omissions.

Table No. 1

Degree-Granting Engineering Courses in Canadian Colleges (only those courses which are definitely labelled "Engineering" are included)

Branch of Engineering	Univ. of Alberta	Univ. of British Columbia	Univ. of Manitoba	McGill Univ.	Nova Scotia Tech. Coll. (Last two years only)	Queen's Univ.	Univ. of Saskatchewan	Univ. of Toronto
Agricultural							x	
Ceramic							x	
Chemical	x	x		x		x	Two years	x
Civil	x	x	x	x	x	x	x	x
Electrical	x	x	x	x	x	x	Two years	x
Forestry		x						
Geological		x						
Mechanical		x		x	x	x	x	x
Metallurgical		x		x		x		x
Mining	x	x		x	x	x		x

Notes:—The engineering course in each case takes four years. In the case of Nova Scotia Technical College the first two years' work are taken at one of the affiliated colleges (Dalhousie, Acadia, Kings', Mount Allison, St. Francis Xavier's and St. Mary's).

At Queen's the Mining course is coupled with metallurgical engineering.

At Saskatchewan the first two years only of Chemical and Electrical Engineering are given.

Table No. 2

Pre-Requisite Requirements for Entrance into the Engineering Courses

Alberta .... Matriculation. (One language, not necessarily modern.) Plus pre-engineering year in Arts.

British Columbia ...... Senior Matric. (Not advised).

or

Junior Matric., plus one pre-engineering year in the Faculty of Arts and Science. This includes one language, not necessarily modern.

Manitoba .... Matriculation, plus one pre-engineering year in Arts. This includes one language, not necessarily modern.

McGill .... Senior Matric.

or

First Year Arts; French or German is compulsory.

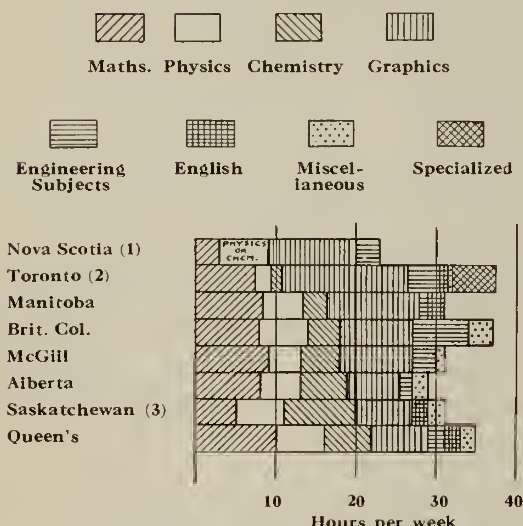
Nova Scotia Tech. College............ First year Arts plus two years (see later) in one of the Affiliated Colleges. The first year in Arts includes one language, not necessarily modern.

Queen's.............. Matriculation, (including Honour Matric. in Algebra, Geometry, Trigonometry, Physics and Chemistry or a language, not necessarily modern).

Saskatchewan........ Senior Matric.
or
Junior Matric. plus pre-engineering year in Arts. French or German is compulsory.

Toronto.............. Honour Matriculation. (This heading differentiates the matriculation from ordinary standards.)
Mathematics, English, Physics, and one language not necessarily modern.
Pass matriculation certificates in the following subjects must also be presented: English, History, Mathematics and any of three of Latin, Greek, French, German, Spanish or Italian and Science.

Table No. 3



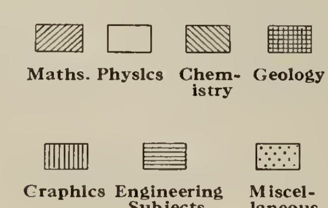
Notes:—The allotment of time in the different branches of study is shown in terms of hours per week, which is considered to be the best indication of the concentration of the courses. The colleges are placed in ascending order of time devoted to the main Science group, including Mathematics, Physics, and Chemistry. The heading Mathematics includes such subjects as Statics and Dynamics.

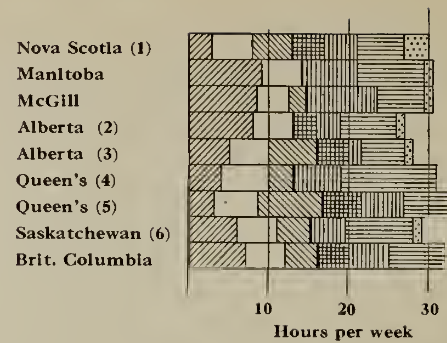
(1) Minimum requirements of Nova Scotia Tech. College in its affiliated colleges.

(2) Toronto differentiates the names of the courses of instruction as follows: Civil, Mechanical, Electrical, Chemical, Metallurgical and Mining engineering. The subjects taken in Mechanical and Electrical are exactly the same, Civil and Metallurgical engineering differing from these by one subject. The course in Mining engineering differs from that in Mechanical engineering by four subjects, and Chemical engineering is so definitely specialized that it is not included in the above analysis.
At Toronto, the 7.5 hours per week shown as mathematics is made up of 3.5 hours mathematics proper and 4 hours per week of mechanics. There is also a certain amount of instruction in mechanics included under the heading of graphics.

(3) Plus 3 hours modern language for Chemical and Ceramic.

Table No. 4





Notes

(1) Minimum requirements of Nova Scotia Tech. College in the affiliated colleges.
(2) Civil and Electrical.
(3) Chemical and Mining (the latter has an additional two hours per week Fire Assaying).
(4) Civil, Electrical, and Mechanical.
(5) Chemical and Mining.
(6) Civil, Electrical, and Mechanical.
Ceramic and Chemical have more chemistry, less mechanical subjects, and take German.

N.B.—Toronto has specialized courses in each branch in the second year, and an analysis is not attempted here.

Table No. 5

Distribution of Time Among Different Subjects in First Two Years of Engineering Courses

A. Mathematics

First Year	per cent of total time	*Second Year*	per cent of total time
Nova Scotia	13.0	Nova Scotia	10.0
Saskatchewan	16.1	Queen's*	12.9
Toronto	20.0	Saskatchewan	20.7
British Columbia	21.6	British Columbia	21.9
Manitoba	27.4	McGill	27.8
Alberta	27.6	Manitoba	29.5
Queen's	28.6	Alberta*	29.6
McGill	29.0		
Average.....21.7 per cent		Average.....21.8 per cent	

B. Physics

First Year	per cent of total time	*Second Year*	per cent of total time
Toronto	5.3	McGill	13.1
McGill	12.9	British Columbia	15.6
Manitoba	16.1	Manitoba	16.4
British Columbia	16.2	Nova Scotia	16.7
Queen's	17.1	Saskatchewan	17.2
Alberta	17.2	Alberta*	18.5
Saskatchewan	19.3	Queen's*	19.3
Nova Scotia (alternative with Chem.)	26.0		
Average....16.25 per cent		Average.....16.7 per cent	

C. Chemistry

First Year	per cent of total time	*Second Year*	per cent of total time
Toronto	4.0	Manitoba	0.0
Manitoba	9.7	Alberta*	0.0
British Columbia	10.8	McGill	6.6
McGill	16.1	Queen's*	9.6
Queen's	17.1	British Columbia	12.5
Alberta	20.7	Saskatchewan	13.8
Nova Scotia (alternative with Physics)	26.0	Nova Scotia	16.7
Saskatchewan	29.0		
Average.....16.7 per cent		Average.....8.46 per cent	

D. Graphics

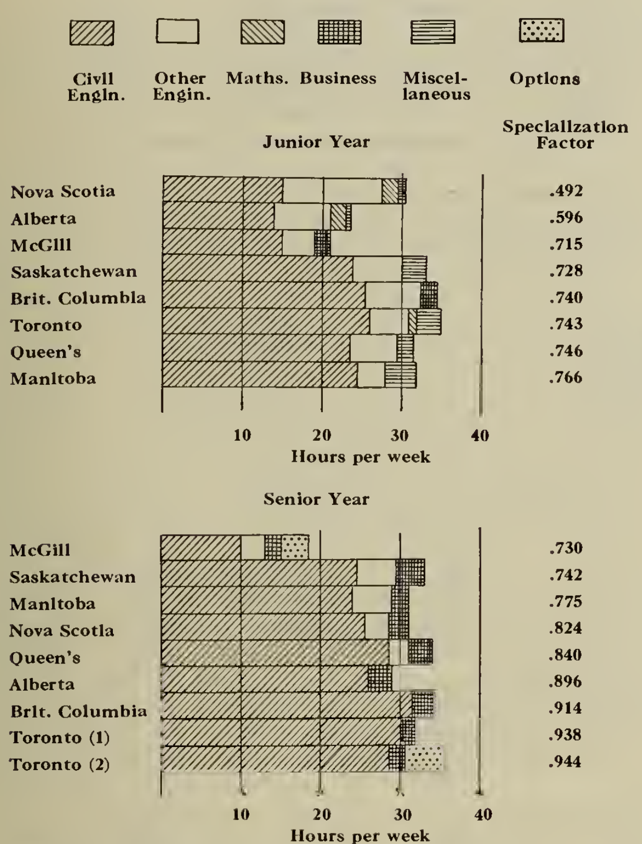
First Year	per cent of total time	*Second Year*	per cent of total time
Queen's	20.0	Alberta*	11.1
Alberta	22.2	Nova Scotia	13.3
Saskatchewan	22.6	Saskatchewan	15.5
British Columbia	24.3	British Columbia	15.6
McGill	29.0	Queen's*	19.3
Manitoba	37.1	Manitoba	23.0
Toronto	41.3	McGill	29.5
Nova Scotia	48.0		
Average.....30.6 per cent		Average.....18.2 per cent	

E. Engineering Subjects

First Year	per cent of total time	*Second Year*	per cent of total time
Saskatchewan	0.0	McGill	19.7
Manitoba	3.2	Nova Scotia	20.0
Alberta	5.2	British Columbia	21.8
Queen's	5.7	Alberta*	25.9
McGill	9.7	Manitoba	27.9
Toronto	10.7	Saskatchewan	29.3
Nova Scotia	13.0	Queen's*	39.8
British Columbia	18.9		
Average......8.3 per cent		Average.....26.3 per cent	

*Second year figures do not apply to Chemical and Mining options of Alberta and Queen's.

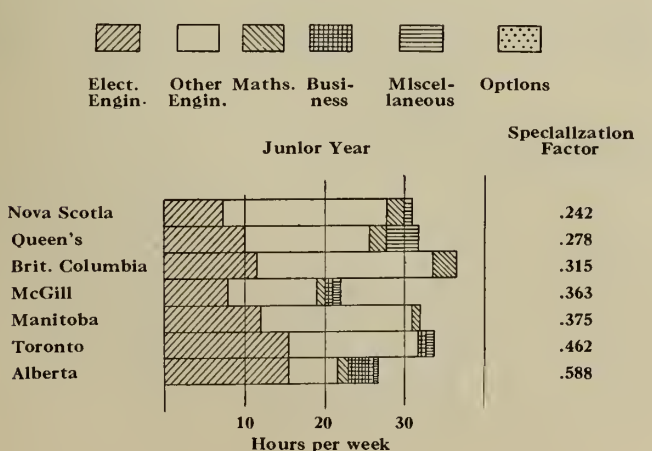
Table No. 6

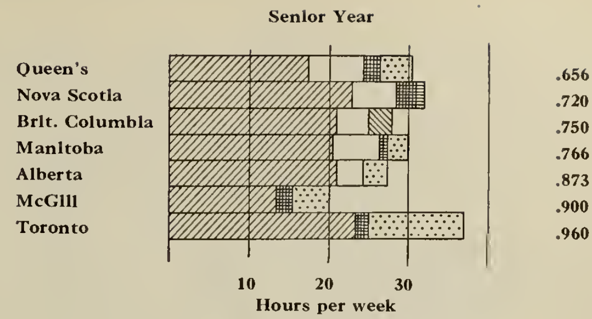


Notes:—(1) Astronomy option. (2) General option.

The "specialization factor" is the ratio of the time spent on Civil Engineering subjects plus the options (which are chiefly Civil Engineering subjects) to the total time per week. "Business" includes Economics, Law, Industrial Administration, etc.

Table No. 7





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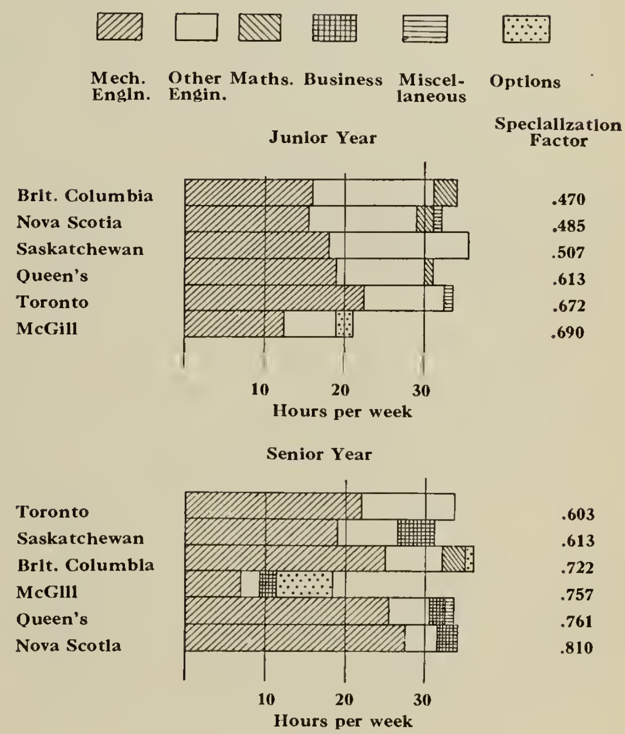

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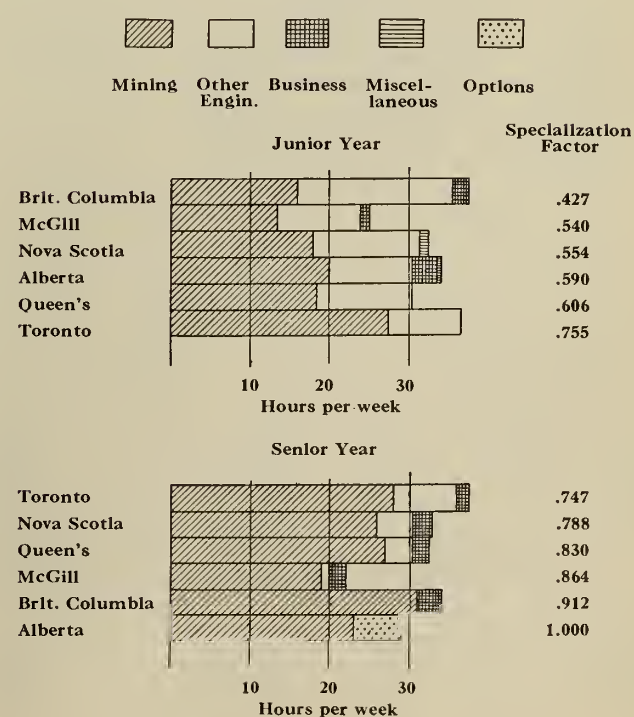
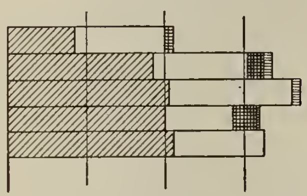


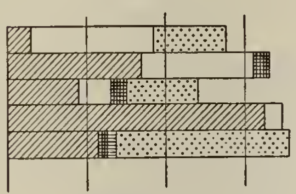
Table No. 10

Junior Year



	Specialization Factor
McGill	.405
Brit. Columbia	.550
Toronto	.554
Alberta	.625
Queen's	.628

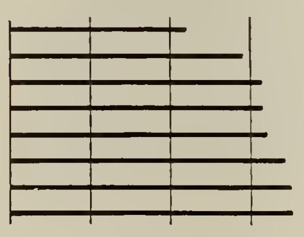
Senior Year



	Specialization Factor
Alberta	.436
Queen's	.515
McGill	.750
Brit. Columbia	.942
Toronto	.945

Table No. 11

Junior Year



McGill	22.0
Alberta	29.0
Queen's	31.4
Nova Scotia	31.5
Manitoba	32.0
Saskatchewan	34.25
Toronto	35.1
Brit. Columbia	35.2

Senior Year

McGill	19.4
Alberta	28.25
Manitoba	30.5
Saskatchewan	32.0
Nova Scotia	32.5
Queen's	32.7
Brit. Columbia	33.4
Toronto	35.5

Table No. 12

Mean Specialization Factors

A. Average specialization factors of the five main courses for each college.

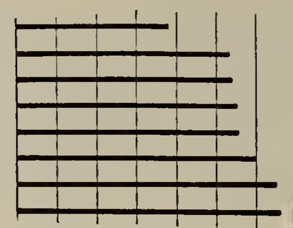
Junior Year		*Senior Year*	
Nova Scotia	.443	Queen's	.721
British Columbia	.500	Nova Scotia	.785
McGill	.542	McGill	.800
Queen's	.574	Alberta	.801
Alberta	.600	British Columbia	.848
Toronto	.637	Toronto	.856

B. Average specialization factors for each of the five main courses.

Junior Year		*Senior Year*	
Electrical	.375	Mechanical	.711
Chemical	.553	Chemical	.717
Mechanical	.573	Electrical	.805
Mining	.578	Civil	.845
Civil	.691	Mining	.857

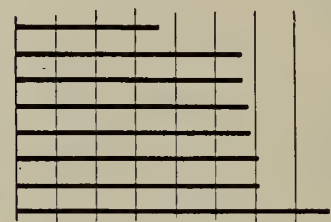
Table No. 13

Junior Year



	Per cent of time on practical work. (Lab. Draughting, etc.)
McGill	38.0 per cent
Brit. Columbia	53.3 "
Saskatchewan	54.1 "
Alberta	55.3 "
Queen's	55.7 "
Nova Scotia	59.8 "
Manitoba	65.0 "
Toronto	66.2 "

Senior Year



McGill	36.0 "
Saskatchewan	56.5 "
Alberta	56.8 "
Nova Scotia	58.2 "
Brit. Columbia	58.5 "
Manitoba	60.5 "
Queen's	60.6 "
Toronto	78.7 "

Table No. 14

Average Percentage of Time Spent on Practical Work. Average of All Colleges for Each Specialized Branch

Junior Year	per cent	*Senior Year*	per cent
Mechanical	51.0	Electrical	51.4
Mining	51.2	Mining	54.0
Civil	53.2	Mechanical	58.8
Electrical	59.6	Civil	61.0
Chemical	61.6	Chemical	68.7

Table No. 15

Requirements for Practical Experience During Summer Vacations

	Practical Experience	*Surveying*
Alberta	Students in Civil Eng. "strongly advised" to work in a draughting office during one summer.	Four Weeks Surveying Camp at end of first year, all students. Four weeks Surveying Camp at end of second year, Civil and Mining.
Brit. Columbia	At least four months' practical work related to his chosen profession: compulsory. Summer Essays.	Three weeks Surveying at end of first and second (engin.) years, all students. Three weeks at end of third, Civils only.
Manitoba		Three and a half weeks in September after first year, all students.
McGill	Six to eight months in practical engineering work, compulsory. Summer Essays, or general reading.	Four weeks at end of first year, all students.
Nova Scotia		Three weeks before third and fourth years for Civils, fourth year only for Mining.
Queen's	At least six months' employment of suitable experience, compulsory. Summer Essays.	Field work done during the session.
Saskatchewan		Four weeks, end of second year, all students. Two weeks, end of third year, Civils only.
Toronto	*Mining:* At least six months experience in mining, metallurgy, or geology; compulsory. *Mech. and Elect.:* At least 1,600 hours of mechanical experience in production, under commercial conditions; compulsory.	August and September after second year for Civil and Mining. Two weeks after third year for Astronomy option of Civil Engin.

Hot Mix Asphalt Pavements

Harvey W. L. Doane, M.E.I.C.,
Maritime Superintendent, Standard Paving Limited, Halifax, N.S.

Paper presented before the Halifax Branch of The Engineering Institute of Canada and the students of the Nova Scotia Technical College in October, 1931.

SUMMARY.—The paper gives an outline of the methods and procedure desirable in constructing modern asphalt pavements, the author pointing out the importance of responsible contractors, good inspection and experienced workmen, the work being such that success depends largely upon proper technique.

Dealing successively with the sub-grade, grading and the road surface, the paper explains the requirements for satisfactory construction, and discusses in some detail the materials used such as asphalt, cement, sand, aggregate and filler. The necessity of handling the various materials properly is stressed and the precautions described which are necessary when placing the pavement on the street. The paper concludes with a brief reference to the formation of waves in asphalt pavements and the improved methods of construction which are now coming into use.

Introduction

In the case of asphalt pavements, as in any other high class construction work, the best results can only be expected when modern equipment, experienced staff, intelligent inspection and suitable materials are employed by responsible contractors who value their reputation.

The necessity for experienced men cannot be too strongly emphasized as probably more pavements are ruined by inexperienced operators than by poor materials. One who knows the game can tell at once, by observation, when there is anything wrong with the mixture, the temperatures, the raking or rolling, without the use of instruments.

Intelligent inspection is a very important consideration, as sometimes an inspector who does not know a fraction of what the contractor does, may insist on unreasonable requirements and miss altogether the really important parts of the specifications. A good inspector will realize that he can learn something from every man, and if he supervises the work intelligently will not only help to produce better work, but may be of real assistance to the contractor as well.

Suitable materials are, as in any job, an absolute necessity. Just what are suitable materials can only be learned by experience, and a great deal of work has been done, and is being done, to devise ways and means of using local materials in such ways and by such combinations, that a satisfactory pavement can be produced at a moderate cost. However, there are certain standard materials which have been tried and tested for many years, and it is these which will be dealt with here.

Perhaps the most important consideration of all is to entrust the work to a responsible contractor who values his reputation, and who will go out of his way to give a good job. A dishonest contractor can slight the work in many ways which no amount of inspection can overcome. There are paving contractors whose work laid without inspection, thirty years old, is good today.

There are many types of treatments for roads on the market today, and the engineer should be in a position to decide which is the most suitable for the particular requirements, considering not only the traffic to be handled and the subgrade conditions prevailing, but also the amount of money available.

The simplest form of construction is of course the earth roadway with which all have been familiar in the past, but with the advent of the motor car this soon proved unsuitable, and then the grade and line were improved, and the surface treated with gravel or broken stone.

As fast moving traffic raises so much dust it was found necessary to use a dust layer, such as calcium chloride or oil. While this helps to lay the dust, it does not do away with the necessary floating surface of small stones and with expensive maintenance. These maintenance charges have increased to such an extent that in some cases the annual maintenance bill for a gravel road is equivalent to the interest and other charges on a permanent pavement.

Then the next step forward is something like a penetration or mixed-in-place pavement. These are cheap and are very satisfactory under some conditions, but are not good enough for modern, heavy, high speed traffic.

Finally, the best treatment developed so far is the hard surface heavy duty pavement, either sheet asphalt, black base or concrete, as conditions warrant.

A road may pass through any or all of these successive stages and if properly planned in advance it may be possible to save much of the expenditure in each process, as the new road can often be built up on the old, as a foundation.

It should be kept in mind that in this age new developments occur very frequently. A few years ago the four-lane traffic super-highways would have been laughed at, and now even they are none too large on busy days. Roads should be designed with the thought in mind that they may have to be enlarged sooner than is at present realized or that some better type than that now known may be developed, so that our efforts will not be wasted but may be used as a foundation for what is to come.

Subgrade

One of the most, if not the most important features of a pavement is the foundation or subgrade. It is the subgrade which ultimately carries the load and it should be carefully studied with this in mind.

The first consideration with any subgrade is adequate drainage. Unless this is properly taken care of trouble is sure to develop sooner or later.

More otherwise excellently designed and carefully built pavements have been ruined by lack of subsoil drainage and the proper elimination of water from the subgrade than from any other single cause.

The idea is to prevent water from getting into the subgrade rather than to remove it after it gets there. Each street or highway is a separate problem throughout its entire length.

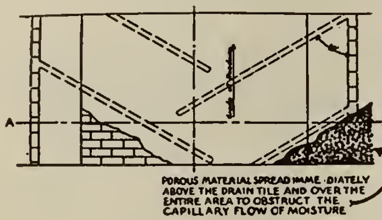
The engineer, therefore, should carefully examine the proposed location of the roadway, noting all evidence of underground flow, or seepage, study the topography of the surrounding country for the action of rainfall on the right of way in different seasons of the year, and if the effects therefrom will render the subgrade in its present condition an uncertain support at any time, he should prepare special plans to prevent, if possible, this water entering the subgrade.

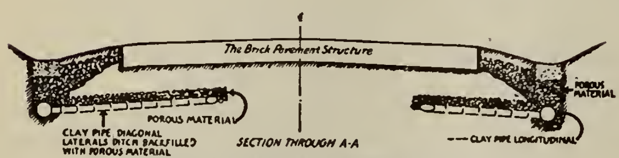
If this is impossible, his efforts should be devoted to planning a rapid removal of the water, even to underlaying the entire pavement structure with broken stone if necessary, where capillary attraction is pronounced. In some cases it is even necessary to place lateral drains at each side of the pavement with connecting drains running across, herringbone fashion, at intervals.

Good ditches on both sides of the road should always be provided so as not only to carry off surface water, but keep down the ground water level as well.

The gravel and sands have natural drainage in themselves due to their porous nature, and as long as the roadway is not on a swamp or in a cut where water will lie, it is a comparatively simple matter to carry it off.

Where clay soils are encountered, special care must be taken to keep the water out of the road bed or frost troubles are sure to occur. The moisture remains in clay for a long time and when the frost comes, heaving is certain to result.

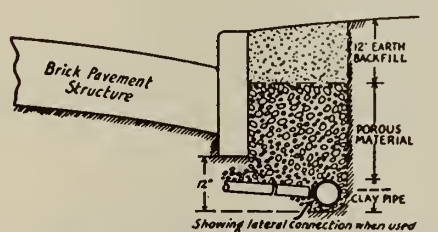




DRAINAGE IS FIRST CONSIDERATION

A suggested treatment for the most aggravated cases of saturated sub-grade. Such a system takes care of all requirements ranging between what water could be disposed of through a line of longitudinal pipe on one side of the roadway to the double herring-bone system sketched above.

Disposal of water away from the roadway should be made as frequently as possible. According to grades, inlets may be placed at intervals through which surface water may enter the underground disposal pipe. Thus the need for deep side ditches is removed and the danger of sub-soil softening by rainfall is greatly reduced.



FOR CITY STREETS

The method shown above for under-draining a city street may be amplified according to the methods and under the conditions described in the first sketch.

Fig. 1

Old gravel roads sometimes make excellent foundations, but they should not have too much clay as this becomes very mushy in wet weather.

Where a road bed is being prepared for paving the gravel should be about eight inches thick and traffic allowed on it long enough so it will be well compacted, or else this should be done with a road roller.

Broken stone is in the same category and should be well bonded and shaped just as in making a macadam pavement.

From an article in the Public Roads Magazine the writer has taken the following:—

"The soil which carries the load has certain properties which may be defined as follows:

1. *Stability*, the property of resisting lateral flow when loaded.

2. *Compressibility*, the property of compressing vertically under load without lateral movement and with a proportional decrease in air or moisture content.

3. *Elasticity*, the property of deforming under load and rebounding upon the removal of load without changing moisture content.

Loss of stability may cause fills to slide, clay to work up into the interstices of base courses, and rutting to occur in flexible road surfaces. Stability depends on the combined effect of internal friction and cohesion of soil particles.

Consolidating the subgrade serves to increase its density and decrease its permeability, and consequently is likely to prove highly beneficial."

But while some soils are compressible, others are highly elastic. As a comparison a piece of wet cotton when compressed stays flat, but a wet sponge when compressed, will expand again after the pressure is released.

Suitably compressible soils are those with material well graded from fine to coarse, and these are highly satisfactory as subgrades even when moisture is present.

Some silt soils without coarse material and with no appreciable amount of sticky colloidal clay, absorb water rapidly and have an appreciable rebound upon the removal of load.

Clay soils without coarse material may behave in exactly the same way.

By capillary action some soils will absorb moisture from the underlying ground water level, causing expansion and consequent heaving and frost action.

Soils without cohesion such as sand and some gravels, do not heave this way because they have little capillarity, and practically all the water freezes at normal freezing temperatures without appreciable increase in volume.

Grading

In grading, all vegetable matter, soft or spongy earth, muck or quicksand, which will not compact under the roller, should be removed and replaced with material which can be suitably compacted.

Where filling is necessary the earth should be applied in layers not exceeding twelve inches in depth, and each layer should be repeatedly rolled and thoroughly compacted before successive layers are applied.

On fills of unusual depth it is often advisable to allow it to settle, perhaps through a winter or rainy season, before completing the pavement.

Depressions created by rolling should be brought up to grade with additional material, the rolling repeated and this performance continued until the subgrade is of uniform density, smooth, even of surface, and true to grade.

It will be found that truly and carefully graded subgrades give much better pavement surfaces than uneven ones. The small humps and hollows in the subgrade will almost always show on the finished surface.

Trenches which have been opened for water or sewer cuts ahead of paving operations should be very carefully back-filled, preferably with water, or else future settlement will form a hollow in the pavement.

Sometimes a subgrade can be greatly improved by the addition of other materials, for instance with clay add sand and stone, with sand add clay and stone, or with stone add sand and clay.

A properly prepared subgrade is undoubtedly one of the most important parts of any roadway.

With asphalt pavements in cities and towns a concrete or stone gutter is usually employed as it gives much the best results. Because water is the worst enemy of pavements, and since they cannot be properly compressed next a curb, disintegration is liable to occur when the asphalt is used right up against the curb.

Base Course or Foundation

On most subgrades some sort of foundation or base course is required for the pavement. The two most used are Portland cement concrete, and asphalt concrete or "black base."

With concrete, the subgrade should be very carefully prepared as previously described, proper drainage should be arranged and the mixture should be in the proportions of about 1: 3: 5. A thickness of six inches or over is usually employed, but under very good subgrade conditions this has sometimes been reduced to four inches under light traffic. For heavy traffic the tendency is towards a much thicker base, in some cases as much as nine inches or ten inches being specified. The surface should be true to grade, but not too smooth or the asphalt will creep under traffic. The concrete should be suitably cured and protected from traffic during hardening and under no circumstances should the asphalt surface be placed on it before it is at least seven days old.

The so-called black base is similar to concrete except that asphalt is used to bind the aggregate instead of Portland cement. Either broken stone or gravel may be used with sand or screenings provided they are satisfactory. In some cases crusher run has been used with excellent results.

Depending on the thickness of base used and the particular conditions, the maximum size of stone permitted varies from 1½ inches to 2½ inches. The aggregate is then uniformly graded down to the smallest particles. The amount of asphalt cement varies from four to seven per cent. The mixture should have all the asphalt cement it will carry without showing fat spots on the surface.

Black base is becoming increasingly popular. On account of the elasticity of the cementing material it forms a partly flexible foundation which is in constant contact

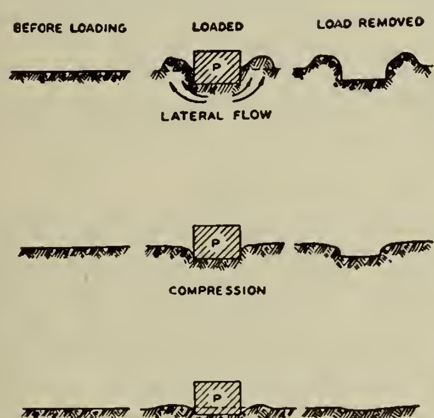


Figure 5.—Diagram Illustrating Properties on Which Reaction Between Soil and Load Depend

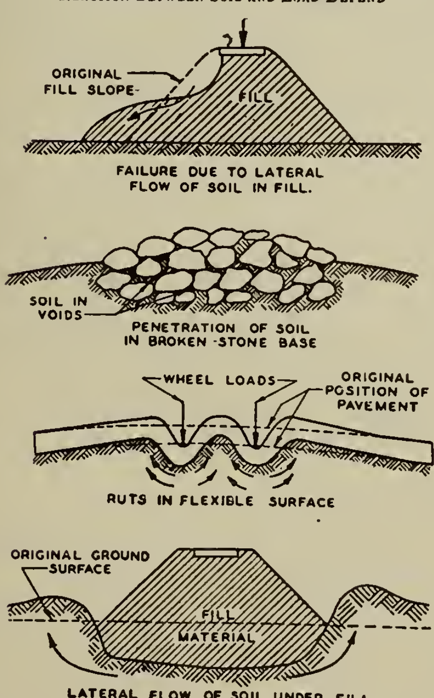


Fig. 2—Types of Road Failure Caused by Lateral Flow of the Subgrade Soil.

with the subgrade, thus using its supporting value to the maximum extent. Under many conditions which would produce cracking in a rigid foundation, the slight yield of an asphalt foundation will maintain the pavement intact.

It also acts as a sort of shock absorber for the impact of heavy vehicles. On account of its flexibility and shock absorbing properties it can be laid in a thinner layer than with concrete to give the same effect. Six inches of black base is usually considered as equal to a concrete pavement, seven inches thick in the centre and ten inches at the edges.

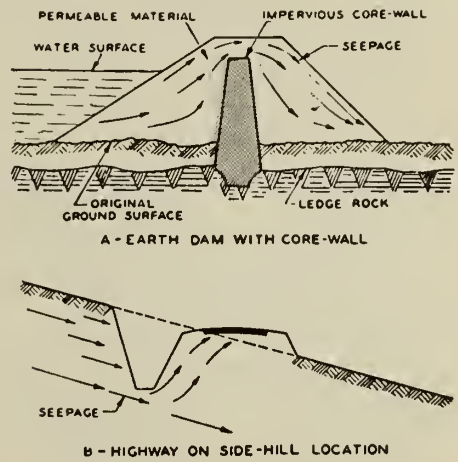


Fig. 3—Capillary Action in Soils.

One particular advantage is that the black base does not have to be cured after it is laid and traffic can use it immediately it has cooled. This means a saving of real hard dollars and cents, particularly to merchants in cities and towns, and the elimination of many costly and annoying detours.

Another great advantage when an asphalt wearing surface is to be laid, is that the surface of the base being coarse grained and open, the sand of the surface ties right into it and forms an almost perfect bond with the base. In cutting out samples the author has had difficulty in separating the base from the top.

Then too, if the base is laid carefully it is waterproof and will prevent moisture from coming up through to the underside of the pavement. This, concrete will not do.

In making repairs over water or sewer cuts, asphalt may be used, and as soon as the patch is completed it is ready for traffic. This is a real advantage in a busy city.

Hugh W. Skidmore of the Chicago Paving Laboratory says:

> "Black base cannot be properly called a recent development; it is actually one of the oldest types of base in the country. However, in its present advanced state, it can be called one of the most important developments in recent paving practice. Having been a close student of this type of construction for many years, I do not know of a single instance where it has failed of performance and that is something that cannot be said of any other type of base. True, it should not be employed in utter disregard of exact type (premixed, hot or cold, penetration, mixed-in-place, etc.) thickness, character of subgrade and drainage, but, taken 'catch-as-catch-can,' it has a remarkable record of performance.
>
> Sometimes no base is required. Now and then cities find themselves the fortunate possessors of natural bases in subgrades of high supporting capacity such as gravel or sand. Where such conditions exist, advantage should be taken of these assets in designing pavement. There are numerous examples of asphalt wearing surfaces laid directly upon native subgrades of this class, which have given complete satisfaction for many years. I have in mind a certain section within the city of Joliet, Ill. where the asphalt surfacing is laid directly upon native gravel subgrade. These pavements have given excellent service for about twenty years."

Old brick, block or concrete pavements are also used as a base for new asphalt pavements. In this case the holes and hollows in the old pavements are usually filled up with a black base called a binder course, having the maximum size of aggregate about ¾-inch, so as to give a uniform contour to the surface.

Asphalt Pavements

On account of its advantages as a paving material, many millions of yards of asphalt pavements have been laid during the last ten years and many of the enormous peak

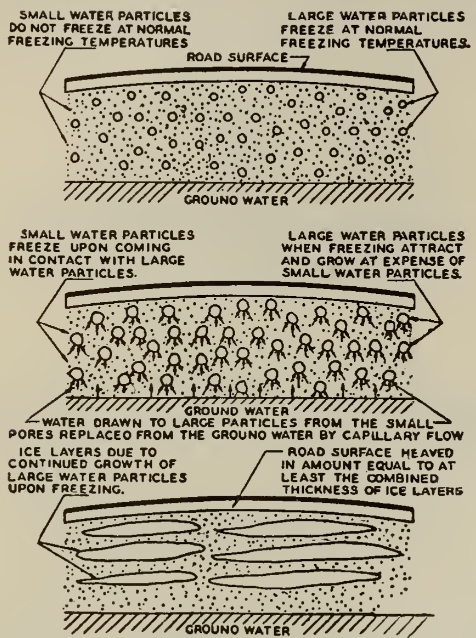


Fig. 4—Diagram Illustrating the Physics of Frost Heave.

loads of modern traffic in our larger cities, and on our highways, are being carried on asphalt.

One great advantage of asphalt pavements in our climate is that they can be laid under colder weather conditions than any other type of pavement, which greatly lengthens the construction season without unduly increasing the cost.

There are several types of surface in use today, the principal one being standard sheet asphalt which is a layer, usually one and one half to two inches thick, of uniformly graded sand and asphalt. Sometimes a binder course is used under this with the idea of filling up irregularities in the base, and giving stability to the surface.

There are also several patented types of surface such as "Warrenite" having small stone right through the mixture, and "Standardite" having stone on the bottom for stability, and sand on top to take the wear. Both these pavements have given excellent service, the latter is intended to combine the advantage of the binder course and sheet asphalt, and apparently it does this excellently.

On highway work the wearing surface is often made by merely closing the surface voids of the black base either with a seal coat of asphalt cement and stone chips, or by filling them with a very thin layer of sheet asphalt. This makes a low first cost pavement, but requires surface treating occasionally to keep it sealed up tight.

Materials

The unrefined asphalt is too hard and brittle for pavement purposes, so it is softened or fluxed to any degree of softness required by the addition of a lighter oil.

The degree of hardness or softness of this mixture which is called asphalt cement is measured by the number of millimeters of penetration in five seconds of a No. 2 cambric needle, carrying a weight of 100 grams at a temperature of 770 degrees F. For cold climates a high penetration or a softer asphalt cement is used than for hot climates. The fluxing is done now at the refineries and the asphalt cement comes all ready for use at the desired consistency. The usual penetration in Nova Scotia is 51/60.

Since asphalt cement is pliable, it should not be counted on to fill voids, but merely as a surface coating for each particle.

It is received on the job either in barrels or more commonly in tank cars. These are often insulated so that there is a certain amount of heat remaining from the refining processes when received at the work.

Tank cars are provided with steam coils by means of which the asphalt cement may be heated when received. It should not be raised over 350 degrees F. The cars should be watched carefully during this heating, as should there be a leaky coil, the asphalt may foam and boil up if heated too fast.

This is then pumped to the paving plant, or else transferred by means of tank waggons.

Broken stone is a very important part of a pavement and if taking the wear of traffic as in black base or "Warrenite" types, should be hard and tough. Where not directly taking the wear it need not be so hard, as long as it will not break under the wheels of the roller.

But all stone should break into approximately cubical angular particles and not spall off like slate does.

The surface should not be smooth and glossy like quartz, because the asphalt cement will not adhere to it satisfactorily.

Sand

The character and size of the sand grains is one of the most important considerations in a sheet asphalt surface. As for the stone, the particles should be hard and angular so as to withstand the abrading action of traffic and keep together so as to make a stable mixture, and they should also be not too smooth or glossy or else the asphalt cement will not take hold properly.

It is seldom that the proper mineral aggregate can be obtained with one sand, and it is often necessary to combine two sands in certain definite proportions to get the desired results. Suitable asphalt sands would in many cases be absolutely unsuited for concrete work, because they are too fine, and often a small amount of dust is an advantage if it can be counted on as filler.

Clay is sometimes objectionable as it may ball up in the mixture, and not act as a filler or take up its portion of asphalt cement. It may go right through into the completed pavement as a ball of clay, having no strength, and actually forming a weak spot. Then, too, it is so light that most of it is lost on heating. A small amount, on the other hand, if not in chunks or balls, may not be at all objectionable.

A sand for asphalt may also contain some vegetable matter. This is burned out on heating and so does not render the sand unfit for use as with concrete.

The character of sands is determined by means of laboratory sieves, and Hubbard gives the following as ideal sand gradings:

Size	Heavy Traffic	Light Traffic	Typical Specifications
	Per cent	Per cent	Per cent
200 mesh	0.0	0.0	0-5 0-5
100 "	17.0 } 34.0	10.0 } 20.0	10-25 } 20-40
80 "	17.0	10.0	6-20
50 "	30.0 } 43.0	30.0 } 45.0	5-40 } 20-45
40 "	13.0	15.0	5-30
30 "	10.0 } 23.0	15.0 } 35.0	5-25 } 12-45
20 "	8.0	10.0	5-15
10 "	5.0	10.0	2-10
Total	100 per cent	100 per cent	

The following table shows the satisfactory results obtained by combining a fine and coarse sand, neither one of which is suitable alone.

Size	1 Part No. 1	1 Part No. 2	Total	Result		Ideal	
	Per cent	Per cent		Per cent		Per cent	
10	0.8	11.2	12.0	6.0		5	
20	0.6	13.4	14.0	7.0	23.0	8	23.0
30	2.0	18.0	20.0	10.0		10	
40	5.2	16.8	22.0	11.0	45.0	13	43.0
50	39.0	29.0	68.0	34.0		30	
80	24.8	5.2	30.0	15.0	31.0	17	34.0
100	25.6	6.4	32.0	16.0		17	
200	2.0	0.0	2.0	1.0	1.0		
Total	100.0	100.0	200.0	100.0	100.0	100.0	100.0

It has been found that particles of sand of size 80 and 100 mesh are absolutely necessary, but that 200 mesh sand is not desirable as an excess will increase the voids in the mixture and cause it to be unstable.

The necessary fines in the mixture are best supplied by using Portland cement or limestone dust ground so small that the greater part of it will pass a 200-mesh sieve. Some authorities consider that limestone dust is preferable as it is an inert substance, whereas cement being active may tend to harden the surface.

This fine material completely fills the voids between the smallest particles of sand and gives a very dense mixture. Dust, or filler as it is called, not only helps to give a solid surface, which will not shove in hot weather, but also helps to prevent cracking in cold weather, and in addition its use means that more asphalt cement can be carried by any given mixture where it is present. It is an advantage to use all the asphalt cement a mixture will carry without being fat because then all particles are thoroughly coated and absolutely bonded to each other, and the surface will be well sealed against moisture.

There is a certain amount of filler which should be used with any sand. Too little does not fill the voids or carry enough asphalt cement and with too much the excess sticks to the large sand grains and balls up, as well as making such a stiff mixture that it cannot be properly raked out on the street.

Trinidad asphalt contains some very finely graded impurities and so does not require as much filler as do the oil asphalts.

With good asphalt sands the amount of filler required usually runs from 10 to 15 per cent, but it must be remembered that a very poorly graded sand cannot be made first class by the addition of large amounts of filler.

Fillers are not necessary in such pavement layers as the body coat of "Standardite" or in binders which do not take the wear of traffic directly, but they are necessary with all surface mixtures, including asphalt concrete.

Asphalt Surface Mixture

A great deal of research work has been done on asphalt surface mixtures and it has been found that the heavier the traffic the finer should be the aggregate. It used to be thought that asphalt concrete was the proper mixture. Then mixtures of smaller stone and sand were tried, and now finally modern practice tends towards sands having all the particles passing a screen with ten meshes to the inch, and being uniformly graded down to the finest dust.

In proportioning a surface mixture the same idea as in concrete is used. The aggregates are graded from coarse to fine so as to give a mixture having the maximum density, and smallest possible percentage of voids, it will be practically impervious to moisture and will also have maximum strength and stability against displacement under traffic.

As with concrete, moisture is the worst enemy of asphalt pavements and so a very close surface is desirable in order to keep it out.

Mineral aggregate of 100 mesh and smaller, right down to impalpable dust, is supplied by the filler, and the cementing material by asphalt cement which together with the sand should give the following as an ideal mixture, according to Richardson.

Bitumen	10.5 per cent	10.5 per cent	Typical Specifications 9–12 per cent	
200 mesh	13.0	13.0	not less than 10 per cent	
100 "	13.0	26.0	10 to 35 per cent	not less than 25 per cent
80 "	13.0			
50 "	23.5	34.5	4 to 35	15-50
40 "	11.0		4 to 25	
30 "	8.0	16.0	4 to 20	10 to 35
20 "	5.0		4 to 12	
10 "	3.0		2 to 8	
Total...	100.0 per cent	100.0		

Of course these are ideal and can only be approached in practice, so specifications state certain limits to allow for some variations.

The Plant

The materials are usually stored in stock piles close to the plant so as to provide a supply close at hand in case of delays in obtaining stone or sand.

The filler should preferably be stored in a waterproof shed, just like cement is handled, because it is so very fine that dampness may cause it to ball up.

Sand and stone from the stock piles are usually handled by means of a clam shell and are placed in approximately the proportions required, at the end of a bucket elevator which takes them up and drops them into the end of a long horizontal drum. This drum is revolving continuously and by means of fins on the inside, tosses the materials about. Heat is furnished by means of coal fires or better still by oil burners. The best practice favours burners both inside and outside of the drum.

As they pass through the drum these aggregates are dried and heated to such a temperature that when they are mixed with the filler and asphalt cement they will not be over 350 degrees F. From the drum the aggregates drop into another bucket elevator which carries them up to screens, where they are separated into the required sizes and dropped into storage bins.

Below the bins is a weighing hopper in which the various aggregates are proportioned, and where the filler is added.

The asphalt cement is heated in suitable kettles to a temperature between 250 degrees F. and 350 degrees F. and pumped over to the mixing platform where it is weighed in a bucket, which should have a visible scale with which the tare may be allowed for each time, as it varies during the day.

The dry aggregates are dropped into a mixing drum where two interlocking sets of revolving paddles toss it around and thoroughly mix it. For best results this dry mixing should be carried on for fifteen seconds. The asphalt cement is then added and the whole thoroughly mixed. This takes about forty-five seconds.

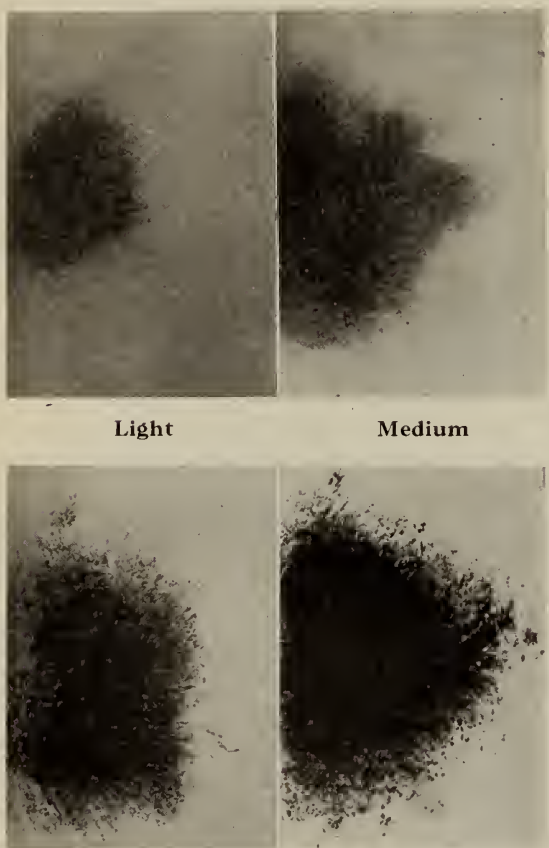
From the mixer the finished mixture is dropped into trucks or carts and transported to the street. Careful temperature control should be kept of all materials at the plant, and analysis of the sand made as often as required. Analysis of the final mixture should also be made, after the asphalt cement has been added.

Very careful plant management is of course a necessity in order to obtain first class results.

Placing on the Street

Black base. When the materials reach the street they are dumped on the subgrade and spread where required to the proper thickness. Care must be taken to spread this mixture uniformly and rake it out thoroughly so the materials will not become segregated. The mixtures should arrive on the street at a temperature between 225 degrees F. and 325 degrees F.

The base is then rolled with a roller weighing at least ten tons until it is finally compacted. The surface should conform to the contour desired for the finished pavement as humps and hollows in the base are apt to reappear on the top.



Light Medium

Strong Heavy

Fig. 5—Pat Paper Stains.

The mixture should contain as much asphalt cement as it will carry, up to the point where it becomes fat and shows patches of asphalt on the surface as it is rolled. The pieces of stone or gravel should glisten with asphalt cement and should not appear dull and lifeless. Asphalt cement usually varies between the limit of 5 and 7 per cent.

When final rolling is completed, traffic may be allowed on the base temporarily.

If a binder is being used it is spread similarly to the black base, the usual practice being to lay just enough binder in the morning so that it can be covered with surface in the afternoon.

Temperature ranges for a binder are between 250 degrees F. and 325 degrees F. With this layer even more care should be taken to ensure a smooth surface when rolled. Usually a 10-ton roller is employed and traffic is not allowed over this course until covered with surface.

The amount of asphalt cement which the mixture will carry is determined as for black base or in some cases by the "Pat Paper Stain" to be described later.

The final surface mixture is of course the most important layer of pavement and must be laid with the greatest care, although of course this does not mean that all the other operations should not be done with equal care, as a fine surface is of no avail if the underlying courses are defective.

The amount of asphalt cement which a surface mixture will carry is determined in several ways but principally by means of a pat paper stain. A small amount of the mixture is taken from the truck as it falls from the mixer and placed on a piece of manilla paper. The paper is then folded over and pressed down with a small wooden paddle. It is struck several sharp blows and the stain on the paper examined. From this, experienced operators can tell whether the sand is fine or coarse by the stain of the grains.

If the stain is light there is not enough asphalt cement but if sloppy and spread all over the sheet there is too much. The happy medium is a strong stain showing every particle covered, but showing no excess of asphalt cement. The temperature at which the test is made is important. It should be from 325 degrees F. to 350 degrees F.

If there is a deficiency of filler the spaces on the paper between the sand grains will not be completely filled in.

If there is too much filler the mixture will appear stiff in the truck and will sometimes ball up. The mixtures should reach the street at a temperature of about 325 degrees F. to 350 degrees F. and should be spread immediately.

It should be dumped from the truck a sufficient distance back from the face so that it will all have to be turned over in shovelling into position.

Before placing the top the edges of all manholes, gutters, stand pipes, etc. are painted with hot asphalt cement and the binder carefully cleaned off. As the mixture falls from the trucks it should break off in sections showing a series of sort of cleavage planes and the asphalt cement should glisten on each sand particle, otherwise there is not enough filler or a deficiency of asphalt cement.

The mixture is handled with hot shovels and placed in position for the rakers, who thoroughly fluff up the material with the prongs of their rakes so that it will have a uniform consistency throughout. This is extremely important so as to provide a uniform density in the finished work and prevent the formation of waves. If the mixture is properly graded it will flow evenly under the rakes and

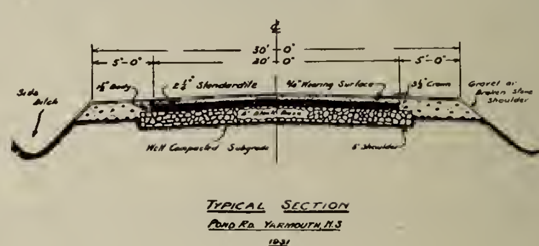


Fig. 6

will not drag behind in small ripples; it will feel as if it had plenty of body provided there is the correct amount of filler and fine sand present.

When the mixture has been evenly spread and raked off smooth, the edges around manholes, gutters, and joints where the roller cannot easily reach, are tamped with hot tampers so as to get maximum compression. The surface is usually left a little high at gutters, etc.

Just as soon as the roller can get on the mixture without picking it up, it should be rolled in such a manner as not to form waves. The rolling is one of the most important parts of the work and none but experienced operators and the smoothest running rollers should be employed.

Rollers should be operated very smoothly and very slowly and a rapid rate should not be used as it does not provide good compression and may form waves.

The roller should overlap the preceding track on each successive trip, starting from the sides and working towards the centre, and after the longitudinal rolling is completed, the surface should be cross rolled and circular rolled as well.

By watching the way the surface behaves under the roller the experienced operator can tell a great deal about the consistency of his mixture, temperature, etc.

The surface should then be checked with a straight edge for inequalities which can often be rolled out.

Fig. 7—Small Asphalt Plant, Yarmouth, N.S.

After final rolling is completed limestone dust or Portland cement is usually brushed over the surface while it is still warm, so as to completely fill the surface pores and impart a pleasing colour to the pavement.

When cool enough, traffic is allowed on, and, with its kneading action, it soon closes up the surface completely so that it fairly shines.

When rolling has been completed the finished surface should be of uniform texture and free from open or porous looking places. Sometimes, however, these may be unavoidable and hot smoothing irons are used to iron these out. Great care must be taken that these irons are not too hot as they may injure the surface.

Slightly different methods are employed in laying "Standardite." This pavement consists of two layers, the lower one being called a body coat, and the upper the wearing surface or top, the total thickness being from 2¼ inches to three inches as required.

For a 2¼-inch pavement, the body coat would be 1¼ inches thick and the top ¾ inch thick, and a three-inch pavement would have a two-inch body with one-inch top.

It is entirely different in construction from any other type of asphalt pavement although the mineral aggregates are standard.

It will be noticed from Fig. 6 that while the stone is well distributed throughout the body of the pavement, at the same time it is so protected by the wearing course that none of this stone comes in contact with the traffic.

This stone varies uniformly from ¼ inch to 1¼ inches. The sand in the body coat is exactly the same as for the top, and is given all the asphalt cement it will carry.

The wearing surface is a standard sheet asphalt containing filler.

With "Standardite" the so-called body coat is carefully spread and raked to a uniform consistency and to the required grade, and is then rolled with a light hand roller which merely pushes down the projecting points of the larger stone.

While this is still hot, the wearing or surface course is laid in the regular way. Since both courses are hot they weld together so that it is impossible to see where the joint was, and the result is a solid rigid pavement, just as if laid in one course.

Waves in Asphalt Pavements

Waves in asphalt pavements have always been a nightmare to engineers, but the causes are now fairly well understood, so that provided proper precautions are taken, it is possible to prevent their formation.

Prevost Hubbard in his report to the International Road Congress at Seville in Spain says:

"The formation of waves, particularly in pavements of the fine aggregate type, occurs to a sufficient extent to warrant a thorough investigation of the subject with the idea of securing data which will enable highway engineers to prevent such defects in future construction. Such an investigation has recently been undertaken by the U.S. Bureau of Public Roads in co-operation with the Asphalt Association and the cities of New York, Philadelphia, Baltimore, Washington and Detroit.

Traffic is, of course, the most direct cause of wave-formation, the thrust of vehicle wheels tending to rearrange the mineral particles of the paving mixture from the surface down. Under certain conditions the mixture is therefore shoved into humps or waves, usually at a right-angle to the direction of traffic, although at curves and intersections, waves due to the side-thrust of vehicles are sometimes noted. When the pavement is sufficiently wide to allow two well-defined lines of traffic, transverse waves are most prevalent near the gutter, where most of the horse-drawn and other slow-moving vehicles travel. Even on comparatively narrow pavements waves seldom extend entirely across the surface. While it is probably true that the impact of fast-moving traffic accelerates wave-formation, once started, or may be directly responsible where irregularities in contour first existed, slow-moving heavily-loaded vehicles are believed to be the predominating cause.

There are a number of conditions which tend to promote wave-formation which are being given careful consideration in the government investigation. These are as follows:

Foundation faults due to lack of support from below, causing local settlement of the foundation.

Uneven contour in foundation, causing variable thickness of asphalt paving-mixture and consequent differences in compression.

Very smooth foundation which may promote slipping of the asphalt paving-mixture over its surface.

Inferior paving-mixture and the use of too soft an asphalt cement for the climate, traffic, or the grading of the mineral aggregate.

Use of too much asphalt cement in the paving-mixture.

Poor grading of mineral aggregate, which creates instability of the paving-mixture irrespective of the consistency and percentage of asphalt cement with which it is mixed.

Use of an excess of rounded particles of mineral aggregate in the paving-mixture.

Construction faults resulting in uneven contours, due to faulty spreading, raking or rolling of the paving-mixture during construction or lack of uniformity in the composition of the paving-mixture.

Lack of proper initial compression during construction, which may be due to use of too light a roller, too little rolling, to the mixture being too cold when rolled or too great thickness of course for a single rolling operation.

Faulty repairs to service openings.

Exterior causes such as the absorption of an excess of oil or gasoline drippings, causing undue softening of the asphalt cement.

Gas-leaks from mains below the pavement structure, causing undue softening of the asphalt cement."

Improved Methods

A great deal of research work has been done in the past by the paving companies themselves and by others towards still further improving asphalt pavements and at present there are many individuals and organizations working towards that end.

The Asphalt Association of Canada, the Asphalt Institute and the Association of Asphalt Paving Technologists of America are noteworthy examples.

Mechanical spreaders for distributing asphalt mixtures on the street and mechanical finishing machines similar to those used for concrete are some of the latest developments which are in the experimental stage.

Experiments are being carried on all the time with the object of still further improving paving plants themselves, such as self-reading pyrometers on mixer and material elevators, automatic weighing devices, agitators to prevent segregation of mineral aggregate in storage bins, dust collectors, oil heaters, improved liners for the mixer, better arrangements for handling the filler, etc.

There is still room for improvement in the method of obtaining compression, as it ought to be possible to develop some better system than by means of the road roller. The general tendency at present is towards the use of heavier rollers for initial compression.

Discussion on "The Use of Low Rank Fuels"

Paper by E. A. Allcut, M.E.I.C., and H. L. Wittek.(1)

PROFESSOR E. S. MOORE (2)

Dr. Moore stated that the paper should be of special interest to Canadians since the country possessed such quantities of low rank fuel and at the same time imported a large proportion of its requirements in coal and petroleum. He did not feel qualified to discuss some of the mechanical engineering features presented in the paper, but would like to call attention to the statement that "the sub-bituminous coals and lignites of Canada were estimated at over a billion short tons." The term "billion" as used evidently did not have the numerical value usually assigned to it on this continent. In 1915 Dowling had estimated the quantity of these low rank coals at 948,450,000,000 metric tons of which over nine-tenths were in Alberta. These figures included probable reserves and some deposits as much as 4,000 feet in depth. Allan recently had made an estimate of the lignite and sub-bituminous coals of Alberta and had estimated that the quantity which might be considered mineable under present conditions at about one-third of the estimate given by Dowling for this type of fuel. On the other hand, Dowling had estimated the lignite in the James Bay region at 25,000,000 tons. This estimate had been raised by recent drilling in the Onakawana area to an indicated tonnage of 100,000,000 short tons.

Since Canada had such an abundance of low rank coal the application of some of the methods outlined by the authors for their consumption might be an asset to the country, which would always be confronted, however, with an unfortunate situation. These fuels were located at a great distance from the main industrial centres or were located near other sources of cheap but high grade fuel, such for example, as in Alberta where they were near the natural gas and bituminous coal fields.

LIEUT.-COL. T. S. MORRISEY, M.E.I.C.(3)

Colonel Morrisey observed that he had read the paper with considerable interest, and would like to congratulate the authors on the vast amount of information on the subject which they had gathered, and so clearly presented.

With the unfortunate distribution of our high grade coal deposits it was a matter of first class importance to develop means of utilizing our lignite and peat supplies for the generation of steam. He believed, provided proper grates and furnaces were installed, as described in the paper, that the problems of burning lignite were well on their way to being solved for the smaller units.

There was, however, a limit to the size of boiler which could be fired with these grates, and as the authors had stated, large underfeed stokers and chain grates imposed high capital expenditures without correspondingly high efficiencies. The same complaint of high capital cost of equipment held good in the case of pulverized fuel systems, but the efficiencies were higher. The fact remained that lignite could be burned satisfactorily in pulverized form, and its adoption would depend upon the relative costs of lignite and high grade coals delivered at the plant.

As lignite had about half the heat value of a good grade of bituminous coal it followed that the grinding costs must be double that for coal to produce the same quantity of B.t.u's; and since grinding costs were high one had naturally turned to the central storage system for preparing lignite, as it required considerably less power per ton than the direct fired system. But the storage system introduced another difficulty in that the lignite must be dried to a greater extent if it was to be stored, than when it was delivered directly from the mills into the furnace.

In 1925 while working on the Lopulco system in the Winnipeg Hydro stand-by plant he had had many opportunities to observe the performance of Souris lignite. The mechanical difficulties of drying and handling, and the high cost of grinding raised the cost of steam with lignite to some 10 or 15 per cent above the cost with high grade bituminous coals at the then current prices, so that lignite was abandoned at that time. It was to be noted, however, that its burning characteristics, once it was got into the furnace, presented no troubles, and good efficiencies and high ratings were possible, although, of course, one could not get the same ratings as with bituminous coals. Lignite had since been burned in some of the subsequent direct-fired installations in western Canada, but he had no definite figures on costs in these cases.

Equally important as the utilization of our natural resources was the utilization of waste products, chief among these being the tremendous amount of wet wood refuse from the pulp mills. During the time he was with Combustion Engineering Corporation many wood refuse burning furnaces were installed. In all these there was a single retort underfeed stoker to burn a small amount of coal to support combustion while burning the wet wood, and also so that the boiler could carry light week-end loads with coal alone when wood was not available. The Dutch oven furnaces varied in design according to the lessons learned from earlier designs, ultimately leading up to the installation at the Lake St. John Paper Company, referred to by the authors, which included an air pre-heater. This was the best and cheapest combination of equipment he knew of, and was actually making steam. Some of the others he feared using wet wood and coal were little more than "refuse consumers," and the amount of steam evaporated was little more than would be evaporated if the same quantity of coal alone were burned.

Designs had been worked up for the application of auxiliary self-contained refuse furnaces, so arranged that the products of combustion could be led into the main coal fired furnaces, but so far he did not know of any such installations. It must be remembered that the high capital cost of modern pulverized fuel or stoker fired furnaces could only be justified by operating them at their highest efficiencies, and he feared that the complications of adding an auxiliary refuse furnace, with its variable fuel feed and interference with draught conditions would so lower the efficiency in the main furnace that the added heat from the refuse furnace might not even compensate for the loss. The same held good of attempts to feed shredded wood refuse directly into main coal fired furnaces.

Drying towers using flue gases from the coal fired boilers to dry the wet wood had been tried, but the equipment as now offered was expensive, and the fact that it was idle six months in the year rendered the economics of this process questionable.

The utilization of wet waste wood, whether as fuel, along one or other of the lines now being tried, or as raw material for some higher grade product, was a problem well worthy of study by inventive engineers.

(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and published in the January 1932 issue of The Engineering Journal.

(2) Professor of Economic Geology, University of Toronto, Toronto, Ont.

(3) 1321 Sherbrooke Street West, Montreal.

John Van Brunt[4]

Mr. Van Brunt stated he was particularly interested in the term "low rank" in place of the usual term "low grade." It seemed to point out a very pertinent differentiation between fuels that were of the nature of by-products, such as wood refuse, tar, coke breeze, the refuse from coal washing and the like, and raw fuels of low quality because of their inherently high ash or high moisture content.

Usually the economics of burning by-product fuels and low rank fuels differed greatly. A by-product fuel was usually produced at the point where it was consumed. The cost might be assumed arbitrarily, but the preferable method of figuring the economy was to value the fuel at the cost of the high grade fuel that was saved by its use.

In the case of low rank fuels, the problem was different in that the low rank fuel had a definite cost delivered at the plant, the cost being made up of the price f.o.b. mine, plus the freight and hauling. Whether a low rank fuel was preferable would depend on many factors. The acid test was whether or not it could produce heat at a lower cost than the available high grade fuel.

Ash, one of the two principal ingredients that classified fuel as low rank, might be present in coal in amounts up to 40 per cent or even 50 per cent. He did not know the upper limit for ash which would make coal economically useless, but the limit varied widely, dependent on local conditions as well as the character of the ash. Mr. W. L. Abbot's opinion, as quoted by the authors, was without doubt correct for the conditions which existed in the plant, or plants he had in mind.

Mr. Kreisinger also was correct in his statement that coal with ash of 40 per cent might be burned, but he would be the last one to say that this could be done under all conditions.

Mr. Van Brunt said that he knew of one plant that was burning coke breeze with an ash content of 30 per cent to 40 per cent. Bone coal of 40 per cent ash could be burned satisfactorily in forced draught travelling grates.

When a freshly mined coal contained moisture in excess of 20 per cent to 22 per cent it identified the coal as a sub-bituminous, or a lignite.

Of the four coals tabulated in the paper, Drumheller and Edmonton appeared to be sub-bituminous, both from analysis and storage characteristics. Tofield and Souris, particularly the latter, might be considered lignites.

Probably any classification was more or less arbitrary. Drumheller, by analysis, approached some of the Iowa cannels, and Edmonton some of the so-called Colorado lignites.

Any of these coals might be burned at satisfactory efficiencies in pulverized form or on forced draught travelling grates. Underfeed stokers might also be used for the first two named, but were less satisfactory with the last two coals.

In his opinion the determining classification for lignite, in addition to moisture, was character of the coke or char remaining after the volatile matter was driven off. In a true lignite the char was very light and porous, much like wood charcoal both in density and structure. Also, a true lignite slacked or disintegrated rapidly on exposure to air and when exposed to heat.

These factors tended to limit the combustion rates possible with this fuel.

In the design of furnaces for travelling grates, consideration must be given to the moisture and ash content, and also the size of the coal.

The thickness of the fire depended primarily on the size of the fuel, coarse coal required a thicker fire than fine coal. Because of the lightness of the coke or char it was readily lifted from the fuel bed, hence at high combustion rates a large amount of carbon was blown up in the furnace and through the boiler setting. This cinder loss was negligible at combustion rates of 30 pounds to 35 pounds per square foot, but increased very rapidly with rates above these figures. The rate of increase was not a straight line, but as some power probably nearly as the square of the combustion rate.

For this reason care should be used in taking catalogue ratings as representative of good performance and claims for high combustion rates should be carefully examined.

Rates of 60 or more pounds per square foot would inevitably be accompanied by high cinder losses, and correspondingly low efficiencies.

The grate surface for this type of fuel should of course minimize siftings and at the same time provide a maximum number of closely spaced small openings.

For high moisture fuels, large areas of refractory surfaces were usually necessary.

For large boilers, the most satisfactory method of burning these fuels was in pulverized form. Contrary to the common impression, the amount of predrying necessary was neither difficult nor expensive. At the Texas Power and Light Company, Texas lignite of 34 per cent moisture was predried to 28 per cent in steam grid dryers. At the maximum combustion rate of 24,500 B.t.u. per cubic foot the total loss due to unburned carbon was under 0.6 of 1 per cent, the total moisture and hydrogen loss was 10 per cent and CO_2 averaged over 15 per cent at all ratings.

The pulverizer performance was entirely satisfactory. Mills of 25 ton per hour nominal capacity were pulverizing 25 to 26 tons per hour to a fineness of 74½ per cent through 200 mesh with 3/10 per cent on 20 mesh. The power for mill and exhauster was approximately 10½ kw. per ton.

At the San Antonio Public Service Company, referred to in the paper, the efficiency quoted was overall boiler, furnace, and air preheater efficiency and not combustion efficiency. In this plant repeated tests for carbon in fly ash leaving the boiler, showed but a fraction of a per cent carbon.

When burning high grade eastern fuels, such as Pocahontas, New River and the like, fly carbon was one of the material losses, particularly at high combustion rates, whereas with lignite this loss was negligible.

This peculiarity of lignite was due to the greater reactivity of lignite char.

Because of this, lignite need not be pulverized as fine as other and slower burning coals.

When pulverizing lignite in high speed mills, preheated air at high temperatures might be used in the mill without danger of fire or explosion.

Very satisfactory results might be obtained if the furnace and burners were correctly designed for the fuel.

In conclusion he stated that in correctly designed furnaces lignite and sub-bituminous coal might be burned at satisfactory capacities and efficiencies on either forced draught travelling grate stokers, or in pulverized form, and further that the design of such furnaces should be intrusted only to those whose experience in the design, construction, and operation of lignite burning equipment qualified them for such work.

J. G. Hall, m.e.i.c.[5]

Mr. Hall observed that Mr. Van Brunt had expressed his views very clearly, but it might be of interest to add a few notes, based on experience in Canada.

The lignites and sub-bituminous coals of western Canada, could be burned on hand fired grates, underfeed

[4] Vice-President, Combustion Engineering Corporation, New York, N.Y.

[5] Vice-President and General Manager, Combustion Engineering Corporation, Ltd., Montreal.

stokers, travelling grate stokers, or as powdered fuel, as evidenced by the fact that it was being done. In making a decision as to which type of firing was to be used all the conditions of each particular installation must be very carefully studied. These conditions included maximum and minimum capacities, load factor, cost of fuel at the plant, etc., in order to choose the type of firing which would give the lowest cost per 1,000 pounds of steam. For instance the author mentioned the fact that Lethbridge sub-bituminous coal had been successfully burned for the last two years in a powdered coal installation. He presumed that he referred to the National Light and Power Company at Moose Jaw. On the other hand, the city of Lethbridge was burning this type of fuel on travelling grate stokers, and had reported very satisfactory results.

Here was an illustration of the statement made above, that each case must be figured on its own merits. In the case of Lethbridge the coal came from the city's own mine, a few hundred yards from the plant, and the design was based on the use of this coal only, so that relatively low cost units could be used. Moose Jaw, however, must depend on buying high priced coal in the open market, so that the design was such that by a few simple adjustments in the burners, etc., any coal available could be used. With them this would be an important item at any time, but more especially so to-day when coal costs were somewhat unstable due to government assistance.

The problem of burning waste wood was now receiving very considerable attention by the pulp and paper industry in Canada. Up until recent years this problem was considered more from the disposal standpoint, but it was realized that considerable profit could be made from the steam generated when it was burned under suitable conditions.

In designing waste wood burning furnaces a Dutch oven setting first used was with an underfeed stoker, burning a sufficient amount of coal to maintain necessary furnace temperatures. Later this idea was developed to include jets of air, properly directed on the wood pile. The next step was the use of an air-preheater, and this method was producing very satisfactory results.

The author mentioned the experience of the Lake St. John Paper Company at Dolbeau. Although a stoker was installed, so that the unit could be used as a normal coal burning unit if necessary, the latest reports were to the effect that when burning wood refuse no coal whatever was necessary, and combustion rates of over 200 pounds per square foot of grate surface per hour had been maintained without trouble.

M. W. Booth, M.E.I.C.[6]

Mr. Booth remarked that the authors had marked the reaching of a definite stage in the art of burning the low rank fuels of Canada, both natural and by-product, which formed so large a portion of the total fuel resources of the Dominion.

The definition of low rank fuels, given in the paper, as covering fuels of high moisture or high ash content, would exclude the products of the coal mines from discussion; but the question of disposing of inferior classes of coals as a by-product of the mining of the main output had been one that had given some concern to the mine operators in Nova Scotia. This question would arise also whenever the demands of the market necessitated the working of the lower grade mines, or when the higher grade mines were reaching the limit of their development. The cleaning of these coals would bring forward the question of disposing of the by-product fuels, which would be entirely one as affected by a high ash content.

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

As referring to the proportion of ash in coal that limits its use in a boiler furnace, the step forward of late years accomplished in this direction was indicated in the paper when one authority was quoted as saying that 20 per cent is the upper limit, and others, presumably later, 40 per cent. One of the problems in the operation of the mines in Cape Breton, that had been already met with and overcome, had been the disposal of a by-product of the picking belts averaging between 20 and 25 per cent ash. With the stoker equipment previously installed in the colliery boiler plants, the upper limit was just about reached with this fuel; but the installation of a pulverized fuel plant more or less specially designed, had made it appear as simple a matter to burn this high ash coal as formerly the standard grades, and with equally as high efficiencies. Average monthly operation in this particular plant showed boiler efficiencies between 83 and 84 per cent, and up to 300 per cent of boiler rating. Other plants in Nova Scotia were equally successful in burning similar grades of coal. And it might be said that the performance of these plants, which in each case were in connection with central power generating stations, had shown the way for the efficient use of what might ultimately form a substantial proportion of the total output of the mines in the Maritime provinces. Freight consideration would prevent any question of shipping these high ash products, or by-products, very far, and the solution would lie in the erection of local central power plants specially designed to burn these fuels, such as described in the paper. Local conditions in Nova Scotia and New Brunswick were such that they lend themselves readily to the super power scheme. Plants were in existence already at suitable points: the Seaboard power plant in Cape Breton, the Allen Shaft power plant in the Pictou county coal fields, and the Canada Power Company plant in Cumberland county, in Nova Scotia; and the newly erected plant of the New Brunswick Power Commission at Minto, New Brunswick,—all at present burnt high ash coals as fuel, and generated power at a cost comparable with hydro. These plants extended and linked together with any present or future hydro plants would enable these provinces to enjoy the advantages of cheap power, to the same extent as what hydro power alone had done for other provinces.

The references to low-temperature distillation in the paper were interesting as indicating the feeling that was becoming more or less prevalent in Canada, that low-temperature distillation had as yet very little field in this country, the peculiar characteristics of the main product not representing any great advance for our conditions over what other fuels, more easily obtained, as for instance high-temperature coke, would represent.

R. L. Sutherland[7]

Mr. Sutherland remarked that the development of the reserves of low rank fuels of Canada was now almost entirely a problem in economics, or perhaps more properly, of economic geography. As the author indicated, technically successful methods and processes for upgrading the low heat value fuels were now available. However, very few of the technically available processes could be applied at sufficiently low cost to warrant their adoption at this time.

During the past twenty-five years there had been an almost revolutionary change in the viewpoint of engineers concerned with the utilization of the lower rank fuels. The word "substitution" that bulked large in the literature was being replaced by the word "competition." It was once the general opinion that the low rank coals must be changed by processing into a material, as nearly as possible, similar in chemical and physical character to the higher rank coals available, in order that they might be substituted for

[7] Consulting Engineer, Saskatchewan Coal Operators Association.

those more refined natural fuels. To-day equipment was available and was being installed to burn the cheapest fuel, cost being determined by transportation and handling charges more than by form or combustion efficiency. Those low rank fuels, once held in low esteem, were now competing in large areas and in increasing volume with the aristocracy of fuels. This was true for all uses of coal from the heating of the small homes by stoves to the firing of the largest locomotives.

Modern developments in combustion equipment had made possible the generation of heat and power from almost any available combustible material without expensive preparation or processing. The choice of fuel, therefore, at least for the larger steam generating units, depended principally on the geographical position of the plant with reference to the source of competing fuels. With the development of central heating plants in the larger cities and of high tension electric transmission lines serving the smaller towns as well as the larger cities, an increasing percentage of the total fuel was being burned in larger generating units.

In the western portion of the Dominion, the use of the several ranks and grades of fuels was becoming more and more a matter of geographical position of the deposits with reference to available markets. In this area a complete range of fuels from wood and peat in eastern Manitoba, through the lignites of Saskatchewan and Alberta to the semi-anthracites of the mountains, was available.

In eastern Manitoba where the distance from the higher rank western coals was greatest, large developed and undeveloped water power resources were available. In Winnipeg, with a population equal to nearly one-half the total of the province, the use of electric energy developed by water power had made rapid progress both for power and heating. In the domestic fuel market the various western fuels competed on a comparatively equal basis with each other and with American coals imported by lake and rail. In the industrial field the American coals had had an advantage which had been off-set in part by government subventions on the western coal in the past few years. East of Winnipeg the American coals had a great advantage.

In the area west of Winnipeg as far as Swift Current, Saskatchewan, and from the international boundary north almost to Saskatoon, Saskatchewan lignite was the most economical fuel on the basis of available heat costs. North and west of this area the fuel requirements could be supplied most economically from the Alberta mines. This area in which Saskatchewan lignite was the most economical fuel was approximately a semi-circle the radius of which was about 300 miles which, incidentally, was the maximum distance estimated by the authors in connection with the northern Ontario deposits, and within which the freight rate did not exceed about $2.30 per ton. Within this area the percentage of the total fuel requirements supplied by Saskatchewan lignite was still relatively low but was being increased rapidly with the installation of proper burning equipment. It would be noted that in the areas east and north-east of that outlined that could be served economically by any western fuel, the present population was limited and the fuel requirements largely supplied by wood. To the west and north-west the increasing freight charges on Saskatchewan lignite, raw or processed, acted to prevent any substantial expansion of markets. It was evident therefore, that any processing of Saskatchewan lignite could only serve to aid in saturating the market within the area outlined, except insofar as that processing might increase the form value of the fuel for special purposes. With the increase in use of the raw fuel the available market for the processed fuel became progressively more limited.

As indicated in the authors' paper, in the simplest and cheapest form of processing lignite, namely by drying, it was practicable to reduce the moisture content to about 20 per cent, equivalent to a reduction of about one-sixth of the weight. The estimated cost of the simplest method of drying with which the writer was familiar, was approximately 30 cents per ton of raw lignite. More elaborate systems, such as that of Fleissner would increase the cost materially. Since the increase in combustion efficiency due to drying would not be more than two or three per cent, the drying cost must be off-set by a reduction in freight and handling costs. In other words, the area in which the dried product would have an advantage over the raw product on the basis of heat value was that outside the $1.80 freight rate. Experience indicated that systems of processing so far developed, producing fuel of higher heat value, were relatively more expensive and therefore the markets for the products, on the basis of heat value, must be found at greater distances and correspondingly higher freight rates.

An exception to this general statement was to be found in the possibility of processing by partial drying or otherwise where an increase in heat value or improvement in form value, would result in the ability of the processed fuel to compete in markets now closed to lignite in its natural state. Two promising examples of this condition were to be found in the ability to fit the fuel for use in existing large pulverized fuel plants within the 300-mile radius and for use in railroad locomotives. Both of these problems were now under consideration and experimental work already done or to be done in the near future, promised to materially enlarge the market for lignite. Calculations had also shown that drying to a moisture content of 20 per cent would permit an extension of the economical shipping range from a maximum freight rate of $2.30 per ton to $2.45 per ton.

On the basis of this analysis it would appear that large scale development of processing, involving heavy capital expenditures was not justified under present conditions and that the trend of development in this area would be toward the increased use of lignite in its natural state.

B. F. Haanel, M.E.I.C.[8]

Mr. Haanel believed that the authors had dealt with the use of low rank fuels in a most able and comprehensive manner. He, as well as the engineering staff of the Division of Fuels and Fuel Testing, Mines Branch, Department of Mines, had for many years been especially interested in the use of low rank fuels for the production of power and for the manufacture of a domestic fuel, and many investigations had been carried out in the Fuel Research Laboratories, Ottawa, with a view to determining in what industrial apparatus and in what way such fuels could be used to the best advantage.

In this connection he wished to direct attention to the authors' use of the word "rank." This did not refer to grade but to the geological age, i.e., the stage in the progression of the vegetable matter from the original plants or trees to the finished product—anthracite or bituminous coal. It should not be used to denote grade, such for example, as a high ash coal.

The large source of energy represented in the peat bogs of Canada had been cited, and in this connection he might state that very complete investigations had been carried out by the Mines Branch regarding a method for manufacturing peat fuel from the raw peat. The authors had stressed the necessity of reducing to a minimum the water present in the fuel, either by mechanical action, by the use

(8) Chief Engineer, Division of Fuels and Fuel Testing, Mines Branch, Department of Mines, Ottawa, Ont.

of waste heat, or by a combination of these two methods, so that the fuel might be used to the best advantage. In the case of peat, which contained in the raw state 90 per cent or more of water, and in lignites, which contained from 36 per cent to 50 per cent of water, the separation of the water was of very serious moment, and also presented a serious problem. In connection with peat, it was his opinion that any method for reducing moisture content by mechanical means, or by the use of heat, would not meet with success so long as higher rank fuels were readily available at comparatively low cost. Much had been said in regard to the Fleissner process for drying lignites but it had been difficult to obtain authentic data on which an estimate of the value of this process could be based. The authors made the statement that: "The consumption of steam is six pounds per pound of water removed, and the final value of the coal is about 80 per cent of the initial volume." This was too high a heat consumption, in Mr. Haanel's opinion, to permit the process under ordinary conditions to be termed economic.

The maximum ash which a fuel might have and still be used economically, had given rise to considerable discussion. As the authors had stated, one authority believed that 20 per cent was the upper economical limit for steam producing coal, while another authority believed that fuel with 40 per cent could be burned under proper conditions. He had entertained for some time the belief that pulverized fuel firing was especially valuable in connection with a high ash coal, inasmuch as it would permit of the use of an inexpensive fuel, but it appeared to have been reasonably demonstrated that the economy in such a type of plant depended largely on its ability to obtain and use a high grade fuel.

The authors' reference to the use of powdered fuel in internal combustion engines was of special interest. He had been following the development of this type of motor for many years and had been informed on more than one occasion that it could be successfully, economically, and continuously employed on certain types of pulverized fuels. But until the Third International Conference on Bituminous Coal, he was not aware that this motor had been developed to so high a degree as to be considered entirely commercial. It was especially interesting to know that lignite fuel was probably the most efficient fuel to burn in such a type of motor, but again, this very likely referred to German brown coals, in which connection it must be borne in mind that there was not much similarity between German brown coals and Canadian lignites. The value of Canadian lignites for use in such an internal combustion engine would have to be demonstrated.

The Holzwarth gas turbine had also been discussed at considerable length in the technical journals. This gas turbine was developed in the shops of the Koerting Company, Germany, in 1908. The test proved the turbine in its original design to be a failure, and from that time on it seemed to drop into obscurity. It was therefore, of special interest to learn that it had actually been developed to a point where a 2,000-kilowatt unit was under construction, and that an efficiency of 30 per cent could be expected on larger units. He would be very interested if the authors would present some details regarding the arrangement of the combustion chambers, method of compressing air, etc.

Extensive tests had also been carried out in the Fuel Research Laboratories regarding the value of low rank fuels for the production of an industrial and power gas in gas producers, and tests had recently been conducted in connection with the burning of northern Ontario lignites on "Pyramid Grates" for steam raising.

C. Tasker[9]

Mr. Tasker observed that he had been interested in the references in the paper to the Fleissner process for the treatment of lignite, having recently returned from a visit to Europe during which he made a careful investigation of the Fleissner process.

First, he would like to correct a mistake in the paper. The authors stated that the consumption of steam was 6 pounds per one pound of water removed. This should have been 0.6 pound of steam; the latest figures showed a steam consumption varying from 0.6 to 1.0 pound of steam per pound evaporated.

The largest Fleissner plant was at Koeflach, in Austria. It consisted of sixteen autoclaves, each having a nett capacity of 15 tons (2,000 pounds) of raw coal, the daily throughput of the plant being 2,000 tons of raw coal. Saturated steam at a pressure of 15 atmospheres was used. Six screened sizes of dried coal were made and sold f.o.r. plant at prices varying from $1.55 per ton for the small sizes to $3.75 per ton for the large sizes. The material was used for kilns, gas generators, boilers, locomotives and domestic heating and gave complete satisfaction.

The plant had been in operation for five years and was paying. The capital cost for the whole of the plant, including boilers, railway, screens, etc., worked out at about $260 per ton per day capacity. Another small plant was operated at Falkenau in Czechoslovakia, on material containing from 40 to 45 per cent moisture as mined. It consisted of two autoclaves, smaller than those at Koeflach, the plant having a total daily throughput of 165 tons of raw coal. Steam at a gauge pressure of 25 atmospheres was used in this plant, and instead of blowing air through after the steaming period, vacuum was applied to the autoclave for about 20 minutes. The dried coal contained from 15 to 20 per cent moisture and screened sizes were sold at prices varying from $1.75 to $3 per ton, as compared with 55 cents to $1.25 per ton for raw coal at the mine. This plant operated six days a week and had given every satisfaction technically and financially.

One of the advantages of the Fleissner process was that in the removal of moisture from the coal, the condensate formed removed also some of the extraneous ash, and the resulting product might have either a less or an equal ash content to that of the raw coal treated. The fuel produced was more resistant to weathering than the original material, and there were no by-products or waste material to be disposed of, while operating costs were low.

E. A. Allcut, M.E.I.C.[10] and H. L. Wittek[11]

The authors observed that Professor Moore's figures for the quantity of low rank fuels available were more definite than those given by the authors, but in the paper, the word "billion" was used in the sense usually understood in Great Britain to indicate a million million or $(\text{million})^2$. It was interesting to note that this was the meaning also given by the Oxford English Dictionary. The effect of geographical situation and freight rates on the possible consumption of such fuels appeared in several of the discussions and was referred to in the original paper under the headings "Introduction" and "Definition."

The authors were in general agreement with the statement of Colonel Morrisey and others, that the larger installations would preferably make use of pulverized fuel, but this general statement was subject to modifying local

(9) Ontario Research Foundation, Toronto, Ont.
(10) Professor of Mechanical Engineering, University of Toronto, Toronto, Ont.
(11) Consulting Engineer, Toronto, Ont.

conditions and to the extra cost of handling and drying the wet fuel and its pulverization. The Lake St. John installation referred to both by Colonel Morrisey and Mr. Hall, was of particular interest in view of Mr. Hall's statement that wood was now being consumed there without the use of coal as an auxiliary fuel. Illustrations of this were given in the original paper, showing that wood could be an important accessory in the steam raising plant, and that a wood furnace need not be merely a "refuse consumer."

The authors agreed that the cost of a drying tower designed for high thermal efficiency might be prohibitive, but pointed out in the paper that it was frequently economical to sacrifice thermal efficiency to some extent, in order to reduce the capital cost, and in this way the scheme might be made economical.

Several of the discussors, including Messrs. Booth, Haanel, and Van Brunt, criticized the use of the term "low rank" as indicating the type of fuels dealt with in the paper.

The original title chosen for the paper was "Low Grade Fuels," as indicating fuels high in moisture or ash content, or both, but, realizing that other fuels would necessarily come within this title, it became necessary to choose a term which would best indicate these characteristics. For this reason and to avoid misunderstanding, the title was amplified by the definition given on the first page. A wider treatment was obviously desirable but was precluded by considerations of space. The limitations of ash content would evidently depend on the method of burning, as the 20 and 40 per cent limits mentioned in the paper were stated in the same symposium and were not, as presumed by Mr. Booth, made at different times. Further information on this point was given by Mr. Van Brunt. Although it was possible to burn high ash coals with high efficiency in pulverized coal furnaces, the authors mentioned the Martin stoker which also would consume high ash coals (35 per cent) with good efficiency.

They agreed with Mr. Van Brunt's remarks to the effect that the thickness of fire and optimum combustion rate was a function of the size of fuel and its specific gravity. This would be a limiting factor in the design of furnaces for by-product fuels particularly. They acknowledged, with thanks, his correction in connection with the efficiency of the San Antonio plant.

Mr. Sutherland's contribution to the discussion was largely an elaboration of the economic aspect of the fuel problem, which was necessarily only briefly described in the paper, this being mainly devoted to the technical side of the subject. Such considerations were vitally important at the present time, but were not final. Future developments might, and probably would, force the use of these fuels and it was necessary to keep abreast of current knowledge and experience in this respect. Also there was the consideration that in some localities mentioned both in the paper and in the subsequent discussion, fuels of this type were the only ones which could be used. The economic radius was always determined by transient conditions and the extent to which this radius might be extended in the future, was at present unknown. The only thing certain was that this radius *would* increase.

References to the Fleissner drying process were made both by Mr. Sutherland and Mr. Haanel. The authors were indebted to Mr. C. Tasker of the Ontario Research Foundation for the information he recently obtained in Austria.

Further details of this process were given by H. Klein in an article on "The Desiccation of Lignite," published in "Fuel" September 1931.

The authors regarded the Rupa pulverized fuel engine as an interesting experiment which was now about to take commercial form and which, if practical, would have considerable importance. The difference between Canadian and German lignites was only one of capacity. According to Mr. Pawlikowski's experience, any pulverized fuel would work in this engine, but if, as in the German lignites, the fuel itself provided some part of the oxygen necessary, higher specific outputs could be obtained. They were aware of the previous history of the Holzwarth gas turbine, but described the new arrangement as a distinct advance in the design and application of these machines. They did not "confidently expect" an efficiency of 30 per cent on these units, but stated that this was the prediction of the builders.

Discussion on "The Structural Design and Erection of Maple Leaf Gardens, Toronto, Ont."

Paper by G. Townsend, A.M.E.I.C., and Charles W. Power.[1]

C. R. Young, M.E.I.C.[2]

The chairman observed that the author had stressed particularly the remarkable performances of the contractors, but from the designing engineer's point of view, he wished also to commend the achievement that was represented in decreasing the weight of the steel from a possible 25 pounds per square foot to 17 pounds per square foot. It showed that the skilled structural engineer could yet find a way to pay for his services.

J. R. Rostron, A.M.E.I.C.[3]

Mr. Rostron inquired whether the central pin was a vertical pin and whether it functioned in the same way as the three-pin arch in an ordinary bridge—in other words was the truss really in the form of a three-hinge arch, in the ordinary acceptation of the term.

He further inquired as to the size of the pin in the centre, what was Lubrite and whether it evaporated.

Fred Newell, M.E.I.C.[4]

Mr. Newell stated in reply to the latter part of Mr. Rostron's question that Lubrite was a trade name given to a graphite combination. It was practically graphite, and after it had been in use for some time it would be found that the graphite was smeared over the whole surface. It did not evaporate and was impervious to moisture, having been used for years under water.

A. W. Connor, M.E.I.C.[5]

Mr. Connor asked whether the roof was all glass, or if there was another covering, and he also inquired if the seats rose uniformly.

(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th, 1932, and published in the March, 1932, issue of The Engineering Journal.

(2) Professor of Civil Engineering, University of Toronto, Toronto, Ont.

(3) City Structural Engineer, City of London, Ont.

(4) Assistant Chief Engineer, Dominion Bridge Company, Ltd., Montreal.

(5) A. W. Connor and Company, Consulting Engineers, Toronto, Ont.

Gordon Wallace, A.M.E.I.C.[6]

Mr. Wallace inquired as to the exact location of the bracing truss to take the wind load from the dome, and how this load was transferred to the corner pier. In other words, was the bracing truss referred to in the plane of the flat section of the roof outside of the dome? If not, where was it located?

C. R. Young, M.E.I.C.

The chairman enquired if the bottom chord of the purlin truss formed the chord of the wind truss.

A. H. Harkness, M.E.I.C.[7]

Mr. Harkness observed that it must not be overlooked that the architects had something to do with the building. They deserved a great deal of credit for having worked out a most ingenious plan for an arena. They had taken advantage of the shape of the lot and of the playing-field, to give all spectators in the building the best possible view of the ice. He did not see how a better solution could have been arrived at, and it deserved as much credit as the remarkably ingenious method of solving the question of covering the building with a roof. The Dominion Bridge Company were to be congratulated on the way the erection of the steel had been handled in harmony with the work of the other contractors.

There were one or two things in connection with the design of the steel about which he would like some information. One was whether the provision for the expansion of the trusses might not have been solved better by the use of teeter columns rather than by the sliding ends. The answer to that might be in the amount of stress produced in the chords of the roof trusses, by friction on the shoes, 10 per cent of the pressure on the sliding shoes, as compared to the total stresses in the chords. Another question was that of the provision for the expansion and contraction of the roof in the wings of the building. In the building, over 200 feet wide, there would be one and a half or perhaps one and three-quarters of an inch expansion across the building, and including the longer span trusses over the wing another half inch. The corners of the arena must be considered fixed while a motion of two inches at the wall end of the roof trusses over the wing might occur. There must be considerable deformation in the main roof truss carrying the ends of these wing trusses or the wall must be pushed out two inches or so to accommodate the expansion and contraction. Therefore, what provision, if any, was made to provide for this expansion?

Mr. Harkness further inquired if in the bay adjacent to the stair tower one side of the bay at the tower was fixed and the other side at the column teetered over two inches.

E. E. Hugli, A.M.E.I.C.[8]

Mr. Hugli inquired whether, in the opinion of those present, welded connections would be practicable for a structure of this kind.

F. P. Shearwood, M.E.I.C.[9]

Mr. Shearwood, in reply to Mr. Harkness' question regarding the corner piers, remarked that the sliding bearings were used at each corner of the arches so as to provide a means of accommodating the temperature deformations of the steelwork, and at the same time exert a certain amount of frictional resistance to the wind forces at each corner instead of concentrating all these on one corner, which would have overlooked its walls. The use of columns sufficiently limber to meet the necessary temperature movements was not considered advisable for such important supports.

Mr. Hugli's question as to whether welding could have been used instead of riveting was a very interesting one. Many engineers had a growing confidence in welding for structural steelwork, but whether it should yet be applied to such a big elastic structure as the roof under discussion, was debatable. It would be interesting to hear the chairman's views as he had made a special study of the subject of structural welding.

C. R. Young, M.E.I.C.

The chairman observed that the expression of his views on riveting would have to be rather elastic. A good deal of investigation on welding on structures had been done at the University of Toronto, but the results were not quite in shape for publication. In the study of the resisting value of welded connections it had been found that the welded type of connection possessed a very considerable degree of rigidity. In general, welded connections seemed to have more rigidity than riveted ones. During the last year a good deal of attention had been given to the behaviour of wind connections of the T-type, and certain gusset plates, too. He was not in a position to go on record yet, but could say that it appeared that several welded wind connections would, before very long, find an important application in buildings of structural steel. If welding was adopted in large and important structures, he thought perhaps the most suitable places would be in connection with wind bracing. Possible failure in some detail would not be disastrous where the detail involved wind bracing, though it might be unsightly and inconvenient; but if there was still some element of doubt in connection with the efficiency of welded connections, it would be more prudent to base doubtful design upon what might be considered a secondary part of the work, rather than upon the primary part. He was sorry that he was not at the moment in a position to give any quantitative information; but the characteristic behaviour of the welded connection was very great rigidity.

C. S. L. Hertzberg, M.E.I.C.[10]

Colonel Hertzberg remarked that in Toronto and Canada generally there had been structures put up that required as much ingenuity and experience as any structures on the continent. He wished that it were a bit more evident to the people who employed engineers throughout the country that these things could be handled in Canada. If owners only had sense enough not to go outside of the country to get brains, a lot of money would be saved. In Canada and the Empire there were engineers who, though they might not have had the experience of some structural engineers in other countries, at any rate, had the ability to tackle any structure in just as economical and sane a manner as any outside engineers.

N. Wagner, A.M.E.I.C.[11]

Mr. Wagner inquired the height of the wind trusses above the shoe plates.

C. J. Madgett, A.M.E.I.C.[12]

Mr. Madgett remarked that he had watched the building from the time the erection was started until it was completed and could appreciate the thought and time that must have been given by the designing engineers to erection problems. It was so worked out that the contractors were enabled to put up the structure without a hitch or accident and at the same time to complete it as per schedule.

With reference to the inquiry as to whether the steel in this building could have been welded, it was his personal opinion that it would probably be a long time before

(6) Consulting Engineer, Toronto, Ont.
(7) Harkness and Hertzberg, Consulting Engineers, Toronto, Ont.
(8) Designing Engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ont.
(9) Chief, Engineer, Dominion Bridge Company Ltd., Montreal.
(10) Harkness and Hertzberg, Consulting Engineers, Toronto, Ont.
(11) Structural Engineer, Hutton and Souter, Hamilton, Ont.
(12) District Manager, Sarnia Bridge Company Ltd., Toronto, Ont.

structures of that type could be entirely welded, owing to the heavy stresses that had to be transmitted from one member to another and also due to the fact that there would be very little duplication of pieces in the framework.

A lot of welding was done at their Sarnia plant in connection with Massillon joists and roof trusses where duplication was always possible and in welding these trusses, the welds were broken up into short lengths as they were found to be more satisfactory than a long continuous weld.

C. R. Young, M.E.I.C.

The chairman observed that Mr. Madgett had raised some very important points and if any present were interested the late Dean MacKay, of McGill University, wrote on the subject in the Journal of Research, and also Mr. Trench had written on the subject of long welds with very little shear. The stress at the end of the weld was much greater than it was at the centre. That probably accounted for the disability of the long weld.

Charles W. Power[13]

In reply to Mr. Rostron, the author stated that the pin was a horizontal one and he was correct in assuming that the truss was in the form of a three-hinge arch. The pin was about a cubic foot in size.

In answer to Mr. Connor's inquiry he observed that there was no glass in the roof. The deck was sheet steel, formed in ridges, and these ridges were about six inches on the centre. Then on top of the steel deck were two half-inch layers of Donnacona board for insulation, and on the Donnacona board was prepared roofing.

With reference to the seats, the rise of these increased, that is, there were three tiers of seats, one behind the other. The front one was the flattest and the back one was the steepest. In addition to that there was a transverse aisle running parallel to the length of the ice area which intervened between each of those banks of seats. Now, the front seat of each bank of seats was raised above this aisle sufficiently so that a man sitting in the front seat would look right over the heads of people going to and from their seats, or standing on this transverse aisle. Access to all the seats was from the top down.

In reply to Mr. Wallace, Mr. Power remarked that the bracing truss was a horizontal truss. There was a truss that ran all the way around the outside of the dome and then this wind bracing truss was between this truss and the next purlin truss above. The bottom chord of the purlin truss formed the chord of the wind truss.

Answering Mr. Harkness, the author said that one end of the truss that carried the flat roof was carried on the main truss that ran from north to south, from concrete pillar to concrete pillar. The other end was carried on a steel column which was embedded in the wall, and any expansion or contraction in that 70-foot truss was simply taken up in the contraction of the wall.

The wall teetered, the columns being embedded in the masonry of the wall. In addition to that the roof deck was at liberty to expand and contract independent of the truss by reason of the extension joint at the junction of the wall and the roof deck. In the case of the last portion of the wall, the last bay, where there was a corner, the wall could not teeter but, of course, the nearest column was some 20 feet away. Therefore the wall deflected two inches in 20 feet. As far as the construction of those corner piers was concerned, Mr. Shearwood had explained the matter.

In reply to Mr. Wagner's question, the author stated that the wind trusses and shoe plates were practically on a level.

In conclusion, Mr. Power observed that he would again point out that the paper, while it was contributed to slightly by himself, was prepared by G. Townsend, A.M.E.I.C., structural engineer of Ross and Macdonald Inc., with the co-operation of the contractors, and he wished to thank the various members for their remarks.

[13] Toronto Manager, Ross and Macdonald Inc., Toronto, Ont.

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Corrosion and Protective Coverings

Applied chemistry stands out among the branches of technology in which remarkable advances have been made during the past ten years. Experimental work in this field is throwing light on many problems whose solutions are of great importance to the engineer, but which remained obscure until the combined efforts of the industrial chemist and the physicist were devoted to their investigation. The engineer's great enemy, corrosion, has been under fire for a long time, but has recently been attacked with new weapons, and in many of its aspects has now proved vulnerable. It is unfortunately impossible for the engineer in active work to devote time to all the recent developments in science and technology which bear on his special branch of the profession, and he therefore welcomes any authoritative presentation, not too lengthy or abstruse, which will inform him as to the progress made in a branch of technical knowledge which concerns his own work. It was no doubt with this end in view that the subject of corrosion was chosen this year for the thirty-eighth James Forrest Lecture of the Institution of Civil Engineers,* and the selection has been fully justified by the instructive summary of our present knowledge of the subject which was given by the lecturer.

The old idea that corrosion is essentially a surface action, which can be prevented by surface treatment, is no longer tenable. It is now known that the most insidious effects may arise in the interior of a piece of metal which is subject to strain in the presence of a corrosive agent, or which undergoes bending or vibration when surrounded by some injurious medium. Much has already been learned as to the real causes and mechanism of corrosion, whether due to surface action by gas or liquid, or to internal attack along the grain boundaries of the material. There are still gaps in our knowledge, but these are being steadily filled up as research proceeds.

In the past, many errors in practice have been made due to imperfect information on this subject. The lecturer, for instance, pointed out that certain methods of boiler feedwater treatment have been responsible for converting comparatively harmless general corrosion into dangerous local pitting, or have even resulted in caustic embrittlement of the boiler plates due to the action of free sodium hydroxide. In the case of boilers and tanks, it is often possible to control the chemical composition of the liquid in contact with the plates, but steel structures, exposed to the atmosphere of our towns and cities, are subject to corrosive influences over which no control is possible. The new non-corrosive alloy steels are not as yet fully available commercially for structural work, and in regard to steel structures generally the prevention of corrosion is therefore still dependent upon the efficacy of surface coatings of paint or cement.

The lecturer remarked that the failure of a paint to furnish adequate protection is, in many cases, not due to failure of the paint film owing to weathering or instability of the pigment or vehicle, but is frequently caused by chemical action on the metal below the film, set up by traces of salt or oxide lying under the film. It is even possible that ingredients in the paint itself may actually start corrosion. "It is evident," he concluded, "that there is no single method of protecting metal which is applicable to all conditions. A method which is successful for certain purposes fails lamentably for others. This only leads back to the statement made in the early part of the lecture—that it is essential for the engineer, if he is to avoid serious trouble, to pay more attention to chemical principles. It will be far better that the engineer shall himself acquire sufficient chemical knowledge to guide his own choice, rather than he shall have to rely entirely on the advice of outside persons, whose knowledge of the engineering aspect of the matter is often imperfect, and whose attitude towards the decision may, in some cases, be not completely disinterested."

A somewhat wider field than that dealt with in the James Forrest Lecture has recently been covered in the papers of a symposium on Industrial Paints and Varnishes published in the Times Trade and Engineering Supplement.† These form a series of articles dealing with recent advances in paint technology and in the development of new paints, varnishes and protective coatings, progress in which has been largely based on the co-operative research work of the paint manufacturers themselves. In the past, manufacturers have not always been willing to impart their technical information to the users of their products, and a welcome change in this policy is indicated by the publication of the results of much of the work carried out by and for the paint industry.

In 1926 the Research Association of Paint, Colour and Varnish Manufacturers established a Research Station at Teddington, to bridge the gap between science and industry, its principal work being fundamental investigations into the properties of materials. Research is being carried out by similar organizations in the United States and elsewhere, and the remarkable results shown in connection with the development of new materials for paint and varnish are of striking importance. Synthetic resins, for example, have revolutionized the varnish industry. The older methods of applying paint have largely been superseded by flowing, dipping and spraying. A wide field of usefulness has been opened to cellulose and cellulose-resin lacquers. Entirely new materials, such as casein, are being used as paint bases, and these, with many others, are features of technol-

* "Some Aspects of the Corrosion Problem," Ulick R. Evans, M.A. (See Engineering, May 6 and May 27, 1932, pp. 550 and 639.)

† The Times Trade and Engineering Supplement, No. 721, April 30, 1932.

ogy of which something must be known by the engineer before he can deal intelligently with his problems of protective coating. Such progress has only been rendered possible because the industry, instead of adhering to the old-fashioned policy of jealously guarding individual trade secrets, has embarked on co-operative research, resulting in real scientific advance, and the fuller understanding and intelligent employment of its products by the user.

The Engineering Institute of Canada Prize Awards—1932

The University of Alberta—William Godlib Siebrasses.
The University of British Columbia—J. W. McRae.
The University of Saskatchewan—Neil Barron Hutcheon.
The University of Manitoba—Lawrence M. Howe, S.E.I.C.
The University of Toronto—J. S. Ball.
Queen's University—A. A. Wilson.
McGill University—Malcolm Porter Jolley.
Ecole Polytechnique, Montreal—Jacques Benoît.
The University of New Brunswick—Stanley B. Cassidy.
The Nova Scotia Technical College—Walter Edwin Bennett.

OBITUARIES

Alexandre Fraser, A.M.E.I.C.

Members of The Institute will learn with regret of the death of Alexandre Fraser, A.M.E.I.C., which occurred suddenly at Montreal on June 11th, 1932.

Mr. Fraser was born at Cap St. Ignace, Que., on April 5th, 1881, and received his education at the College of Ste. Anne de la Pocatiere and the Ecole Polytechnique, Montreal, graduating from the latter institution in 1909.

Following graduation, Mr. Fraser was until 1911 assistant engineer on the St. Lawrence Ship channel for the Dominion Department of Marine. On April 1st, 1911, he joined the Department of Highways of Quebec as

ALEXANDRE FRASER, A.M.E.I.C.

assistant chief engineer, and was appointed chief engineer in 1924, holding that office until the time of his death. In his capacity as chief engineer, he had to supervise construction and maintenance work in all parts of the province, and to his efforts may be attributed in no small degree the improvement in Quebec roads and highways during recent years. In 1923-1924 Mr. Fraser gave a series of lectures on highway engineering at the Ecole Polytechnique, Montreal, and at the time of his death was on the directorate of that college.

Mr. Fraser was a member of the Royal Automobile Club of Canada, of the Province of Quebec Safety League, of the engineers and officials branch of the American Road Builders Association and of the Canadian Good Roads Association.

He joined The Institute (then the Canadian Society of Civil Engineers) as a Student on May 2nd, 1907, and became an Associate Member on November 9th, 1912.

CHARLES CHAMBERS, M.E.I.C.

Charles Chambers, M.E.I.C.

General regret will be felt at the death of Charles Chambers, M.E.I.C., which occurred at his home in Calgary, Alta., on June 1st, 1932.

Mr. Chambers was born at Richmond, England, on December 21st, 1862, and received his early education at the Perse Grammar School, Cambridge, and Clifton College. In 1884 he graduated from the Royal Indian Engineering College, Cooper's Hill, subsequently serving a pupilage of one and a half years in the drawing office and workshops of the Anglo-American Brush Electric Light Corporation Ltd., in London.

In 1887 Mr. Chambers was employed on the engineering staff of the Bombay Port Trust on the construction of the Victoria docks; in 1888 he was an assistant engineer with the Bhavnagar-Gondal-Junagadh-Porbander Railway in India, being in charge of the construction of the Verawal sub-division. From the end of October 1888, to the beginning of February 1891, Mr. Chambers was an assistant engineer on the survey of 120 miles of railway with the Delhi-Umballa-Kalka Railway Company, Ltd. In 1891-1892 he was an assistant engineer on the staff of the Public Works Department of the government of India. During the year April, 1894-March, 1895, he was assistant engineer with the Irrigation Department, Punjab government, and subsequently, until 1897, was on the engineering staff of the Bombay Port Trust. In 1903-1904, he became first assistant engineer with the Central South African Railways, and in 1904-1905, was employed by the Municipality of Johannesburg, South Africa. From January to September, 1906, he was appointed by the government of British East Africa as a member of the Municipal Council of Nairobi, and during that time acted as assessor to the municipality.

Returning to England in 1910, Mr. Chambers was engaged by the Midland Railway Company as assistant resident engineer on their harbour and docks at Heysham for a short period.

Coming to Canada in that year, Mr. Chambers managed and worked his own farm in Alberta until May, 1912, when he joined the engineering staff of the Irrigation Branch, Department of the Interior, as inspecting engineer, remaining with the Department until his retirement in 1925. In 1890 Mr. Chambers was elected an Associate Member of the Institution of Civil Engineers, and in 1919 became an Associate Member of the American Society of Civil Engineers.

He joined The Engineering Institute of Canada as a Member on August 27th, 1918, and was well known as a senior member of the Calgary Branch. His modest and kindly disposition endeared him to a wide circle of friends.

PERSONALS

W. M. Johnstone, A.M.E.I.C., formerly in the city engineer's office, Hamilton, Ont., has been appointed deputy engineer, city hall, Ottawa, Ont.

G. Vibert Douglas, A.M.E.I.C., has been appointed professor of geology at Dalhousie University, Halifax, N.S., and will take over his new duties at the commencement of the next session. Mr. Douglas graduated from McGill University in 1920 with the degree of M.Sc.

T. H. Doherty, S.E.I.C., has accepted an appointment with the National Research Council, Ottawa, Ont. Mr. Doherty graduated from McGill University in 1929 with the degree of B.Sc., and was for a time with the Lima Locomotive Works, Inc., at Lima, Ohio.

T. R. Durley, Jr.E.I.C., formerly assistant superintendent at plant No. 1 of the Canada Cement Company at Montreal East, Que., has been transferred by that company to plant No. 13, which is located at Fort Whyte, Man. Mr. Durley graduated from McGill University in 1928, with the degree of B.Sc., and following graduation was for a time with the General Electric Company at Schenectady and Philadelphia, and with the Canadian General Electric Company at Peterborough, Ont.

O. J. McCulloch, A.M.E.I.C., is now connected with Angus Robertson, Ltd., Montreal. Mr. McCulloch was for a time with Porter Brothers and Robert Porter at Detroit, Mich., and in 1927 was engaged on the construction of the Welland Ship Canal at St. Catharines, Ont. Later he was with the Sydney E. Junkins Company of British Columbia, Ltd., at Vancouver, B.C., and in 1931 he was connected with the tunnel division of the Rayner Construction Ltd., at Toronto, Ont.

D. T. Main, M.E.I.C., has been appointed vice-president and secretary-treasurer of Adanac Supplies Limited, and vice-president of Canadian Waugh Equipment Company, Ltd., Montreal. Mr. Main was for some time located at Watervliet, N.Y., as vice-president of Bird Archer Company of New York, and in 1922 returned to Canada as works inspector and sales engineer in charge of the engineering sales department of the National Steel Car Corporation Ltd., at Hamilton, Ont. In 1923 Mr. Main was appointed Montreal manager of the corporation, which position he has recently resigned.

D. J. Emrey, A.M.E.I.C., has been appointed road superintendent of the county of Waterloo, Ont. Mr. Emrey is a graduate of Queen's University of 1922, and was for a time field superintendent, bridge department of the Canadian DesMoines Steel Company Ltd., of Chatham, Ont. He was later on the staff of the Fort William Paper Company at Fort William, Ont., and in 1925 became connected with Price Brothers and Company Ltd., being successively construction engineer at Riverbend, Que., construction superintendent at Riverbend and Donnacona, Que., and manager of the Donnacona board mill. In 1931 he was with the Department of Northern Development at Minden, Ont.

L. S. Dixon, M.E.I.C., of Ottawa, Ont., has been awarded the degree of Mechanical Engineer by the University of Maine. In 1923 Mr. Dixon was chief engineer for the three plants of the Eddy Paper Corporation in the vicinity of Three Rivers, Mich., and was later consulting engineer with the Riordon Pulp Corporation at Temiskaming, Que. In 1924 he became connected with the Bogalusa Company Inc., in Louisiana, and in 1926 resumed his connection with the Riordon Pulp Corporation at Temiskaming. In 1928 he was appointed construction manager for the Riordon division of the Canadian International Paper Company, and in 1930 joined the staff of the E. B. Eddy Company Ltd., at Hull, Que., as construction manager.

R. B. Jennings, M.E.I.C., has joined the sales staff of the Fuel Oil division of the McColl-Frontenac Oil Company, Ltd., Montreal. After receiving his education in Humberside Collegiate Institute, Toronto, and the University of Toronto, Major Jennings was engaged in railway location and construction, and was appointed resident engineer, Canadian Northern Ontario Railway, in 1909. He served in this capacity on the various lines under construction until January, 1916, when he enlisted in the Canadian Overseas Expeditionary Force. He was appointed lieutenant, and promoted to Major in the 10th Battalion, Canadian Railway Troops, with active service in France and Belgium. Returning to Canada in 1919, Major Jennings was appointed division engineer, Toronto division, Canadian National Railways, Toronto. In 1921 he became division engineer, Ottawa Division, and in 1922, division engineer, Montreal division, resigning from that position in 1926 to become general manager of Robert W. Hunt and Company, Ltd., with headquarters at Montreal. Prior to accepting his present position, Major Jennings was railroad sales engineer with Crane Limited, Montreal.

Donald Ross-Ross, A.M.E.I.C., chief industrial engineer of the Howard Smith Paper Mills Ltd. and subsidiary companies in charge of the "Point" bonus system at the various mills, has become a member of the Canadian Society of Cost Accountants and Industrial Engineers. Mr. Ross-Ross is the author of a number of technical articles on paper mill combustion problems and costs. He graduated in mechanical engineering from McGill University in 1917, and following graduation joined the Royal Canadian Navy, becoming an engineer sub-lieutenant. After being demobilized, he taught the classes of the Soldiers' Civil Re-Establishment in power plant engineering at the Central Technical School, Toronto, until their completion in the spring of 1920. He then joined the Dominion Rubber Company in their planning department, receiving a three months' schooling in this work. Mr. Ross-Ross was later appointed assistant mechanical superintendent of the general rubber goods factory of the same company in Montreal. In 1925 he joined the Howard Smith Paper Mills Ltd., as combustion engineer at the Cornwall division, in 1927 he became production engineer of the division, and in 1929, was appointed chief industrial engineer.

Recent Graduates in Engineering

Congratulations are in order to the following Students and Juniors of The Institute who have recently completed their course at the various universities.

McGill University

Honours, Medals and Prizes

Jue, Gordon Jing, Montreal, Que.—B. Eng., (Ci.); (one-half) Departmental Prize for Summer Essay; Undergraduate Society's Third Prize for Summer Essay.

Lea, William Chester, Victoria, P.E.I.—B.Eng., (Ci.); Honours in Civil Engineering; British Association Medal; The Engineering Institute of Canada Prize (1931).
Lochhead, Kenneth Young, Lachine, Que.—B.Eng., (Ci.); Honours in Civil Engineering; British Association Medal.
Murray, William MacGregor, Montreal, Que.—B.Eng., (Mech.); Honours in Mechanical Engineering; British Association Medal; The Babcock-Wilcox and Goldie-McCulloch Scholarship.
Ouimet, Joseph Alphonse, Jr., Montreal, Que.—B.Eng., (El.); Honours in Electrical Engineering; British Association Medal; Montreal Light, Heat and Power Consolidated First Prize; Undergraduate Society's First Prize for Summer Essay; The Jenkins Brothers Limited Scholarship.
Poole, Gordon Dean, Montreal West, Que.—B.Eng., (Ci.); (one-half) Departmental Prize for Summer Essay.
Ross, Arthur LeBreton, Sault Ste. Marie, Ont.—B.Eng., (El.); Honours in Electrical Engineering; Montreal Light, Heat and Power Consolidated Second Prize.

Degree of Bachelor of Engineering

Atkinson, Thomas Martin, B.Eng., (Ci.), St. Thomas, Ont.
Backler, Israel Irving Saul, B.Eng., (Ci.), Montreal, Que.
Bailey, James Alfred, B.Eng., (Chem.), Montreal West, Que.
Bennett, Robert Douglas, B.Eng., (Chem.), Montreal, Que.
Champagne, Georges Albert, B.Eng., (Chem.), Montreal, Que.
Cumming, John Eliot, B.Eng., (El.), Saskatoon, Sask.
Dexter, Joseph Dimock, B.Eng., (El.), Brooklyn, N.S.
Dobbin, Davin Crawford, B.Eng., (Ci.), Montreal, Que.
Dunlop, Robert John Forrest, B.Eng., (El.), Montreal, Que.
Gersovitz, Frank, B.Eng., (Ci.), Westmount, Que.
Hart, Herbert Trench, B.Eng., (El.), Kingston, Jamaica, B.W.I.
Holland, Trevor Clive, B.Eng., (Ci.), Westmount, Que.
Houghton, Thomas Walter, B.Eng., (Mech.), Westmount, Que.
Johnson, Robert Ernest Lacey, B.Eng., (El.), Westmount, Que.
Jost, George Barber, B.Eng., (Ci.), Ottawa, Ont.
Lecky, William John, B.Eng., (Mi.), Montreal, Que.
Letch, Harry George, B.Eng., (El.), St. Lambert, Que.
Oleskevich, Veni, B.Eng., (Chem.), Chatham, N.B.
Parish, Charles Ernest, B.Eng., (Ci.), Hamilton, Ont.
Phillips, Frederick Rene, B.Eng., (Ci.), Westmount, Que.
Price, Harold Buchanan, B.Eng., (Ci.), Montreal, Que.
Shearwood, Alexander Perry, B.Eng., (Ci.), Westmount, Que.
Smith, Norman Janson Winder, B.Eng., (Ci.), Montreal, Que.
Watier, Arthur Hubert, B.Eng., (El.); Westmount, Que.

Degree of Master of Engineering

Arcand, Louis Joseph, B.Sc., (McGill), M.Eng., (Ci.), Montreal, Que.
Crawford, James Merrill, B.Sc., (McGill), M.Eng., (El.), Montreal, Que.
Jacobsen, Eric Rivers, B.Sc., (McGill), M.Eng., (Ci.), Montreal, Que.
Moore, William Herbert, B.Sc., (McGill), M.Eng., (El.), Montreal, Que.
Ogilvy, Robert Forrest (A.M.E.I.C.), B.Sc., (McGill), M.Eng., (Industrial), Montreal, Que.

Queen's University

Honours and Medal

Richards, Victor Lloyd, St. Thomas, Ont.—B.Sc., (Me.); Governor-General's Medal; Honours in Mechanical Engineering
Dore, Richard Francis, Ottawa, Ont.—B.Sc.; Honours in Civil Engineering.
Thomas, Charles Edwin, Hamilton, Ont.—B.Sc.; Honours in Electrical Engineering.

Degree of B.Sc.

Banjafield, Philip Grant, B.Sc., (Ci.), St. Thomas, Ont.
Climo, Percy Lloyd, B.Sc., (Me.), Cobourg, Ont.
Cotton, Charles Henry, B.Sc., (Me.), Ottawa, Ont.
Crain, Harold Fowler, B.Sc., (Me.), Ottawa, Ont.
Darling, William Stanley, B.Sc., (Ci.), Brockville, Ont.
Ehmann, John Michael, B.Sc., (El.), Regina, Sask.
Langman, John N., B.Sc., (Ci.), Aurora, Ont.
MacLachlan, James Robert, B.Sc., (Ci.), Ottawa, Ont.
Reid, John Matthew, B.Sc., (Me.), Kingston, Ont.
Smith, Carl Clifford, B.Sc., (El.), Hamilton, Ont.
Stanbury, Charles McCorkell, B.Sc., (Mi. and Met.), St. Thomas, Ont.
Turner, Alexander John, B.Sc., (Me.), Hamilton, Ont.

Nova Scotia Technical College

Honours and Medals

Baker, Max Leo, Pinehurst, N S.—B.Sc., (Me.); Honours in Mechanical Engineering; Governor General's Medal.
Pedder, Arthur William, Dartmouth, N.S.—B.Sc., (Me.); Honours in Mechanical Engineering.
Thompson, Frank Lawrence, Moncton, N.B.—B.Sc., (Me.); Alumni Medal.

Degree of B.Sc.

Akin, Thomas Bernard, B.Sc., (Ci.), Windsor, Ont.
Bayer, Douglas Thomas, B.Sc., (El.), Sydney, N.S.
Chisholm, Donald Alexander, B.Sc , (Ci.), Mulgrave, N.S.
Corkum, Perry Daniel, B.Sc., (El.), Feltzen South, N.S.
Frecker, George Alain, B.Sc., (El.), Halifax, N.S.
Hamilton, Parker Cleveland, B.Sc , (Ci.), Halifax, N.S.
Harrigan, Mayo Arthur Perrin, B.Sc., (El.), Halifax, N.S.
Hull, Roland Street, B.Sc., (El.), Woodstock, N.B.
Knodell, John Frederick, B.Sc., (El.), Halifax, N.S.
Lang, John Taylor, B.Sc., (El.), Halifax, N.S.
Lewis, Daniel Urquhart, B.Sc., (Me.), Plymouth, Mass.
Lombard, Robert Alexander, B.Sc., (El.), Malagash, N.S.
McGee, Henry Conlon, B.Sc., (El.), Big Island, N.S.
McLean, Gordon Mitchell, B.Sc., (Me.), Souris, P.E.I.
Mitchell, Lawrence Everett, B.Sc., (Me.), Campobello, N.B.
O'Leary, Bernard Augustine, B.Sc., (Ci.), Shelburne, N.S.
Pamenter, Archibald Francis, B.Sc., (Ci.), Bridgewater, N.S.
Parsons, Ezra Churchill, B.Sc., (Ci.), Walton, N.S.
Prescott, Ronald Reid, B.Sc., (El.), Wolfville, N.S.
Ross, George Victor, B.Sc., (El.), Oxford, N.S.
Spence, Earl Boyce, B.Sc., (Mech.), St. Croix, N.S.
Spence, Graydon Dill, B.Sc., (El.), St. Croix, N.S.
Stanfield, John Yorston, B.Sc., (Ci.), Truro, N.S.
Williams, Cameron Scott, B.Sc., (El.), Antigonish, N.S.

University of Toronto

Degree of B.A.Sc. (with honours)

Black, Ernest Arthur, B.A.Sc., (Ci.), Toronto, Ont.
Hendrick, Max Morton, B.A.Sc., (Me.), Toronto, Ont.
Micklethwaite, William Emruth, B.A.Sc., (Mech.), Toronto, Ont.
Moore, John Franklin, B.A.Sc., (El.), Toronto, Ont.
Southmayd, Charles Goodrich, B.A.Sc., (Me.), Toronto, Ont.
Thom, James Edwin, B.A.Sc., (Me.), Toronto, Ont.

Degree of B.A.Sc.

Ewens, Frank Gordon, B.A.Sc., (Me.), Toronto, Ont.
Fisher, John Alexander, B.A.Sc., (Ci.), Lindsay, Ont.
Heimburger, Boris, B.A.Sc., (El.), Toronto, Ont.
Lee, Frederick Sydney, B.A.Sc., (Ci.), Toronto, Ont.
McDougall, Elmer Jay, B.A.Sc., (El.), Toronto, Ont.
McQueen, Duncan Roderick, B.A.Sc., (Ci.), Collingwood, Ont.
Park, Beverley Duhig, B.A.Sc., (Me.), Toronto, Ont.
Pepall, John Ritchie, B.A.Sc., (El.), Toronto, Ont.
Porter, Joseph Gordon, B.A.Sc., (El.), Toronto, Ont.
Powell, John Giles, B.A.Sc., (Ci.), Toronto, Ont.
Smith, Herbert Malcolm, B.A.Sc., (Ci.), Toronto, Ont.
Tait, Douglas Leonard, B.A.Sc., (Ci.), Toronto, Ont.
Whytock, James William, B.A.Sc., (Ci.), Toronto, Ont.

University of Alberta

Honours and Prize

Jackson, Kenneth Arthur, Pincher Creek, Alta.—B.Sc.; Honours in Electrical Engineering; The Association of Professional Engineers of Alberta Prize.

Degree of B.Sc.

Dale, John Clapham, B.Sc., (El.), Kitscoty, Alta.
Hawkins, James Edward, B.Sc., (El.), Strome, Alta.
McKenzie, Ralph Baynton, B.Sc., (Chem.), Lethbridge, Alta.
McPherson, Ross Cody, B.Sc., (El.), Edmonton, Alta.
Orr, Walter Alyn, B.Sc., (El.), Wetaskiwin, Alta.
Reikie, Matthew Ker Thomson, B.Sc., (Chem.), Edmonton, Alta.
Stanley, Thomas Douglas, B.Sc., (El.), High River, Alta.
Story, George Lumgair, B.Sc., (El.), Edmonton, Alta.
Tollington, Gordon Charles, B.Sc., (El.), Calgary, Alta.

University of New Brunswick

Honours and Medal

Akerley, William Burpee, Saint John, N.B.—B.Sc., honours in Civil Engineering; The Ketchum Silver Medal.

Degree of B.Sc.

Brittain, Norman Westaway, B.Sc., (Ci.), Fredericton, N.B.
Gough, Robin William,, B.Sc., (Ci.), Fredericton, N.B.
Hughson, Horace Gifford, B.Sc., (Ci.), Fredericton, N.B.
Denton, Allan Leslie, B.Sc., (El.), Sanbury County, N.B.
Miller, George Grant Boundy, B.Sc., (El.), De Bec, Carleton County, N.B.

University of Manitoba

Honours and Medal

Scott, Lloyd George, Winnipeg, Man.—B.Sc., (El.); University Gold Medal.
Jones, Llewellyn Edward, Transcona, Man.—B.Sc., (Ci.); University of Manitoba Travelling Scholarship in Engineering.

Degree of B.Sc.

Capelle, William Abram, B.Sc., (Ci.), Winnipeg, Man.
Chipman, Robert Avery, B.Sc., (El.), Winnipeg, Man.
Clark, Samuel Findlay, B.Sc., (El.), Winnipeg, Man.
Hood, George Leslie, B.Sc., (El.), Winnipeg, Man.
Murray, Walter Muir, B.Sc., (El.), Winnipeg, Man.

University of Saskatchewan

Degree of B.Sc.

Lazorka, Demetrius, B.Sc., (Ci.), Saskatoon, Sask.

Dalhousie University

Diploma in Engineering

Bacon, Charles Ives, Diploma, North Tryon, P.E.I.
Fraser, Campbell, Diploma, Richmond, Que.
Hamilton, Parker Cleveland, Diploma, Halifax, N.S.
Knodell, John Frederick, Diploma, Halifax, N.S.
Matheson, Joseph Silver, Diploma, Halifax, N.S.
Taylor, Lewis James, Diploma, Victoria, P.E.I.

Ecole Polytechnique

Honours, Medals and Prize

Lanctot, Guy, Montreal, Que.—B.A.Sc., (Chem.); Silver Medallist; Silver Medal offered by "Association des Anciens Elèves de l'Ecole Polytechnique"; the Louis Bourgoin's Prize.

Degree of B.A.Sc.

Warren, Pierre, B.A.Sc., (Ci.), Pointe-au-Pic, Que.

ELECTIONS AND TRANSFERS

At the meeting of Council held on June 21st, 1932, the following elections and transfers were effected:

Associate Members

HUTCHISON, David, B.Sc., (Queen's Univ.), constrn. supt., Power Corporation of Canada, Ltd., Montreal, Que.

KREBSER, Louis E., in charge of Toronto office, Walter J. Armstrong, M.E.I.C., 1135 Beaver Hall Hill, Montreal.

LAPLANT, John Frederick, general municipal work for Town of Simcoe, Ont.

LAWSON, Horace Hetherington, (Grad., R.M.C.), Associate Professor of Surveying, Royal Military College, Kingston, Ont.

Juniors

FLINTOFF, Allan Fredrick, (Univ. of Toronto), asst. res. engr., Dept. Highways Ontario, Chatham, Ont.

NEIL, John Stuart, B.Sc., (Univ. of Alta.), dftsman and designer, City of Calgary, Alta.

PETURSSON, Hannes J., B.Sc., (Univ. of Man.), res. engr. on constrn. of Trans-Canada Highways, Dept. Northern Development, Winnipeg, Man.

TURNBULL, Donald Orton, (Grad., R.M.C.), power house engr., Masson Power Development, Masson, Que.

Affiliate

McCULLOCH, John Alexander, gen. mgr., J. A. McCulloch & Co., adjusters and appraisers for aircraft, etc., also aeronautical consultant, 134 Coristine Bldg., Montreal, Que.

Transferred from the class of Associate Member to that of Member

CLARKE, John Leonard, B.Sc., (Univ. of London), transmission and foreign wire relations engr., The Bell Telephone Company of Canada, Montreal, Que.

HARVEY, David William, B.A.Sc., (Univ. of Toronto), gen. mgr., Toronto Transportation Commission, and president, Gray Coach Lines, Ltd., Toronto, Ont.

LARIVIERE, Alex., B.A.Sc., C.E., (Ecole Polytechnique), member of Quebec Public Service Commission, Quebec, Que.

Transferred from the class of Junior to that of Associate Member

BLUE, Albert Crawford, B.A.Sc., (Univ. of Toronto), mgr., works and engrg., Riley Engineering and Supply Co. Ltd., Toronto, Ont.

Transferred from the class of Student to that of Associate Member

FRASER, Willard Bruce, B.Sc., (McGill Univ.), engrg. dept., Canadian Industries Ltd., Montreal, Que.

MOLLEUR, Gerald Avila, B.A.Sc., C.E., (Ecole Polytechnique), engr., Quebec Streams Commission, Quebec, Que.

MOORE, Lewis Nicholas, B.Sc., (McGill Univ.), asst. to divn. equipment engr., (E.O.D.), Bell Telephone Company of Canada, Ottawa, Ont.

MULLIGAN, Henry Ineson, B.Sc., (McGill Univ.), 3550 Shuter St., Montreal, Que.

SANDERSON, Edward L., B.A.Sc., (Univ. of Toronto), asst. engr., Township of North York, 97 Empress Ave., Willowdale, Ont.

Students admitted

PORTER, Joseph Gordon, B.A.Sc., (Univ. of Toronto), 41 Pauline Ave., Toronto 4, Ont.

STRONG, Robert Lloyd, B.A.Sc., (Univ. of Toronto), Perth, Ont.

BOOK REVIEWS

Principles of City Planning

By Karl B. Lohmann. McGraw-Hill, New York, 1931, cloth 6 x 9 in., 376 pp., illus., figs., $4.00.

Reviewed by A. G. DALZELL, M.E.I.C.*

In the preface to this volume it is stated: "This volume is intended to be of service to those who are studying and teaching city planning and to city officials, particularly to members of zoning or planning commissions." The book can be heartily recommended for this purpose, and it should find a place in every well stocked public library. It is, as the author says, "deep enough for practical usefulness and high enough to give the reader a sweep of vision and an exercise of his constructive imagination."

The brief history of town planning which is given of necessity refers to the old world, but the book is intended primarily to stress the development and accomplishment of the planning movement within the United States; which has mainly taken place within the last quarter of a century.

Many celebrations have taken place this year, and more will be held, to commemorate George Washington, known as the Father of his country. The technical journals of the United States have drawn attention to the surveying and engineering work done by George Washington before he became president, and the city which bears his name will always embody his vision of city planning, even though the actual planning was done by L'Enfant. It is somewhat strange that though the cities of Detroit and Buffalo were affected in some measure by the planning of Washington, all city planning, not only in the United States but in Canada, has been based on a method devised by an Englishman, the rectangular plan for the city of Philadelphia prepared by William Penn. It cannot be disputed that by following such a plan the cities of the North American continent have been saved from narrow streets and many conflagrations, but in an age when streets have to serve very different purposes than in the seventeenth century, a rectangular plan regardless of the topography, and a uniform width of street regardless of the possible traffic, has been found to be both wasteful and inefficient.

The problems of city planning are from their very nature engineering problems, but have not always been so regarded. The co-operation of the architect and the landscape architect may be very desirable, but the real problem is an economic one, and the most beautiful plans will be useless unless they can be carried out. Professor Lohmann stresses the importance of educating the public as to the value and necessity of a city plan, quoting Professor Overstreet of the department of philosophy of the College of the City of New York as advising "that city plans in any stages of their development should never be presented to the people for approval, but rather should be submitted to the voters for their consideration, and for any constructive suggestions," for, as the author says, "one must remember that permanent progress is achieved only by educating from the bottom up, rather than by supplying plans from the top down."

Robert D. Kohn, the president of the American Institute of Architects, in a recent presidential address said: "It is essential that we examine into the validity of those purposes which we have sought to attain, assure ourselves that they are still worth while working for in our own day and generation, measure the extent to which we have made progress in the past, and, most important of all, find out where we have failed to do so."

To engineers and architects who have had any share in city planning this period of unrest is a time in which thought should be given to the purpose which has controlled city planning in the past, and unless the professions can reaffirm these purposes, then it is time to consider new plans and principles, and Professor Lohmann's book will stimulate thought and stir the imagination.

*158 Redpath Ave., Toronto 12, Ontario.

Graphic Solution of Road and Railway Curve Problems with the Aid of Lemniscate Transition Curves

By F. G. Royal-Dawson. E. & F. N. Spon, London, 1932, paper, 5¼ x 8¼ in., 12 pp., figs., 6d. net.

Reviewed by C. S. GZOWSKI, M.E.I.C.*

Doubtless every engineer, whether employed in road or railway engineering has encountered alignment problems taxing his ingenuity. These may be in many cases most conveniently solved by graphical methods.

The present demand that highways be improved for greater speed, and that road hazards be eliminated requires a more specialized treatment of highway alignment than has so far developed in this country.

The author has in his pamphlet clearly shown by typical examples how alignment problems may be solved graphically with the aid of a set of lemniscate transition curves.

Professor Royal-Dawson's book on Curve Design and his pamphlet on the Graphic Solution of Road and Railway Curve Problems, particularly his treatment of lemniscate transition curves, should be a valuable addition to any draughting office dealing with highway work.

*Chief Engineer, Construction Department, Canadian National Railways, Montreal, Que.

Metal Aircraft Construction

By M. Langley. Gale & Polden, London, 1932, cloth, 5¼ x 8½ in., 240 pp., photos, figs., tables, 15/- net.

Reviewed by MARTIN J. BERLYN, A.M.E.I.C.*

This book is an important contribution to the aircraft designer's bookshelf, but is so admirably written that the mechanically-minded layman also will find in it a store of easily assimilable information.

The author modestly describes his work as a "review" of modern practice in metal construction of aircraft, but it is, in fact, a comprehensive report upon, and analysis of, the various ways in which metal has been used in the solution of the aircraft designer's problems.

One suspects that the author has the English bias against welded steel tube construction for fuselages. As a supporter of this method, the reviewer was disappointed with the slight attention given to it and believes that the author is misinformed when he confidently asserts that the welded tube fuselage is "undoubtedly heavier" than the drawn-strip-steel type.

Near the beginning of the book is a statement to the effect that the advantages of metal construction are not apparent in machines of less than 3,000 pounds weight. In this the author evidently refers to structural and manufacturing advantages, because the advantages of metal construction, from the maintenance engineer's viewpoint, are independent of the size of the machine and are overwhelming.

The book opens with a brief history of the use of metals in aircraft construction and a summary of the pros and cons.

The second chapter is full of information on the various kinds of steel and the "aluminium" alloys at present in use; and a couple of pages are devoted to a survey of the possibilities of magnesium, which, though full of promise, has not yet become a serious challenge to the materials at present in use.

The body of the book deals in turn with the main components of aircraft, and the way in which the different kinds of metal construction are applied to these several components.

Beginning with mainplanes, the author goes on to fuselages and flying boat hulls, subsidiary structures, such as landing gear and flying controls, and finally, discusses fuel tanks, which present some nasty problems when subjected to great accelerations.

The last chapter handles detail design and shop practice and is most informative.

The whole book is free from any sort of heaviness; and is copiously illustrated with excellent sketches, photos, and diagrams.

A surprising omission occurs in the author's failure to make any reference to rigid airships; or, in fact, to any lighter-than-air machines. Granting that the future of the rigid airship is doubtful, the Zeppelins were magnificent examples of metal aircraft construction and did more than anything else to foster the use of magnesium.

A particularly interesting point in rigid airship history is that metal superseded wood as a structural material right from the beginning.

One hopes that the subsequent editions of this excellent book will include a chapter on airships because some of the most startling developments in metal construction have been inspired by airship problems.

An excellent book with no sins of commission.

*Technical Assistant, Hydraulic Department, Dominion Engineering Works, Ltd., Lachine, Que.

Canadian Steel Construction

Issued by Canadian Institute of Steel Construction. First Edition, 1932. Paper, 8 by 5½ in. 96 pp. $1.50.

This handbook published by the Canadian Institute of Steel Construction contains complete information on sizes of structural steel shapes and plate which are at present rolled in Canada.

A comprehensive table of the properties and load carrying capacities of plant and angle columns is given, together with column base plates for various sizes of columns.

Technical functions of web plates, cover plates and four angles are included for the convenience of designers of built-up beams and girders.

Dimensions, functions and allowable loads for structural steel shapes rolled in Canada are also given.

In order to study the recovery of sulphur dioxide, Canadian Industries Limited erected an experimental plant at Hamilton, Ontario, where they duplicated conditions found at plants producing sulphur dioxide gases of low concentration as a waste product. Sulphur was burned and the fumes diluted to varying percentages of concentration, to simulate the waste gases of industry. This experimental plant was the development of a new method whereby sulphur dioxide may be separated from the waste gases and liquefied and has proved so successful that it is now supplying a portion of Canada's requirements for liquid sulphur dioxide. The product is shipped in steel containers and is ready for use by merely turning a valve. The process can be adapted to a much larger output, and as many times the total annual consumption of sulphur in Canada goes to waste each year in the form of gases of low concentration, the development promises to be of substantial value to the Dominion.

Canadian Industries Limited is now considering the erection of a plant for the manufacture of liquid sulphur dioxide on a large scale.

RECENT ADDITIONS TO THE LIBRARY

Reports, etc.

DEPARTMENT OF THE INTERIOR, FOREST SERVICE, CANADA:
- Bulletin No. 80: British Columbia Softwoods—Their Decays and Natural Defects.
- Circular No. 35: The Effects of Seasoning on the Buoyancy of Logs.

SAINT JOHN HARBOUR COMMISSIONERS:
- Port of Saint John, [1932].

HARBOUR COMMISSIONERS OF MONTREAL:
- Annual Report for the Year 1931.

AIR MINISTRY, AERONAUTICAL RESEARCH COMMITTEE, GREAT BRITAIN:
- Reports and Memoranda—
  - No. 1418: Addition of Rolling Moments due to Roll and Sideslip.
  - 1429: Flow of Compressible Fluid in the Neighbourhood of the Throat of a Constriction in a Circular Wind Channel.
  - 1431: Age-Hardening of Aluminum Alloys.
  - 1435: Dimensional Stability of Heat-Treated Aluminum Alloys.
  - 1439: Effects of Sideslip on Rolling and Yawing Moments.
  - 1441: Investigation of Atmospheric Turbulence by Aircraft Carrying Accelerometers.
  - 1442: Motions of a Stalled Bristol Fighter Fitted with Auto-Control Slots and Interceptors.
  - 1446: Control Column Giving Warning of Dangerous Wing Loads.
  - 1448: Full Scale Lift and Drag Curves of a Standard Seaplane.
  - 1453: The Interference on the Characteristics of an Aerofoil in a Wind Tunnel of Circular-Section.

BUREAU OF STANDARDS, UNITED STATES:
- Misc. Pub'n 133: Standards Yearbook, 1932.
- Handbook No. 16: Wood Poles for Overhead Electrical Lines.

NATIONAL ELECTRIC LIGHT ASSOCIATION:
- Prime Movers Committee, Engineering National Section:
  - Higher Steam Pressures and Temperatures.
  - Burning of Liquid and Gaseous Fluids.
- Hydraulic Power Committee, Engineering National Section:
  - Cavitation and Its Influence on Hydraulic Turbine Design.
- Motor Transportation and General Records Committee:
  - Uniform Motor Vehicle Operating Cost Classification.

UNIVERSITY OF IOWA:
- Bulletin 2: Laboratory Tests on Hydraulic Models of the Hastings Dam.

PURDUE UNIVERSITY:
- Engineering Bulletin, Research Series No. 38: Development of a Direct Contact Water Heater.

Technical Books, etc.

PRESENTED BY THE JOHN FRITZ MEDAL BOARD:
- Biography of Michael Idvorsky Pupin, Medallist for 1932.

PRESENTED BY D. M. LEGATE:
- A German-English Technical and Scientific Dictionary, by A. Webel. 1930.

PRESENTED BY MODJESKI, MASTERS & CHASE:
- Tacony-Palmyra Bridge Over the Delaware River, [63 pp., 23 plates].
- The Louisville Municipal Bridge Over the Ohio River. [47 pp., 43 plates].

PRESENTED BY JOHN WILEY & SONS, INC.
- Mechanical Fabrics, by G. B. Haven. 1932.

PRESENTED BY BRITISH STEEL EXPORT ASSOCIATION:
- British Standard Specification No. 4-1932: Dimensions and Properties of British Standard Channels and Beams for Structural Purposes (revised, March, 1932), together with a Supplement of Uniformly Distributed Loads . . . for British Standard Beams . . .

PRESENTED BY INTERNATIONAL ELECTROTECHNICAL COMMISSION:
- I.E.C. Rules for Electrical Machinery. 3rd ed., revised 1930.

PURCHASED:
- American Society of Civil Engineers, Manuals of Engineering Practice:—
  - No. 2: Definitions of Terms Used in Sewerage Disposal Practice, adopted by the American Society of Civil Engineers, July 16, 1928.
  - No. 3: Manual on Lock Valves, 1930.

Catalogues, etc.

LINK-BELT COMPANY:
- Material Handling and Power Transmission Data Sheet No. 6: Designing the Belt Conveyor—Types of Drives. [1 pp.].

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, LIMITED:
- Automatic Controls. [16 pp.].

CANADIAN OHIO BRASS COMPANY, LIMITED:
- O-B Unit-Type Coupling Condensers. [22 pp.].

CRANE COMPANY:
- The Flow of Steam Through Pipes. [23 pp.].

BRANCH NEWS

Border Cities Branch

H. J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.
B. A. Berger, S.E.I.C., Branch News Editor.

The April meeting of the Border Cities Branch was held in the Prince Edward hotel on April 15th, at 6.30 p.m.

The speaker on this occasion was Charles S. Kane, A.M.E.I.C., of the Dominion Bridge Co. Ltd., Montreal. Mr. Kane gave an illustrated address on "The Kane System of Composite Construction."

The Kane System of Composite Construction

The speaker opened his address with a brief historical sketch of building construction in which he mentioned the various floor systems in common use.

With the rapid increase in building height, fireproof construction became imperative. There were other incentives besides the fire hazard. Buildings had to be permanent as well as sanitary and vermin-proof. This led to the use of wrought iron, followed by steel and concrete.

Concrete is found to be the cheapest form of fireproofing, but when used as haunching for I-beams, its strength is usually disregarded since the action is too complicated for calculation. Incidentally, beams haunched in concrete are not painted since the former is an almost perfect preventative of corrosion.

In the Kane system, I-beams are replaced by welded trusses haunched in concrete and in which the concrete is made to bear its proper share of the load. The chords of the trusses are composed of two angles reinforced if necessary by steel rods. These chord angles are separated by a web angle which is bent continuously and welded to them.

The design of these trusses is made by the trial and error method, facilitated by the use of tables. The relation of steel to concrete must be maintained and the resulting stresses must not exceed the allowable in either material. The procedure is somewhat as follows:

The load per foot is divided into construction and live load.

The distance of the chords back to back is settled after the concrete has been determined.

The lever arms can now be estimated.

The bottom chord is figured for both construction and super-imposed load.

The top chord is figured directly for the construction load and the super-imposed load depends on the concrete strength.

The type of floor connection is influenced by the spacing of the panel points. The latter having been decided upon, the web may be determined and is usually figured for uniform load.

The super-imposed shear is taken by the concrete stem reinforced by stirrup straps.

Full continuity of the beam is obtained by joining the trusses at the point of contraflexure.

The three types of columns which may be used with this system are (*a*) full structural steel, (*b*) core column or rolled structural steel and concrete, and (*c*) the composite or structural steel, steel hoop and concrete.

The Kane system has as many advantages as the conventional type of steel construction and in addition has several others:

1. Economy due to (*a*) reduction in weight, and (*b*) saving in construction labour cost.
2. All forms are hung from the steel, thus the contractor does not have to wait for the concrete to harden but may pour several floors at once. He may also use the hardened floors as storage space.
3. Special loading conditions can be taken care of by special heavy beams.
4. Since all connections are either welded or bolted, silent erection is possible. This makes the system admirably suitable for additions to schools, hospitals, etc.
5. The built-up members obviate the necessity of heavy rolled sections, thus making possible an all-Canadian steel building.

The system is by no means confined to building construction. It is particularly adaptable to bridges due to the elimination of shoring.

Mr. Kane illustrated his address with lantern slides and followed it with a motion-picture of the shop and field fabrication procedure.

At the close of the lecture, Mr. Kane answered the numerous questions put to him by his interested audience and was unanimously accorded a hearty vote of thanks by those present.

Members of the Architectural Association and the Contractors Association were the guests of the evening.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
G. Moes, A.M.E.I.C., Branch News Editor.

Annual Meeting

The annual meeting of the Hamilton branch which was held recently was a dinner meeting held in the Royal Connaught hotel. Immediately following the dinner routine business was transacted, following which the report of the executive committee for the past year was presented. This report is given below complete with the exception of a list of meetings and a statement of membership. However those meetings occurring during 1931, and the membership at December 31st, 1931, are included in the annual Branch report published in the February, 1932, issue of The Engineering Journal.

A total of ten Branch meetings was held during the year, exclusive of meetings at which the Hamilton Branch were the guests of other organizations.

The Branch has undertaken two new departures in the field of Branch activities this year. On December 3rd the Branch was addressed by Professor W. T. Jackman on the general subject "Transportation." This was the inaugural meeting of a series of talks on the various aspects of transportation, two of which have been held, namely "Air" and "Water." The Institute fell in line with our programme by devoting a session at the annual General Professional meeting to the discussion of transportation. This programme will be continued in the Fall. At the conclusion of the series, a resume will be prepared by a committee with G. Moes, A.M.E.I.C., as chairman.

The other new activity is the sponsoring of papers prepared by committees of the Branch. The response to the request for volunteers has been very gratifying. The following is a list of the papers which are now in course of preparation, together with the names of the chairmen-authors.

Subject	*Chairman-Author*
Transportation	G. Moes, A.M.E.I.C.
The Value of Photography to Engineering	A. R. Hannaford, A.M.E.I.C.
The Status of the Engineer in Industry	J. B. Carswell, M.E.I.C.

During the year the By-laws have been revised and brought up to date.

Eleven Executive committee meetings were held during the year, with an average attendance of over seven at each meeting.

At this time it is not possible to submit a financial statement, as the Branch Year closes on May 31st and the rebates of fees have not yet been received. It is expected that a deficit of about $150.00 will be shown. This is mainly accounted for by the printing of Professor Jackman's paper, and the recently adopted policy of paying a portion of the Councillor's expenses to Council meetings. The lantern used at the meeting was purchased during the year at a cost of $150.00. A financial statement will be submitted to the Executive Committee at its next meeting after May 31st.

This report would not be complete without acknowledgment of the excellent service of our energetic chairman, E. P. Muntz, M.E.I.C., and E. M. Coles, A.M.E.I.C., chairman of Papers committee.

The chairman contributed very extensive comments on the Executive committee report in his usual eloquent manner. Following the adoption of the report a resolution was unanimously adopted confirming the actions of the Executive committee during the past year and commending them on their efforts.

Reports of the meetings and Papers committee and of the Membership committee were read. The former report was adopted and the latter report, which contained a number of controversial matters, was referred to the Executive committee for further consideration.

The chairman then announced the names of the newly elected Executive committee and requested all the members, both newly elected and continuing, to stand so that the Branch would know them. The following is a list of the new Executive committee.

Chairman	E. P. Muntz, M.E.I.C.
Vice-Chairman	H. B. Stuart, A.M.E.I.C.
Secretary-Treasurer	J. R. Dunbar, A.M.E.I.C.
Executive Committee	J. Stodart, M.E.I.C.
	W. A. T. Gilmour, Jr.E.I.C.
	E. G. MacKay, A.M.E.I.C.
	T. S. Glover, A.M.E.I.C.
Branch News Editor	G. Moes, A.M.E.I.C.
Councillor	F. W. Paulin, M.E.I.C.

The Hudson Bay Railway

The chairman then introduced the speaker of the evening, Dr. H. A. Innes, Professor of Political Science, who gave an illustrated talk on the "Hudson Bay Railway." Dr. Innes travelled as far north as Chesterfield Inlet, 600 miles north of Churchill, and thus was able to describe the nature of the country, more particularly some of the engineering difficulties connected with the building of the railroad.

The pictures of Churchill showed how complete are the grain handling facilities, but left the impression that it will be many years before it will prove to be economically sound. In the discussion which followed, the speaker thought that in a normal season of three months a total of 28,000,000 bushels of grain could be handled.

Following Dr. Innes' address the chairman tendered him a hearty vote of thanks on behalf of the Branch.

After the address an extended informal discussion took place on Institute policies and future plans of the Branch.

London Branch

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

The regular May meeting was held on the 18th, in the County Council chamber, Ridout street, the speaker being S. W. Archibald, O.L.S., A.M.E.I.C., and his subject "Development of the Sub-Arctic and Winter Location and Construction at Flin Flon, Manitoba."

The chairman of the Branch, D. M. Bright, A.M.E.I.C., presided, and introduced the speaker.

CONSTRUCTION AT FLIN FLON, MAN.

Mr. Archibald devoted the first part of his talk to a short history of the discovery, financing and later development of the Flin Flon mines. Power was required at the mines and after due consideration, it was decided to establish a hydro-electric plant at Island Falls about 58 miles distant. This required the installation of power transmission lines and it was on the layout and construction of this that he was engaged. The first installment was the erection of a small dam and power station, together with the power transmission line, at a point six miles distant from Island Falls. The work on the main power line from Island Falls to Flin Flon was done in the winter of 1928-29, the men, material and supplies being transported on sleds drawn by dog teams from camp to camp along the route. The steel towers, 50 feet high, were fabricated on the ground and erected 880 feet apart, six to the mile, and carried four cables of 16,000 h.p. capacity. Suitable foundations had to be found for these and this often caused deviations from the direct line.

Bearings, locations and levels were taken during the day time and worked out around the camp fires at night. The party was supplemented by a number of Indians and some amusement was caused by the speaker's description of their vagaries. The dogs too were an interesting feature and views were given showing teams, men and camps. Hilly country was traversed on the line of route, consequently many streams and lakes were encountered. Advantage was taken of the frozen surfaces of the latter for transportation purposes.

Mention was made and views were shown of what might be described as freight trains composed of large sleds carrying material and supplies for Flin Flon, hauled by tractors, from the Pas. Some of the loads, such as machinery, were large and heavy, but were transported without accident.

Jas. A. Vance, A.M.E.I.C., in moving a vote of thanks, said that the carrying on of work under the conditions described should make us appreciate the comforts we enjoy here.

W. R. Smith, A.M.E.I.C., seconded the vote of thanks and remarked that his experience in the bush, some sixteen or seventeen years ago, was very different and more arduous as the use of tractors was not then sufficiently advanced.

About thirty members and guests were present.

Moncton Branch

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

A meeting for the nomination of Branch officers was held on May 13th. A very pleasing ceremony took place when A. C. Selig, M.E.I.C., was informed that Council had granted him Life Membership on recommendation of the Branch executive, and the official notification presented to him by chairman, G. E. Smith, A.M.E.I.C. Mr. Selig made a feeling reply.

The annual meeting was held on May 30th. G. E. Smith, A.M.E.I.C., chairman of the Branch presided. The annual report and financial statement was presented and on motion adopted. Scrutineers R. H. Emmerson, A.M.E.I.C., and J. R. Freeman, A.M.E.I.C., reported on the balloting for election of Branch officers and it was announced that the following will act for 1932-33:—

Chairman	T. H. Dickson, A.M.E.I.C.
Vice-Chairman	H. W. McKiel, M.E.I.C.
Secretary-Treasurer	V. C. Blackett, A.M.E.I.C.
Executive Committee	H. J. Crudge, A.M.E.I.C.
	R. H. Emmerson, A.M.E.I.C.
	J. G. MacKinnon, A.M.E.I.C.
	E. V. Moore, M.E.I.C.
	A. C. Selig, M.E.I.C.
	F. L. West, M.E.I.C.
Ex Officio	L. H. Robinson, M.E.I.C.
	G. E. Smith, A.M.E.I.C.

A vote of thanks was tendered the retiring officers on motion of H. J. Crudge, A.M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C.

TWELFTH ANNUAL REPORT

The eleventh annual meeting of Moncton Branch was held on May 30, 1931.

The Executive committee held six meetings during the year. There were nine meetings of the Branch. At these meetings papers were read, addresses delivered and business transacted as follows:—

1931

Sept. 26th—A meeting was held in the Y.M.C.A. S. G. Porter, M.E.I.C., President of The Engineering Institute of Canada, addressed the Branch on matters of importance to the Engineering Profession.

Oct. 29th—A public meeting was held in the city hall. Professor H. W. McKiel, B.A., B.Sc., M.E.I.C., delivered an illustrated address on "The Origin and Constitution of the Earth."

Nov. 17th—T. H. Dickson, B.A., B.Sc., A.M.E.I.C., gave an illustrated address on the "Unit Cars of the Canadian National Railways" before the student members of The Institute at Mount Allison University, Sackville, N.S.

Nov. 26th—A public meeting was held in the city hall. Major H. W. L. Doane, B.Sc., M.E.I.C., delivered an illustrated address on "Modern Hot-mix Asphalt Pavements."

Dec. 10th—A public meeting was held in the city hall. N. T. Avard, manager of the Maritime Coal Railway and Power Co. Ltd., Amherst, N.S., read a paper on "Pulverized Coal and Its Contribution to Industry."

Dec. 16th—A joint meeting of Moncton Branch and the Engineering Society of Mount Allison University was held at Sackville, N.S. L. H. Robinson, C.E., M.E.I.C., assistant engineer, Maintenance of Way, Canadian National Railways, Moncton, read a paper on "The Engineer in Bush Country."

1932

Jan. 28th—A public meeting was held in the city hall. C. M. Anson, B.Sc., A.M.E.I.C., assistant to the general manager, Dominion Steel and Coal Corporation, Sydney, N.S., delivered an illustrated address on "The Manufacture of Steel Rails."

Mar. 8th—J. G. MacKinnon, S.P.S., A.M.E.I.C., read a paper before the student members of The Institute at Mount Allison University, Sackville, N.B., on "The Care of Surveying Instruments."

May 13th—A meeting was held for the purpose of nominating Branch officers for the year 1932-33.

In addition to the meetings listed above, a series of nine lectures were delivered before the Branch during the week of February 22nd by J. M. Portugais, B.Sc., A.M.E.I.C., technical engineer, Canada Cement Company, Montreal. There were also practical demonstrations by Mr. B. S. Boyd, chemist of the company.

Because of prevailing unsatisfactory business conditions, no supper meetings were held during the year. The attendance of members at Branch meetings was on the whole very good. Late in the season, an active and aggressive attendance committee was appointed, with J. R. Freeman, A.M.E.I.C., as chairman. This committee only functioned at the final technical meeting but it is hoped their work will be continued next year. All technical meetings were open to the public. They were always advertised beforehand in the press and, judging by the attendance, proved very popular.

Some of the best speakers in the Maritime Provinces were secured to address our meetings and much valuable information on timely subjects was presented in the papers read. L. H. Robinson, M.E.I.C., chairman of the Papers committee, is to be congratulated on the success attending his efforts.

With sincere regret we record the passing of two prominent members of Moncton Branch, William Brouard MacKenzie, M.E.I.C., a past chairman of the Branch died suddenly on March 16th. The death of Everett Thomas Cain, A.M.E.I.C., a member of the Branch executive, occurred after a short illness, on May 4th.

The following is a statement of our membership at the present time:—

MEMBERSHIP

	Resident	*Non-Resident*	*Total*
Members	9	2	11
Associate Members	21	7	28
Juniors	2	1	3
Students	39	3	42
Branch Affiliates	2	..	2
	—	—	—
	73	13	86

The thanks of the Executive of Moncton Branch are due L. H. Robinson, M.E.I.C., chairman of the Papers committee, C. S. G. Rogers, A.M.E.I.C., chairman of the Entertainment committee, J. R. Freeman, A.M.E.I.C., chairman of the Attendance committee, Mr. W. U. Appleton, general manager, Atlantic Region, Canadian National Railways, for his kind co-operation in connection with the cement and concrete lectures, and the Moncton Tramways, Electricity and Gas Company for the loan of their moving picture projector.

The financial statement of the Moncton Branch for the year ending December 31st, 1931, will be found in the section headed "Branch Reports" on page 103 of the February, 1932, issue of The Journal.

Niagara Peninsula Branch

Paul Buss, A.M.E.I.C., Secretary-Treasurer.

ANNUAL MEETING

The annual meeting of the Branch was held on May 26th at the Fox Head Inn, Niagara Falls.

Mr. Andrew E. Hay, Canadian sales manager of Pratt and Lambert, was the principal speaker, and he entitled his subject "Turning on the Power."

TURNING ON THE POWER

"Power," Mr. Hay argued, "existed today in three principal forms: mechanical power, money power and man power, of which the last is by far the most important. Without it, the other two forms could not have been conceived.

"We have within ourselves illimitable resources and reserves which have been, so far, barely scratched and upon our determination to expand these forces will depend the progress of the world.

"Modern educators are endeavouring to train the younger generation in the processes of thinking, rather than teaching them to absorb a lot of facts in a parrot-like manner. Facts, and the results of past experience, are useful as a base to start from, but it is still more important that we should move forward and this is impossible without originality.

"The training of character is also essential. Healthy bodies and healthy minds are necessary adjuncts to original thought. In modern business, honesty is still the best quality, many of the leaders considering it to be of even more value than ability.

"Peace of mind is more to be desired than great riches," urged Mr. Hay, "and peace of mind does not necessarily follow the acquisition of wealth. On the other hand the discovery of a new idea, or the perfection of some part of your work does result in an intense satisfaction and mental happiness which cannot be equalled. Money, however, is a very useful means to this end, and should not be altogether despised, but should be recognized for what it is, merely a necessary tool."

Harry M. King, M.E.I.C., proposed a vote of thanks and complimented Mr. Hay upon the ease and the delightful humour with which he had conveyed such a timely message.

Walter Jackson, M.E.I.C., chairman for his last meeting, after two years in office, introduced the new Executive before adjournment.

Ottawa Branch

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

At the last regular luncheon meeting of the Ottawa Branch for the spring season, held at the Chateau Laurier on Thursday, May 12th, the guest speaker was Maj.-Gen. Hon. Sir Newton J. Moore, K.C.M.G., V.D.

C. McL. Pitts, A.M.E.I.C., chairman of the local Branch, presided at the luncheon and in addition to the speaker and chairman, head table guests included: Hon. Charles Stewart, Col. the Hon. J. L. Ralston, Maj.-Gen. J. G. Parmelee, Senator Lorne C. Webster, Grote Stirling, M.P., M.E.I.C., Lewis Cote, M.E.I.C., J. H. Campbell, Dr. Charles Camsell, M.E.I.C., Charles Burchell, A. M. Irvine, G. J. Desbarats, C.M.G., M.E.I.C., L. L. Bolton, M.E.I.C., and Frank Neate.

Some Impressions of a Round-the-World Tour

The speaker stated that he intended in an informal way to detail some of his impressions while on a recent world-tour from England by way of Canada, New Zealand, Australia, India, and Egypt, dealing particularly with New Zealand and Australia.

He left England in August, 1931, crossed the Atlantic on the "Empress of Britain," and passed through Canada leaving Victoria, B.C., by the steamship "Niagara" going by way of Honolulu and the Fiji Islands to New Zealand. In common with other parts of the world, New Zealand is suffering from trade depression but is doing all in her power to meet the situation. The country is covered with heavy timber and a dense undergrowth, in which small areas have been cleared. Due to the advanced methods of agriculture these cleared areas are capable of twice the production of former times. Sheep raising is an important industry, and it is quite usual for as many as one thousand sheep to be pastured on 100 acres. The practice of harrowing the sheep pastures at least once a month is followed.

After several weeks' stay in New Zealand, the speaker journeyed to Sydney, Australia, where he was immediately struck with the notable developments that had taken place since he was there some twenty years ago. The capital city, Canberra, by the terms of the union of the various states, had to be at least 100 miles from both Sydney and Melbourne, the two largest cities in Australia. The speaker considered Canberra to be so isolated, so far away from the real business interests of the Commonwealth, that it was difficult for those in authority to take a broad business view of government affairs. It was even possible, in the speaker's opinion, that reconsideration would be given to the location of the capital city and that quite possibly at some future time the present site would be abandoned in favour of either Sydney or Melbourne.

In South Australia he visited Iron Mountain, where the iron ore contains from 55 to 65 per cent of the metal, and thence travelled to western Australia where he re-visited some of the localities which had interested him in his earlier life in the various offices he had held in the State government. His visit to Kalgoorlie recalled the days of 1892 when as a land surveyor he surveyed the mineral area which subsequently became famous.

After the thanks of the meeting had been extended to the speaker by the Branch chairman, an announcement was made by Dr. R. W. Boyle, M.E.I.C., chairman of the Proceedings committee, that a Colloid Symposium would be held in Ottawa from June 16th to 18th, at which some two hundred visitors were expected from the United States, the guest of honour being E. Hatschek of London, England.

Quebec Branch

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

Annual Meeting

The annual meeting of the Branch was held at 7.30 p.m. on May 9th, 1932, at the "Club des Journalistes." The meeting was preceded by a dinner and members attending greatly enjoyed themselves.

At the close of the dinner, Marc Boyer, S.E.I.C., retiring Secretary-Treasurer, read his report which was unanimously adopted.

In Mr. Boyer's report, the activities of the Branch for the past year were briefly reviewed. The Branch held ten meetings with an average attendance of about thirty-five members. Eight meetings of the council took place in the course of the past year. After the reading of the Secretary-Treasurer's report, the officers for the ensuing year were elected, the results being as follows:

Honorary Chairman	A. R. Decary, M.E.I.C.
Chairman	Hector Cimon, M.E.I.C.
Vice-Chairman	Alexandre Larivière, A.M.E.I.C.
Executive	T. J. F. King, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.
	Philippe Méthé, A.M.E.I.C.
	J. S. Bates, A.M.E.I.C.
	L. C. Dupuis, A.M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
Ex-Officio	A. B. Normandin, M.E.I.C.
Secretary-Treasurer	Jules Joyal, A.M.E.I.C.

Mr. Cimon, re-elected chairman, conveyed the thanks of the meeting to the retiring members of the Executive and to the retiring Secretary-Treasurer, for their work of the past year; he also told the meeting how he was appreciating their confidence in his ability as chairman. All members attending the meeting were called upon to say a few words.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
G. C. Clark, S.E.I.C., Branch News Editor.

The annual meeting of the Saint John Branch of The Engineering Institute of Canada was held at the Riverside Golf and Country Club on the evening of May 10, 1932. The meeting was preceded by a dinner at which John N. Flood, A.M.E.I.C., retiring chairman of the Branch, presided. The toast to the King was proposed by A. A. Turnbull, A.M.E.I.C. Alex. Gray, M.E.I.C., chief engineer and general manager of the Saint John Harbour Commission, proposed the toast to the guests, which was responded to by Brigadier J. L. R. Parsons, C.M.G., D.S.O., Officer Commanding Military District No. 7; R. G. McInerney, Commissioner of Public Safety, and F. X. Jennings representing the local press. The toast to The Engineering Institute of Canada was proposed by Sydney Hogg, A.M.E.I.C., and responded to by Geoffrey Stead, M.E.I.C., district engineer of the Dominion Department of Public Works.

The report of the Executive and financial statement for the year ending April 30th were read by G. H. Thurber, A.M.E.I.C., Secretary-Treasurer. The report showed an increase in membership of eighteen over the previous year. During the 1931-32 season seven meetings of the Branch and fifteen meetings of the Executive were held.

Other reports received were from the committees on entertainment, salaries and publicity. The reports of the auditors and committee on natural resources were deferred.

The officers of the Branch elected for the coming year were:—A. A. Turnbull, A.M.E.I.C., chairman; G. A. Vandewoort, A.M.E.I.C., vice-chairman; G. H. Thurber, A.M.E.I.C., Secretary-Treasurer (re-elected), and J. H. McKinney, A.M.E.I.C., new member of the Executive.

Following announcement of the new officers of the Branch, Mr. Flood paid tribute to the co-operation rendered him by the past year's executive and members.

After the business session, cards were enjoyed by members in the lounge of the club.

New Metal in Canada's Mineral Production

Selenium is the latest addition to the numerous refined metals now produced in Canada. A statement of the Department of Mines, Ottawa, notes that this metal is obtained as a by-product in copper refining and was produced for the first time in Canada early in 1931 at the plant of the Ontario Refining Company, Ltd., Copper Cliff, Ont. When market conditions improve, continues the statement, it is likely that selenium will also be recovered at the new refinery of Canadian Copper Refiners, Ltd., at Montreal East. Canada, it is pointed out, is now in a position to produce selenium in large quantities but the market for any output is at present restricted.

Selenium in its metallic form, is characterized by a unique action towards light which made possible the development of the photo-electric cell or "electric eye." Although this is the well-known characteristic, selenium finds its chief market in the glass industry where it is also used in the pottery industry for the same purpose. In the manufacture of rubber products, selenium serves as a vulcanizing and accelerating agent and because of reputed properties of increasing resistance to abrasion of rubber up to as much as 80 per cent, it may have a large potential market in the rubber industry. One of the most important potential uses is in the production of selenium cells for television transmission and reception.

Preliminary Notice

of Applications for Admission and for Transfer

June 20th, 1932

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, 1932.

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

GIBB—SIR ALEXANDER, G.B.E., C.B., of London, England, Born at Broughton Ferry, Scotland, Feb. 12th, 1872; Educ., University College, Univ. of London, 1890-91; 1891-95, indentured pupil to Sir John Wolfe Barry, K.C.B., F.R.S., and H. M. Brunel; 1895-96, chief asst. to res. engr., East Dock, Barry; 1896-98, res. engr. for Sir John Wolfe Barry on Metropolitan Rly. widening between Aylesbury and London for Great Central Rly., etc.; 1898-1900, res. engr. on design and constrn. of Whitechapel and Bow Underground Rly.; 1900-1916, managing director, Easton Gibb & Son, Public Works Contractors, work included full responsibility for constrn. of King Edward VII Bridge over the Thames, Alexandra Docks and Deep Lock Entrance at Newport, Mon., Wales; also constrn. of H.M. Naval Base at Rosyth, Scotland; War Service; 1916-18, as Colonel in the Royal Engrs., chief engr., port constrn., to the British Armies in France and Belgium, and Deputy Director of Docks; 1918-19, as Brig.-Gen., Royal Marines, chief engr. for the reconstruction of the ports of Belgium, including Ostend, Zeebrugge and the Bruges Ship Canal; Govt. Service: as civil engr. in chief of the Admiralty, responsible for all engrg. work of H.M. Dockyards and Ports; 1919-21, as director general of civil engrg., to the Ministry of Transport, responsible for control and supervision of all civil engrg. work in connection with all rlys., docks, harbours, canals and waterways in Great Britain and Ireland; 1922 to date, senior partner, Sir Alexander Gibb and Partners, London, England. Consltg. engrs., engaged particularly in dock and harbour engrg., river training, hydro-electric works, dams and bridges. 1931-32, carried out survey of national ports of Canada for the Dominion Government.

References: G. H. Duggan, H. H. Vaughan, R. A. Ross, A. Surveyer, J. C. Smith, C. H. Mitchell, J. M. R. Fairbairn.

GONZALEZ—LOUIS CARLOS, of 1610 Sherbrooke St. West, Montreal, Que., Born at Bogota, Colombia, S.A., Nov. 19th, 1905; Educ., B.Sc. (Civil), McGill Univ., 1930; Summers, 1926-27, rodman, dftsman., surveying and dfting., for P. A. Beique, A.M.E.I.C.; 1927, carpentry shop asst., Fraser Brace Co.; 1928, mapping, dfting., Southern Canada Power Co.; 1930 to date, surveying, computing, dfting. designer, Beauharnois Construction Co. Ltd., Montreal.

References: M. V. Sauer, L. H. Burpee, J. A. Knight, R. H. Reid, E. Brown.

GROSS—PHILIP NORCROSS, of Toronto, Ont., Born at Worcester, Mass., July 1st, 1901; Educ., B.Sc., McGill Univ., 1926; 1920-26, timekpr., material clerk, etc., during summers, with Anglin-Norcross Ltd.; 1926-29, engr., Toronto office, Anglin Norcross Ltd., 1929-32, Ontario Manager, Anglin-Norcross Ltd., and at present, vice-president and manager, Anglin-Norcross Ontario Ltd.

References: J. M. R. Fairbairn, A. H. Harkness, C. S. L. Hertzberg, L. deB. McCrady, E. P. Muntz.

HIELD—RICHARD FRANK, of Montreal, Que., Born at London, England, Oct. 13th, 1902; Educ., 1918-24, Northampton Polytechnic Inst. (evenings); 1915-17, fitter, Parkinson & Co., London; 1917-18, turner, Handley Page, aeroplane mfrs., London; 1918-21, armature winder; 1921-24, sales engr., Electrical Engineering & Equipment Co., London; 1924-27, sales engr., with full responsibility in carrying out of wiring and plant installations, Power Contracts, Ltd., London; 1927-30, sales engr., with full responsibility under factory design depts., Crompton Parkinson Ltd.; 1930 to date, sales mgr., with full responsibility for design and installn. of various types of electr'l. equipment, Crompton Parkinson (Canada) Ltd.

References: J. L. Busfield, C. V. Christie, P. S. Gregory, G. E. Newill, F. S. B. Heward, A. Laurie.

LeBAS, LEOPOLD CHARLES, of Edmonton, Alta., Born at St. Heliers, Jersey, Channel Is., Aug. 7th, 1882; Educ., 1st Class B.O.T. Cert., London, Eng., 1906. 1st Class Alberta Stationary Engrs. Cert., 1914; 1898-1902, ap'ticeship at Troup Curtis & Co., elect'l. engrs., London, Eng.; 1902-04, ap'ticeship, Robertson & Co., marine engine works, Albert Docks, London, Eng.; 1904-13, 2nd, 3rd and 4th engr. in charge of watch; 1915-16, in charge of intermediate inspection of machined work for submarine engines, Vickers, Ltd., Ipswich, England; 1916-18, asst. head inspr. of machine work, gauges, jigs, etc., Thwaites Bros., Bradford, Eng.; 1919-20, chief engr., City of Medicine Hat power plant; 1920 to date, chief engr., City of Edmonton power plant.

References: A. Ritchie, W. J. Cunningham, V. Pearson, R. J. Gibb. W. R. Mount.

MARTIN—EDWARD NEWCOME, of Montreal, Que., Born at York, Ont., June 6th, 1882; Educ., B.Sc., McGill Univ., 1905; During vacations with Dominion Coal Co. Ltd., Steel Co. of Canada, Crows Nest Pass Coal Co., Granby Cons. Smelting Co.; 1905-06, director, summer school of surveying and metallurgy, McGill University; 1905-07, with Smith, Kerry & Chace, Consltg. Engrs.; 1907-08, asst. engr., E. A. Walberg; 1908-12, mgr., Walker Fyshe Co. Ltd.; 1912-14 mgr., Fyshe Martin Co. Ltd.; 1914-19, mgr., Energite Explosive Co. Ltd.; 1920-29, mgr., Gold Dust Corpn. Ltd.; 1929-30, mgr., David N. Finnie & Co.; at present, manager for Canada, British Steel Export Association, 1538 Sun Life Bldg., Montreal, Que.

References: G. R. MacLeod, J. B. D'Aeth, R. S. Lea, J. G. G. Kerry, R. J. Durley, H. R. Little, W. S. Lea.

MASSE—FERNAND ANDRE, of 301 Beverley St., Sault Ste. Marie, Ont., Born at Sault Ste Marie, July 8th, 1908; Educ., B.A.Sc., Univ. of Toronto, 1931; 1929 (summer), surveying for Dept. Northern Development; Summer 1930, in labs. of Abitibi Paper Company, and Sept. 1931 to date, asst. chemist with same company.

References: A. H. Russell, G. H. E. Dennison, H. F. Bennett, A. A. Rose, A. L. Farnsworth.

ROBERGE—ANTONIO, of 5 Belvedere Ave., Que., Born at St. Bartholemew, Que., July 12th, 1900; Educ., B.Sc. (Chem.), Ecole Polytechnique, Montreal, 1926; 1924 (4 mos.), topog'l. survey, Ottawa; 1925 (4 mos.), 1926 (6 mos.), geodetic survey, London, Ont.; 1926-29, on engrg. staff, Canadian Celanese Co. Ltd., Drummondville, Que. Work included constrn. and mech'l. drawings, dfting office, asst. to erecting engr., in charge of machy. installn., and as asst master mechanic; 1929-31 with Z. Langlais, A.M.E.I.C., consltg. engr., Quebec, on reinforced concrete design of bldgs., dams, retaining walls, etc.; 1932 (Feb.-May), temporary work with Quebec Streams Commission; May 1932 to date, res. engr., Battlefields Reservoir, City of Quebec.

References: A. Frigon, O. O. Lefebvre, J. A. Lalonde, H. Cimon, Z. Langlais, T. J. Lafreniere.

VOKES—CHRISTOPHER, of Regina, Sask., Born at Armagh, Ireland, Apr. 13th, 1904; Educ., Grad. R.M.C., 1925. B.Sc. (Civil), McGill Univ., 1927. 1927-29, Course at School of Military Engineering, Chatham, England; 1925, Lieut., R.C.E., 1929, promoted Capt., and stationed at Winnipeg until 1931; March 1931 to date, Dist. Engr. Officer, M.D. No. 12, Regina, Sask.

References: A. C. Garner, S. R. Parker, A. P. Linton, J. W. D. Farrell, R. H. Murray, G. R. Turner.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BISHOP—REGINALD WORTH, of Hamilton, Ont., Born at Owen Sound, Ont., Mar. 18th, 1884; Educ., Grad., R.M.C., 1903; 1903-05, rodman, topogr., and transitman, 1905-06, asst. engr., mtce of way, 1906-08, res. engr., mtce. of way, C.P.R., Ottawa; 1908-14, partner, Bishop & Buchannan, contractors; 1915-1919, C.E.F., Dist. Engr. Officer, M.D. No. 1. London, Ont.; Lt.-Col., Can. Engrs.; 1919-25, mgr., Bishop & Pringle, Ltd.; 1925-29, Supt. for the following contracting firms: E. C. Goldie, Ltd., Toronto, J. A. Vance, A.M.E.I.C., Woodstock, J. R. Page, Toronto, Nelson River Co., Toronto; 1930, partner and supt., J. D. Armstrong Co. Ltd., Hamilton, Ont.; 1930 to date, bridge engr., City of Hamilton, Ont. (*S. 1903, A.M. 1907.*)

References: C. R. Coutlee, A. J. Grant, H. L. Trotter, H. J. Lamb, W. L. McFaul, R. K. Palmer, E. M. Proctor.

STUART—WILLIAM HENRY, of Montreal, Que., Born at Cheltenham, England, Aug. 2nd, 1888; Educ., 1905-06, 1907-08, 1914-15, studied Arts and Engrg., Univ. of Minnesota; 3 mos. study at Oxford Univ. during convalescence; 1905 (June-Oct.), Apr. 1906 to Oct. 1907, Apr. 1908 to Mar. 1912, rodman, instr'man., dftsman., transitman, calculator, bridge inspr., G.T.P. constrn., Edmonton to Prince Rupert; Mar. 1912 to Aug. 1914, res. engr., G.T.P. Ry.; 1916-18, overseas, 2nd Candn Tunnelling Co.; 1919-21, res. engr., and 1921-26, res. engr. in charge constrn. and design of water supplies and assigned to special study of engrg. work, C.N.R., Winnipeg; Mar. 1926 to date, supt. of facilities, covering all engrg. and bldg. in connection with the Hotel Dept., C.N.R., also Sleeping, Dining and Parlor Car Dept., in charge of civil and mech'l. engrg. of two depts. (*A.M. 1919.*)

References: J. Callaghan, J. L. Busfield, C. Ewart, R. A. Black, A. J. Gayfer, F. S. B. Heward, A. L. Ford.

FOR TRANSFER FROM THE CLASS OF JUNIOR

FLEMING—CANMORE DRAKE, of Toronto, Ont., Born at Windsor, Ont., Jan. 2nd, 1899; Educ., B.Sc. (Mech.), McGill Univ., 1924; 1925 (summer), with Whitehead & Kale, River Rouge, Mich.; 1926-27, United Fuel & Supply Co., Detroit, Mich.; 1927 to date, with Anglin Norcross Limited and Anglin Norcross Ontario Limited, work included supervision of machy. installn. and foundations and minor constrn. works, and charge of constrn. equipment. (*S. 1924, Jr. 1928.*)

References: F. P. Flett, J. M. R. Fairbairn, G. E. Evans, W. A. Messenger, H. A. Bodwell, C. M. McKergow.

FOR TRANSFER FROM THE CLASS OF STUDENT

CORNISH—CHARLES RISCHMAN, of 323-26th St. East, North Vancouver, B.C., Born at Vancouver, Mar. 22nd, 1905; Educ., B.A.Sc. (Civil), Univ. of B.C., 1929; Sept. 1924 to Sept. 1925 and summers 1926-27-28, rodman and instr'man., City of Vancouver; 1929-31, hydrometric recorder, Dom. Water Power and Hydrom. Bureau, Vancouver, in charge stream gauging in Cariboo district; 1931 (June-Dec.), instr'man., highway constrn., National Parks of Canada. (*S. 1928.*)

References: W. B. Young, W. H. Powell, C. E. Webb, G. H. Whyte.

EMERSON—ROBERT ALTON, of Kenora, Ont., Born at Plum Coulee, Man., Apr. 12th, 1911; Educ., B.Sc. (C.E.), Univ. of Man., 1930; Summers 1928-29-30, rodman, inspr. of rock ballast, transitman, C.P.R.; 1930-31, instructor, Univ. of Man.; Aug. 1931, transitman, and Sept. 1931 to date, locating engr., Dept. Northern Development, Kenora, Ont. (*S. 1929.*)

References: J. N. Finlayson, G. H. Herriot, R. W. Moffatt, S. C. Wilcox, J. C. Holden, A. M. Mills.

LUCAS—JOHN WILLIAM, of Ottawa, Ont., Born at Toronto, Ont., June 6th, 1906; Educ., B.Sc. (Civil), 1930; Summers, 1924-29, rodman, levelman, and instr'man., Highways Branch, Alta. Govt., 1928, with Con. Mining & Smelting Co., Trail; 1930-31, rodman, Beauharnois Construction Co.; 1931 to date, tester of bldg. materials, Dept. Public Works, Ottawa, Ont. (*S. 1928.*)

References: E. Viens, P. G. Gauthier, W. H. Norrish, R. S. L. Wilson, R. W. Boyle.

MacDONALD—MURRAY VICKERS, of Swift Current, Sask., Born at Fort William, Ont., June 16th, 1910; Educ., B.Sc. (Civil), Univ. of Sask., 1931, D.L.S., S.L.S.; Summers 1925-26-27, municipal engrg. and surveying; Summers 1928-31, land surveying, Reilly & MacDonald; Fall of 1931 to date, with City of Swift Current, establishing street grades and on minor engrg. works. (*S. 1931.*)

References: P. J. MacDonald, C. J. Mackenzie, G. M. Williams, R. A. Spencer, A. R. Greig.

SCHULTZ—CHARLES DAVIES, of Vancouver, B.C., Born at Vancouver, Oct. 26th, 1904; Educ., B.A.Sc. (Forest Engrg.), Univ. of B.C., 1931; Summers, 1924-25, compassman and topog'r., 1926-27-28, timber estimator and reconn. man, Forest Surveys Divn.; 1929 (summer), P.G.E. Resources Survey; 1930 (summer), asst. party chief, Elk Forest survey, and 1931 to date, asst. party chief, South Kamloops survey, working on compilation of field notes and reports, etc. (*S. 1928.*)

References: C. R. Crysdale, W. H. Powell, H. L. Swan, R. W. Hibberson, J. H. Blake.

Progress in Gas-Driven Vehicles

Recent reports and articles seem to point to the fact that the technical problems in connection with the use of compressed coal gas as a fuel for motor vehicles have been partially overcome, says a recent article in Motor Transport. In various parts of France especially, motor transport vehicles are to be found operating exclusively on compressed gas. Amongst these there are two Paris gas-driven buses which have been in operation now for three years, covering about 35 miles a day on one charge of gas. The engines are of rather an old type and have had their compression ratio increased from 4.25 to 5.4 Slow running and acceleration are better than with liquid fuel; hill-climbing has been improved; deposit on the piston heads is rather less and there is, of course, no dilution of crank case oil.

Compressed gas was first used in 1927 when light-weight bottles, wire bound, electrically welded and weighing between 66 and 77 pounds made their appearance. At the present time light chrome-nickel steel bottles are sometimes used, but mild steel bottles are more commonly employed.

Before the gas can be admitted to the engine, its pressure has to be reduced either to, or just above, atmospheric pressure. The Panhard and Levassor Company has developed a type of reducing valve and mixing chamber which has given very good results. On this the reducing valve only acts when the engine is in operation. The Paris Gas Company has developed another type of reducing valve and gas mixer which is used on its own vehicles and which has been demonstrated in several French competitions.

In the various demonstrations carried out in France, gas of widely different value has had to be used ranging from town illuminating gas at 4,500 calories to methane gas at 7,250 calories per cubic m. Because of these variations an air adjustment is essential to proper working, although, of course, if the vehicles were always in operation around one centre, this adjustment would be very slight.

As an indication of the gas consumption, one of the Paris buses with a total weight of 7 tons has a gas consumption ranging from 0.800 to 0.830 cubic m. per km. on town illuminating gas, improving to 0.325 cubic m. per km. on methane.

Considerable progress has been made in the manufacture of high tensile alloy steel bottles for storing gas under very high pressure and the latest patterns are now about 60 per cent of the weight of those previously employed.

The results of various tests have shown, without question, that the thermal efficiencies obtainable with town gas are superior in many ways to those obtained when running on petrol. It has also been noticeable that with town gas the average carbon monoxide content of the exhaust gases is very much lower than when running on petrol.

—*The Gas Engineer.*

High-Speed Propelling Engines

Much has been said lately concerning the tendency towards the adoption of higher speeds for internal combustion machinery for ships as well as on land, and a notable example of this trend in engineering design will be found in the new cross-channel motor-ship which has been ordered in Belgium for service between Dover and Ostend. Like the turbine ships now operating on this route, this vessel has to cover the distance between the two ports in about three hours, at an average speed of 22 knots. Two Sulzer motors, each of 7,500 B.h.p., are to be installed, this power being developed at 258 r.p.m. Actually the engines must attain a maximum of 17,000 B.h.p., a remarkable figure in a ship of very slightly over 3,000 tons gross. Comparisons with a geared turbine installation show that the weight of machinery for the two classes of plant is approximately the same, and that there is not much difference in the space required, the advantage being on the side of the internal combustion machinery. That one of the usual two funnels can be dispensed with is somewhat of an advantage from several points of view in a ship in which deck space is valuable.

The engines are of the single-acting two-stroke design, with twelve cylinders 580 mm. in diameter with a piston stroke of 840 mm. The notable feature of this plant is the relatively high piston speed, which is in the neighbourhood of 1,400 feet a minute. It would appear that Diesel engine designers no longer fear high piston speeds which a few years ago were considered detrimental to reliability. The actual weight of the propelling engines is in the neighbourhood of 50 pounds to 60 pounds per B.h.p. which, although not so remarkable as in the double-acting two-stroke high-speed machinery of the German motor battleship "Deutschland," is in marked contrast to the usual 120 pounds to 200 pounds of normal mercantile engines.

The auxiliary generating plant will also be of the high-speed type, the four 450-kw. units turning at 550 r.p.m. They do not, however, represent a new design, since such machinery is already utilized on Diesel-electric locomotives. It will probably be found that the total machinery weight, including propellers, shafting and, in fact, everything relating to the machinery department will be in the neighbourhood of 700 tons, which represents a considerably lower figure per B.h.p. than has previously been attained in any mercantile Diesel ship—*Times Trade and Engineering Supplement.*

Zuyder Zee Reclamation

The tremendous reclamation project whereby half a million acres of farm lands will be added to the arable area of the Netherlands, is well on its way to completion through the main closing of the embankment from Wieringen Island to the Freisland coast. This closing took place on May 28th last, making the former Zuyder Zee Yssellake.

This main embankment was started in 1927, is 18½ miles long, 120 feet wide at the top and 400 feet wide at the sea bed. It contains sluices and locks with a roadway and railway, which are yet to be constructed, on the top.

The area enclosed by this embankment, which prevents the entrance of the North Sea into the centre of the Netherlands, is divided into four main sections, or polders, making up the arable land, with another 270,000 acres forming Yssellake into which the Yssel river flows with a normal discharge of some 6,750 cubic feet per second.

Of the four polders projected, the one in the northwest section has already been reclaimed and covers a surface of approximately 50,000 acres, one fourth of this area being already under grass or cultivation at the present time.

In view of the present financial situation in Holland, however, the Dutch parliament has decided to postpone work on the other three polders for the time being.

In connection with the northwest polder, it is interesting to note that the enclosure of this section was completed for economic reasons in 1930, with the Zuyder Zee still open to the sea. The embankment for this section was 11 miles in length, and was necessarily made stronger than is intended in the case of the others.

Two pumping stations for the draining of this section were opened in 1930 and commenced removing water from the polder which was covered to a depth of about 15 feet, at the rate of 884,500,000 gallons a day.

One pumping station, located at Medemlik, is electrically operated, with three, motor-driven, horizontal centrifugal pumps, each having a capacity of 86,000 gallons per minute. The other station, at Den Oever, is a Diesel engine station, with two vertical centrifugal pumps driven by 400-600 b.h.p. engines, using gas oil, each pump having a capacity of about 61,000 gallons per minute.

The whole project dates from eighty years ago, but the actual work commenced in 1918 after a most extensive study had been made as to the effects of tides in the area to be enclosed and the probable effects of this enclosure on the surrounding lands.

The total cost of enclosing this area has been estimated at $44,000,000, and that of reclaiming the four polders, including compound interest on loans, $186,000,000. The returns have been estimated at $205,000,000.

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Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

MECHANICAL ENGINEER, Jr.E.I.C. Univ. Toronto '22. A.A.S.M.E. Diversified experience, one year teaching, three years Canadian Westinghouse Co., past four years in charge of mechanical laboratory of leading manufacturer in U.S.A. Sound technical knowledge and good organizing and executive ability. Wishes to return to Canada. Position with industrial or commercial laboratory. Apply to Box No. 138-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. At present employed. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, B.A.Sc., C.E. of Toronto, P.E. of N.B., desires employment. Experience includes three years on highway pavements, six years on city pavements and bridges, as well as general municipal engineering, two years on railway construction, four years on mining, assaying and drainage work. At present near Saint John, but willing to go anywhere. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

CIVIL ENGINEER, A.M.E.I.C., age 40, experienced in structural and mechanical design and mill construction, desires connection with engineering, manufacturing or sales organization. Apply to Box No. 334-W.

CIVIL ENGINEER, A.M.E.I.C., married, thirty years experience in municipal engineering, highway and pavement work, also qualified sanitary engineer. For the past twenty years engaged as construction engineer on large works, including buildings, sewerage and water systems. Experienced executive and up-to-date methods used. Permanent position desired as engineer or superientendent. Location immaterial. Available at once. Apply to Box No. 336-W.

ENGINEER, age 30, with experience as railway instrumentman, assistant engineer on erection of large buildings, and mechanical, structural and railway draughting and design, desires position in Ontario. At present engaged in surveying for a township; available immediately. Qualified Captain in military engineering. Apply to Box No. 377-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and movable structures. General experience in the building trades. Apply to Box No. 399-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 29, married; experience over the last nine and a half years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations of hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial, available at once. Apply to Box No. 477-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

CHEMICAL ENGINEER, graduate of McGill University, Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in design, manufacture, sales and installation of pulp and paper, also mining machinery, seeks association with firm as sales engineer. Apply to Box No. 633-V.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C., Experience: Installation staff Can. Gen. Elect.; student's test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

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ELECTRICAL ENGINEER, B.Sc. '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experienced in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power

Situations Wanted

plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc. (Univ. of Man. '31), age 22. Experience includes two months surveying and two summers draughting maps and treated timber bridges with highway department. Interested in manufacture of electrical equipment, water power engineering, radio and telephone, highway engineering. Available on one month's notice. Apply to Box No. 747-W.

MINING ENGINEER, university graduate '30. Experienced in surveying, mapping, assaying, examination of prospects, diamond drilling and a season on Dominion Geological Survey. Employed at present but available on short notice. Apply to Box No. 748-W.

SALES ENGINEER, BSc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available shortly. Apply to Box No. 749-W.

CIVIL ENGINEER, M.A. (Cantab.), A.M.Inst. C.E., A.M.E.I.C. Age 27. Unmarried. Three years experience on hydro-electric construction, tunnels, dams, penstocks, etc., geodetic and general surveying. Three years experience on design of hydro-electric structures and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 751-W.

CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.), D. and S.L.S. Age 28. Available May 15th to September 15th. Will consider any offer for above period. Ten years experience in highway, drainage and railroad engineering; surveying of all types; sewerage and waterworks design; sales and newspaper work. Owns a car and has a thorough knowledge of prairie provinces. Apply to Box No. 760-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box 770-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monumental and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

ELECTRICAL ENGINEER AND AVIATION PILOT, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

SALES REPRESENTATIVE. Electrical engineer with ten years experience in power field interested in representing established firm for electrical or mechanical product in Montreal territory. Excellent connections. Apply to Box No. 795-W.

MECHANICAL ENGINEER, S.E.I.C., B.Sc. (Queen's '32). Age 23. Single. Three years as moulder's helper, machinist, etc., in foundries, machine shops and hydro-electric construction; also field and office draughting on power house construction. Good references. Available at once for summer work. Apply to Box No. 797-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in Municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

CIVIL ENGINEER, B.A. (Mech. Sc. Trip.): late mathematical scholar (Pet. Cambridge); Jr.E.I.C., age 28, graduated 1926. Extensive experience in all phases of hydro-electric development embracing design, field work, supervision, and contractor's office work, both in Britain and Canada. Also as resident engineer on large road contract in Scotland. Would work, and secure useful introductions, in any part of the world. Available June 15th. Apply to Box No. 801-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C. with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available the 1st of July, will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (Queen's '32), age 21. Three summers surveying in Northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available on short notice. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married: experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

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Oil Circuit Breakers

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Paper presented before the Peterborough Branch of The Engineering Institute of Canada on January 28th, 1932.

SUMMARY.—Discussing briefly the general principles involved in the operation of oil circuit breakers, the paper describes the application of these principles in recent practice, and analyses the results obtained, particularly with regard to speed of operation and the size of the circuit breakers required for a given capacity.

During the last three or four years there has been a marked increase in activity in connection with oil circuit breaker design, and there have been more constructive articles in the technical press in those few years than in the whole previous life of oil circuit breakers. This desirable condition is due partly to the increasing willingness of large utilities to lend their systems for testing purposes, and partly to the increase in number and size of manufacturers' testing laboratories devoted to research work on oil circuit breakers.

A 100,000-kv.-a. 13,200-volt testing generator is installed at the General Electric Company's high power laboratory in Schenectady, also step-up transformers giving voltages up to 265 kv. The generator is designed to take full advantage of the stored energy in rotating parts and it is possible to obtain six to eight times normal rating under short circuit conditions. The recovery voltage conditions are very severe, more so than are likely to be met in actual service. Typical values are 1,200 volts per m.s. at 14,500 volts and 2,800 volts per m.s., at 110,000 volts. The set has been in operation since the early part of 1927 when it took the place of a smaller set that had been in service for some years previously.

The refinements of design to bring about freedom from oil throw and to reduce the total overall operating time of high tension breakers to 8 cycles or less on a 60-cycle basis, have been particularly notable and universal. Real progress has been made in the United States in the development of simplified rating schedules, for voltage, current and rupturing, thus benefiting both the user and manufacturer because of the fewer varieties. It is regrettable that Canada has been backward in this regard.

A great deal of research work has been done on interrupting means for A.C. circuits other than oil circuit breakers, these include the vacuum breaker, the deion circuit breaker, the gas blast breaker and the expansion breaker. Much work has also been done on non-inflammable substitutes for oil. Although there are known to be a number of deion air breakers in operation at 12-kv. and a number of gas blast breakers mostly 6-kv. and 10-kv. in operation in Europe, the supremacy of the oil circuit breaker is not at the moment seriously threatened. One very good reason for this lies in the high dielectric strength of oil (approximately 200,000 volts per inch at normal frequencies, and 600,000 volts per inch on an impulse basis). Gas in comparison has a maximum dielectric strength of around 50 kv. per inch. Insulation problems appear to be the chief limitation of all oilless breakers.

In the case of a high voltage arc sprung in air the arc may be interrupted at some indeterminate time, due to attenuation, or due to accidental air turbulence inserting sufficient insulation so that the recovery voltage cannot re-establish the arc.

The same circuit under oil springs a radically shorter arc and the gas and arc products are confined in a gas bubble that takes on the shape of the containing vessel if confined and continues until the collapse of the gas bubble or there is sufficient turbulence to permit the oil to flow in and interrupt the oil circuit at the zero point of the current wave.

The most severe conditions imposed upon an oil circuit breaker are met when the power factor of a short circuit approaches zero. Under these conditions the generated voltage is nearly a maximum at the moment of current zero. Most short circuits are of low power factor but luckily there is always some electrostatic capacity in the connected apparatus and it is not a case of a circuit of pure reactance where the voltage would recover instantly. Immediately following the current zero, the voltage across the circuit breaker must rise from practically zero to the generated value. This rise occurs as an oscillation the form of which will be determined by the electrostatic capacity and reactance of the connected circuit. Some peaks of the oscillation may rise considerably above the generated voltage peaks.

Fig. 1 is an example of the wave shapes obtained. Since the recovery voltage depends in the speed of the rise and its magnitude on such factors as reactance of the system and capacitance and characteristics of the connected machinery, it is subject to wide variations, the peak being reached anywhere from a minimum of two or three microseconds up to two or three milliseconds. If an oil circuit breaker is to function satisfactorily the design must be such as to give a rate of increase of dielectric strength in the arc path after the current zero, greater than the rate at which the recovery voltage is impressed across the path. Tests have shown conclusively that the severity of the duty on an oil circuit breaker increases with increased speed of voltage recovery. Due to this marked difference in performance of oil circuit breakers under different rates of voltage recovery it might appear desirable from some standpoints for manufacturers to offer two breakers, one

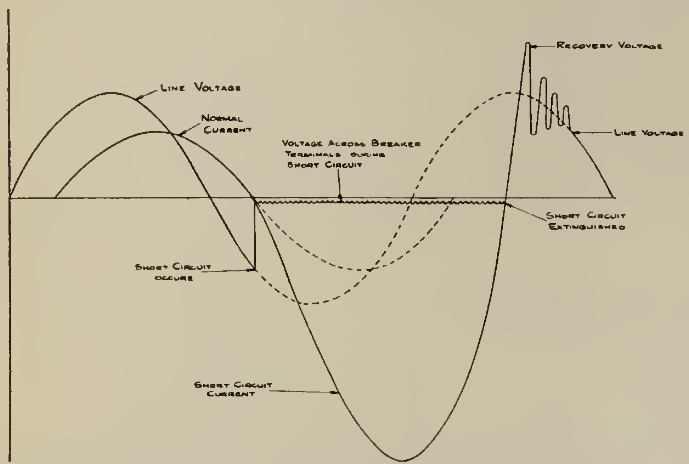

Fig. 1—Diagram of Arc Extinction and Recovery Voltage.

design for line switching where recovery conditions are best and another and more costly design for generator switching. Such duplication of design would actually be very undesirable both from the manufacturers' and users' viewpoints, so that conservative designers have followed the practice of building breakers good for the worst conditions.

Recent and successful endeavours have been made along the lines of producing breakers that are much less sensitive to changes in recovery rate within the limits usually encountered. Before describing these recent designs tribute should be paid to some of the early designers of oil circuit breakers. One frequently meets the opinion that it is only in very recent years that rational oil circuit breaker designs have become available. In fairness to the early designers this impression should be corrected. One of the most effective heavy duty designs available to-day incorporates unchanged basic design that was evolved over twenty-five years ago. This is especially noteworthy when one considers the entire absence of research and testing facilities at that time.

The objective of breaker designers in recent years has been mainly to devise ways and means to make more efficient use of the oil in the prevention of arc re-establishment after a current zero. No designers known to the author attempt to rupture the arc at any other point. There is some disagreement on the relative merits of gas and oil in arc rupture, but is it felt that since oil has a dielectric strength many times that of the gases formed by an arc in oil, that any arguments presented on the value of blasting gas through the arc products apply with even greater force when oil is the dielectric blasted across the arc products. This is why the developments in the following paragraphs all employ solid oil, instead of mixed gas and oil, as the interrupting medium. These developments are all forms of the basic idea that in addition to guiding and controlling the oil and arc, best results are obtained when adequate pressure is present at the moment the main arc is sprung.

Fig. 2 shows the now well-known oil blast explosion chamber. This consists of an upper butt contact *A* — an intermediate contact *B* and a hollow contact *C*. In the closed position these three contacts are pressed together under heavy pressure. When the breaker is tripped the contacts *B* and *C* move together away from contact *A* and in so doing draw a short arc between *A* and *B*. This arc forms gas and places the oil in the explosion chamber under pressure for which there is very little relief until contact *B* reaches its stop. A second arc then starts between *B* and *C*. Successive half cycles of arc at a given current flow, add definite amounts of gas to the volume surrounding the upper arc and provide continuously increasing pressure available to act on the gas bubble, surrounding the lower arc. As soon as the gas generation around the lower arc is less than the escape of gas to the outside of the chamber, pressure from the upper arc will close in the oil walls surrounding the lower gas bubble, finally displacing the arc products by solid oil of high dielectric strength. If the first current zero — due to high recovery voltage rate or other causes—does not give the final interruption the next current zero finds a longer oil barrier pushed into place by greater pressure—and so on till interruption. Even when the arc is drawn beyond the chamber throat this action is still effective to clear the circuit. Many laboratory and field tests have been made on this design and a definite gain is shown over the old style explosion chamber contacts. A straight line can be drawn between the arc durations of these two types of contacts—there is no overlapping.

A number of 138-kv. breakers with oil blast explosion chambers are already in service in Canada. This type of contact can readily be applied to existing explosion pot breakers. The reaction from the pressures in the plain explosion chambers or the oil blast explosion chamber are nearly in line with the bushings, thus placing the bushing in compression rather than applying a bending stress.

Fig. 3 shows another application of the general principle. This is a 15,000-volt breaker with rectangular tank that may be either three poles in one tank or separate tanks per pole. The contacts in this case are enclosed in an insulating chamber with an outlet directly in front of one

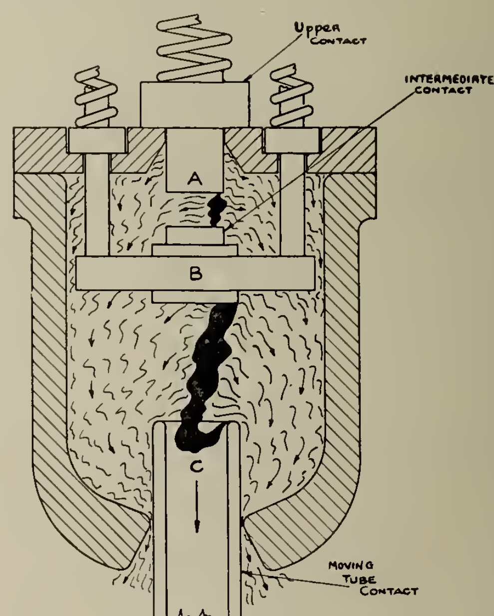

Fig. 2—Diagram of Oil Blast Explosion Chamber.

of the contacts. The arcs drawn when opening under load create pressure within the chamber, and this pressure in seeking the only outlet provided, directs a blast of oil between the contacts adjacent to the opening, effectively interrupting the arc in a very short period of time. The illustration shows the arrangement to prevent piston action. The extension of the lifting rod below the blade has somewhat greater area than the rod and gives greater pull downward than the upward thrust given by the area of the lifting rod. An interesting feature of this type of oil blast breaker, is that it has not been necessary to change the type of contact, so that the experience of years on contacts best able to withstand heavy momentary current and carry full load continuously without undue heating, can be fully utilized. A long series of tests have shown consistent results with this type of breaker.

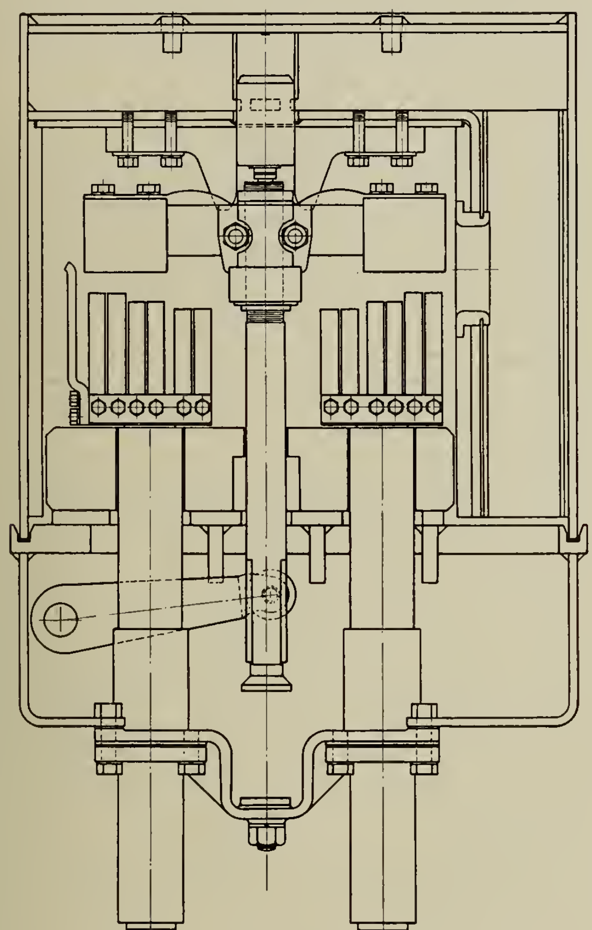

Fig. 3—Cross Section Through 15,000-Volt Breaker with Rectangular Tank.

The 15,000-volt breaker above described shows on test moderate pressures in the arcing chamber and negligible pressures above the oil. Tests at voltage recovering rates well above the average show maximum arc duration 1.75 cycles and maximum arc length 1½ inches. This permits the use of rectangular tanks and taken with the short stroke required, gives a very compact breaker, that should have great possibilities in solving the problem of stepping up the rupturing ratings, with minimum alteration to the physical layout of power stations that have outgrown their original breakers. In some cases this type will go in the same space as an old plain break breaker of one-tenth the rupturing rating.

The third example of the application of the general principle is the cross jet baffle in the live tank "H" breaker. Fig. 4 shows a cross section of the arrangement used. As the breaker opens an arc is drawn between the bayonet and the stationary contact. This arc decomposes a small quantity of oil and creates gas and pressure in the lower portion of the oil vessel. As the bayonet moves upward the gates (of special arc resisting alloy) close behind it, being moved to the closed position by springs protected from the arc. A second arc is drawn above these gates as the bayonet leaves them. This second arc is immediately subjected to a blast of clean oil—impelled by the pressure in the lower chamber, and at current zero the arc products are displaced by solid oil—effectively preventing re-establishment of the arc. Several hundred tests have been made on this cross jet baffle and the arcing time rarely exceeded one cycle.

The pressures in the arcing chamber are under 200 pounds and pressures above the oil level are low. The improved performance compared to the old type of baffles is notably consistent. It is quite a simple matter to substitute these cross jet baffles for old style baffles on existing breakers, there being no change in the size of the breaker. This type of breaker requires a notably small amount of oil. A 15,000-volt ten inch diameter tank breaker with a rated rupturing capacity of 1,000,000 kv.-a. requires only nineteen Imperial gallons of oil (a standard tank type breaker of corresponding rating requires two hundred gallons). This fact combined with modern oil tight features and venting almost completely eliminates the oil hazard and comes close to the ideal of a breaker, retaining all the advantages of oil in arc rupture, without the usual attending disadvantages.

Another form of the oil blast principle, instead of using an arc to generate pressure for driving oil into the arc area uses a piston to force the oil in mechanically. This form is known as the impulse breaker. In the previous forms described the amount of available pressure from the pressure generating arc is somewhat variable. Breakers are naturally proportioned to be most effective near their full rating. For service interruptions when the current is small, the pressure generated is correspondingly small and the arc length increases. In the impulse breaker, the pressure is independent of the arc and therefore does not vary with the current, thus permitting a very short stroke. This form will limit the total duration of short circuits to one cycle on 25-cycle circuits and although it has not yet been built for higher frequencies it would probably be two cycles on 60-cycle circuit. At present it is being built only

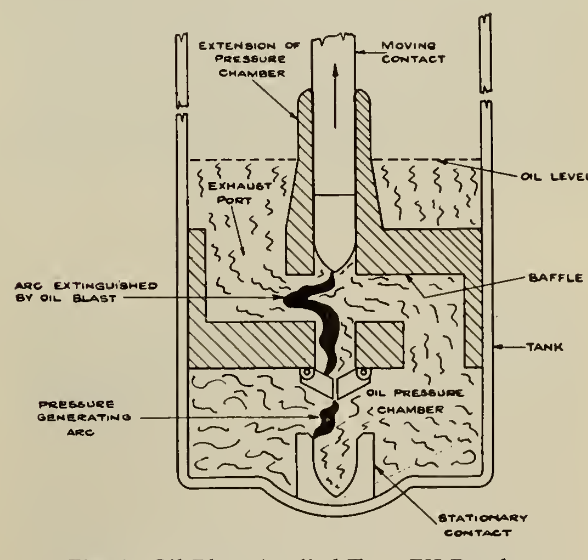

Fig. 4—Oil Blast Applied Type FH Breaker.

for single-phase work at 12,000 volts and has an interrupting rating of 50,000 amperes at this voltage. Fig. 5 indicates the manner in which interruption takes place. At the moment of current zero, AA represents the boundary surface between oil and arc products. In a given increment of time the oil surface moves forward to $A'A'$ giving a certain thickness of oil film over the lower contact to hold back the rising potential. The rate at which the boundary advances is determined by velocity of the oil flow.

This immediately suggests that a breaker of this type could be used to determine the effect of oil velocity, current-voltage and recovery voltage rate, in obtaining successful interruptions and check the general theory quantitatively. Some four hundred tests were made at 13,200, 6,600 and 3,800 volts and at currents up to 23,000, 44,000 and 66,000 amperes at these voltages. The inductances and capacitances of the various circuits were measured and recovery voltage rates for the various connections calculated. The results clearly indicate that successful interruption or failure depends on the oil velocity exceeding or falling below a certain value for a given rate of voltage recovery. Neither the voltage nor current enters into the result. The value of dielectric strength for the oil-indicated by the tests was 550,000 volts per inch, i.e. nearly the impulse strength of oil. This is as might be expected from the accepted theory of the mechanism of oil breakdown which states that breakdown occurs through the lining up of impurities until a chain is formed part of the way at least between electrodes. If the time available for formation of the chain is cut very short, the chain will not be able to form, so that in this type of breaker, impurities will have relatively little effect.

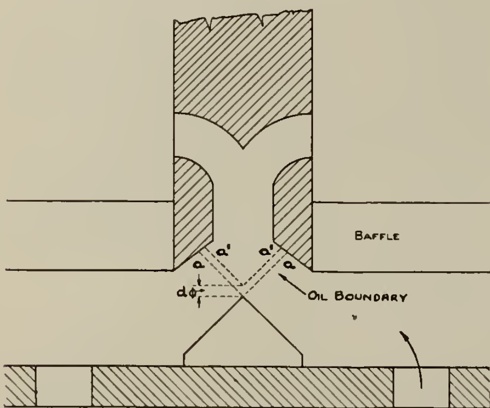

Fig. 5—Oil Boundary at Time of Interruption.

It is interesting to note that while higher speed breakers were sought primarily to improve system stability, several other advantages have been obtained, that in themselves would entirely justify high speed breakers. These are:—

1. Lessened shock to synchronous apparatus.
2. Lessened effect on paralleling communication circuits.
3. Less damage at the point of arc.
4. Lesser depreciation to contacts and oil, thus opening the way to a higher duty cycle.

Volts per inch of arc has frequently been suggested as a basis for comparison of interrupting performance. This is satisfactory only if the factors affecting the value are appreciated and the comparison made on a basis of like conditions. It is not correct for instance to assume that the magnitude of voltage recovery is the system voltage before short—it can readily be more than double this value. The volts per inch of arc decrease as the rate of recovery voltage increases and increase in speed of moving contact also has the effect of decreasing the value even though the total arcing time may be lessened. In other words, figures on voltage per inch of arc are practically valueless unless three factors are given, i.e.

Recovery voltage magnitude
Recovery voltage rate
Speed of contacts.

Total arc energy has also been used as a criterion of the duty on the breaker structure. Shortening the arc length will decrease the total arc energy, but not necessarily the amplitude of the pressure pulsations. An actual comparison between a plain contact breaker and a special contact showed 5 per cent total arc energy and 62 per cent pressure peak. Arc energy in a given half cycle would be the true measure to use. To obtain satisfactory speed records, indicators must be used having speeds several times that of the best engine indicators.

There are two minor points that also should be mentioned. The first is a form of insurance known as the emergency vent. Accidents impossible to foresee do happen at times to the best of machinery and considering the importance usually attaching to the circuit of a heavy duty breaker, reasonably cheap insurance to minimize the effect of the rare accident is warranted. The emergency vent consists of a large hole in the breaker cover, normally closed by concave and convex discs designed to let go at a pressure above that due to rated short circuit operation but well within the ultimate strength of the breaker structure, thus affording relief from excessive pressure that otherwise might wreck the breaker and create a serious oil fire. The vent of course must be piped to a safe location.

The other point is the matter of operation in the extremely cold weather met with at certain seasons in nearly all parts of Canada. Typical switch oil has a flow point of −40 degrees and where temperatures are liable to fall to or below this value for a sufficient length of time to reduce the oil to near this temperature, heaters should be provided. So far as is known no rupturing tests have ever been made with congealed oil, and the action of a breaker in such a medium is a matter of speculation. To enlarge breaker tanks to allow the use of heaters of sufficient area for continuous operation or without carbonization on the heater surface would not be justified, so heaters as usually designed are a compromise and should only be energized for the short periods when dangerously low temperatures are feared.

Clearing Traffic Interruptions on the Mountain Subdivision of the Canadian Pacific Railway

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SUMMARY.—The author describes the emergency methods adopted in dealing with a situation which arose on Saturday, September 5th, 1931, at the western portal of the Connaught tunnel on the main line of the Canadian Pacific Railway at Glacier, B.C., when a sudden flood buried the tracks under some ten thousand cubic yards of rocks and mud, carrying debris into the tunnel and interrupting traffic. Matters were complicated by a washout which occurred almost simultaneously, about 30 miles west of Glacier, and undermined the western end of the bridge, carrying the tracks over Twin Butte creek. The line was opened for traffic on the afternoon of Thursday, September 10th.

The original bed of the Illecillewaet river occupied the location selected for the west portal and fan house of the Connaught tunnel, at Glacier, B.C., the tunnel being five miles in length, and carrying the double track main line of the Canadian Pacific Railway under Mount MacDonald at the summit of the Selkirks. A new channel to accommodate the river was constructed before starting the tunnel, the upper end of which is about 600 feet south-east of and 80 feet above the tunnel portal. A low concrete wall was

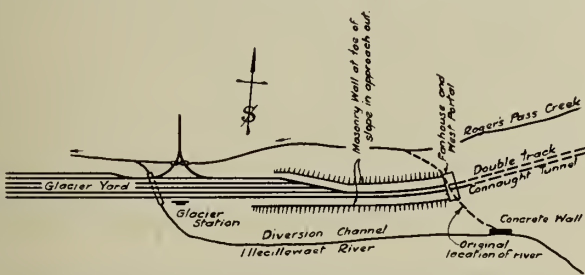

Fig. 1—West Portal of Connaught Tunnel.

built at the upper end, but main dependence was placed on the artificial channel, which was deemed to be of ample capacity to carry any possible excess flow of water that might occur.

Fig. 1 illustrates the main features at the west portal of the tunnel.

Since construction about sixteen years ago this diversion had been inspected from time to time and had functioned in a satisfactory manner in carrying off the natural flow of the water. During the early portion of September, 1931, however, the weather at this high altitude was unusually warm, both day and night, which had an unusual effect upon the glaciers, and resulted in flood stages being registered in all the mountain streams in the vicinity. Following this hot spell a warm rain set in, which continued for about seventy-two hours.

At seven o'clock in the morning of Saturday, September 5th, the Illecillewaet had overflowed at approximately the point where the diversion commenced and water began pouring into the approach cut made for the railway and into the lower storey of the fan house. The rush of water was so great that in a few hours ten or twelve thousand cubic yards of rocks, mud and other debris were deposited on the railway tracks, part outside and part inside the tunnel portal, and reaching almost to the crown of the arch. The early stages of the flow deposited enough material to form a dam, which diverted the water eastwards over a five-foot summit near the west end of the tunnel. This stream eventually reached a depth of 30 inches over rail level inside the tunnel, thus forming a river flowing eastward through the tunnel which was never intended by the engineers in the original tunnel project.

Inside the tunnel 2,000 ties intended for tie renewals had been distributed and these were floated out of the east end of the tunnel, a distance of approximately five miles, and piled up, strange to say, close to a considerable washout, 75 feet long and 10 feet deep, through the double track embankment just outside the east portal.

The water that flowed west from the west-end portal of the tunnel carried a large quantity of debris, causing some of the side tracks in Glacier yard to be washed out.

The ventilating fans and engines are on the top floor of the fan building, located at the west end of the tunnel, and sustained practically no damage, but the floor below, where the pumps and boilers are located, was blocked with sand and mud, and the oil tanks floated out, breaking pipe connections and generally disorganizing the installation.

Telephone, telegraph and signal cables were carried in a wooden box set in the concrete tunnel lining. Near the west end this box was torn from its fixtures, but all wires, including those for automatic signals, continued in service, though some were deeply buried in mud and water.

While the flood was at its height the only means of getting from one end of the tunnel to the other was on foot by the old route over Rogers pass, which meant a tramp of about twelve miles, which in the inclement weather then prevailing was not at all popular with the hard worked local officers and men.

The first problem in dealing with the situation was to direct the river back into its channel, and crews of men

Fig. 2—View from West Portal—Debris 17 to 18 feet Above Top of Rail.

Fig. 3—Fan House West Portal—One Track Cleared for Traffic.

were immediately put to work. Dynamite was freely used to clear and deepen the channel and dams and brush and rock deflecting dykes were built to close off the break in the bank, but it was late Sunday night before this was accomplished.

In the meantime a bridge crew had been brought from Calgary to repair the washout at the east end of the tunnel.

By daylight on Monday morning track clearing operations were in full swing, and it was fortunate that all the needed equipment had been moved to the site which was the original cause of the trouble near the two portals of the tunnel, as by Sunday night reports were received that the banks were washing out at the west end of the bridge over Twin Butte creek, located about 30 miles west of Glacier station. The immediate effect of this was that a zone of territory 35 miles in length was completely isolated as far as transportation of equipment was concerned.

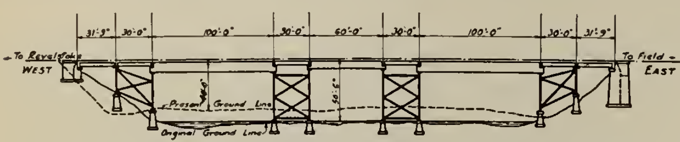

Fig. 4—Elevation Old Structure Twin Butte Creek.

The conditions which existed at the west portal of the tunnel are clearly shown in Figs. 2 and 3.

A crawler shovel equipped with a dragline, which had arrived, was of great assistance due to the ease with which it could be moved about, thus reaching material which was not accessible to the regular railway equipment. This shovel first made a cut about six feet deep over the top of the slide, casting the material to one side. A tail track followed through this cut, and as soon as a length of such track was ready 30 steel air dump cars were spotted for loading with the regular railway steam shovel and were moved out and empties pushed in by a second work engine. This method of clearing the debris was only made possible, however, through the use of the crawler equipment as the depth of material was too great for a railway shovel to load cars on a tail track over the top.

The crawler dragline was also brought into operation for clearing the tunnel entrance, and as soon as sufficient material immediately at the entrance was removed the boom was lowered and pushed into the tunnel, where the bucket operated on the material. Owing to the boom not being of sufficient height to allow regular dumping this material had to be man-handled, which slowed up the speed of the work from the dragline, but it gave a much higher output than would have been secured by hand labour only.

As far as the track in the tunnel was concerned, there was very little damage done other than the washing out of the ballast in places and some heavy rocks and mud which had been carried in from the west end, and these had to be removed. At the west portal this material was no less than 18 feet deep, tapering down to two feet at a point about 150 feet inwards; for the next seven or eight hundred feet there was about one foot to six inches of mud over the rail, which was removed as soon as the washout at the east end of the tunnel was passable for a pusher snow plough. This plough was successfully operated to a point about 150 feet from the west end of the tunnel, from which point hand labour was called upon to clear the south track, throwing the material over to the west track, where a stream of men kept the work going continuously, part of them resting while the others were at work until the south track was cleared, ready for trains, at three p.m. on Thursday, September 10th. The final completion of the work on the other track and Glacier yard, however, occupied several days more.

Before the clearing of tracks was completed arrangements had been made to deepen and straighten out the original diversion of the river in order to guard against a repetition of a similar occurrence in the future. The crawler shovel and dragline used in the clearing work were moved to the site and proved very efficient in enlarging, straightening and deepening to a minimum of six feet the new bed where it is expected the river will in future hold its course.

Now to revert to the Twin Butte bridge, to which reference has already been made. The head waters of the creek spanned by this bridge are near the origin of the Illecillewaet river, high up at the Great Glacier, which meant that climatic conditions had the same effect on both streams. The valley of the Twin Butte at the point where the railway crosses it 30 miles west of Glacier station is quite flat, considering that it is a mountain valley, and was well covered with large trees, which showed no signs of recent floods.

A general elevation of the railway bridge is shown in Fig. 4 and as will be observed it is a steel trestle 440 feet long and about 50 feet high, the substructure consisting of masonry and concrete.

A rough calculation would show that approximately 350,000 cubic yards of debris, consisting of mud, rocks and trees were brought down the stream and deposited in this valley within a distance of about half a mile, about half on each side of the railway bridge. It is not possible to give the exact time occupied by this movement, but it probably did not exceed four hours.

The result of this tremendous deposit in a comparatively flat valley caused the centre of the old stream bed to become one of the highest points and the stream

Fig. 5—Condition of Bridge Previous to Repairs.

Fig. 6—Commencement of Construction of Temporary Bridge.

itself was thrown against the west bank, undermining the two west pedestals of the most westerly tower of the steel trestle and the west abutment to such an extent that it moved forward and downwards. The first tower bent was left suspended 18 feet in the air, its supporting pedestals having been entirely undermined, the abutment being held from further movement merely by the strutting effect of the westerly steel span.

Therefore the problem presented was to move the abutment out of the way without further damaging the steelwork of the bridge. The scheme adopted was to cut all fastenings between the east end of the damaged span and the first steel tower, connect a cable from an ordinary Lidgerwood ballast unloader located some distance west of the bridge, to the end of the first steel span; a strain was taken upon the cable, which had the effect of pulling the span clear of the standing steel, and, at the same time, releasing the abutment. After this was done holes were dug behind and partly under the back corners of this "U" abutment, which were then heavily charged with dynamite, the intention being that the explosion would blow out the bottom and since the top was held back by the span and the cable previously referred to, the abutment would settle vertically and laterally, instead of immediately sliding down towards the steel tower. When the explosion took place everything occurred almost exactly as expected—in fact a little better, as the east end of the steel span came free and settled down so quickly that it blocked any rolling tendency of the abutment. Due to the force of the explosion the abutment was also broken into several pieces, greatly facilitating removal.

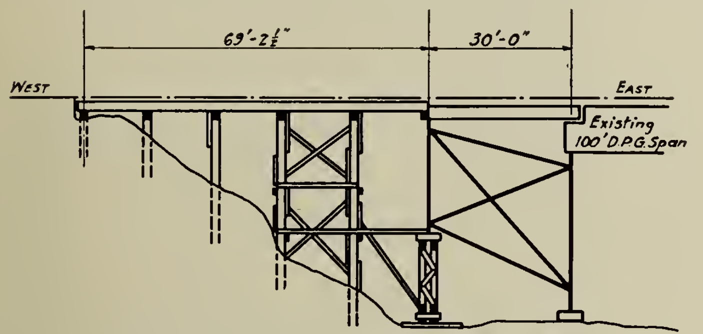

Fig. 7—Temporary Structure at West End.

After a working space had been cleared of debris, construction was immediately started on a temporary pile trestle to carry the railway from the end of undamaged steel to the embankment, a distance of about 100 feet, which was accomplished by using piles driven by an ordinary railway self-propelled steel track driver and steam hammer. Sixty-foot piles were used and penetration of approximately 15 feet was obtained. The ground was then levelled off under the two tower bents and mattresses of old bridge ties were placed on the ground so levelled, the towers having been pre-framed, the whole was tightly wedged into position. The effect of this work was to support the steel tower on this temporary substructure (see Fig. 7) and the bridge was put into service at 1.30 o'clock p.m. on Thursday, September 10th, which was about an hour and a half in advance of the completion of the clearing work being done at the Connaught tunnel 35 miles eastward, and synchronized very well with the general opening for traffic through the whole washout zone. The elapsed time from early Saturday morning to about midday Thursday, September 10th, was considered a remarkably quick piece of restoration work in the eternal conflict between railway men and the great forces of nature in our mountain regions.

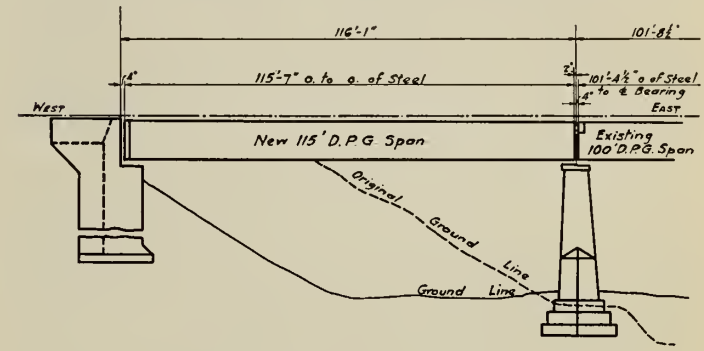

Fig. 8—Proposed Permanent Structure at West End.

Permanent repairs on the bridge were immediately commenced. The crawler shovels and draglines were utilized to clear debris, which was piled about the temporary work to serve as protection should there be another flood. Both banks of the stream were heavily rip-rapped for a height of 15 feet above the present level and some clearing of the channel was done to further control the situation.

Instead of replacing the damaged steel and tower, it has been decided to build a 100-foot shore span and support it on a permanent concrete pier in place of the steel tower on pedestals (see Fig. 8), thus giving a more unrestricted waterway and avoiding risk in case of a possible recurrence of the trouble.

Discussion on "Central Heating System of the City of Winnipeg"

Paper by G. W. Oliver[1]

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

Mr. Humphreys observed that he had known only of one strictly steam heating plant which had made money, namely, at Farabault, Minn. The New York Steam Heating Company lost money for many years, but he understood it was now making a little. At Rochester, there was a small group of factories within about 2,000 feet of the electric light station, which were heated with exhaust steam, and this small installation was, of course, profitable.

N. M. Hall, M.E.I.C.[3]

Professor Hall stated that the paper brought up to date the record of a plant that in its general set-up was somewhat out of the ordinary. Planned originally in 1922 as a standby to the city's hydro system, it had emerged as a standby plant combined with a district heating system serving the adjoining commercial district, using steam from off peak load power in electric boilers, supplemented by the coal-fired boilers of the original standby plant. To the original boiler plant there had been added recently a fourth of similar size of 1,100 boiler horsepower, but without a superheater, which limited it largely to heating service only.

(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and published in the January 1932 issue of The Engineering Journal.

(2) Chief Engineer, Gas Department, Montreal Light, Heat and Power Consolidated, Montreal.

(3) Professor of Mechanical Engineering, University of Manitoba Winnipeg, Man.

The decision in 1922 to use pulverized coal in boilers and furnaces of that size was somewhat courageous; but the paper left with the reader the impression that the choice was a satisfactory one; and the fact that the fourth unit since installed was almost identical in design and size appeared as further evidence of satisfaction on the part of the plant officials. The generating pressure of 250 pounds with 150 degrees of superheat though not necessary for heating, was dictated by the power standby feature.

The underground distribution system presented no unusual features. Conservative design in all details had been followed, and the decision to reclaim no condensate made possible by the good quality of raw water from the city's system, had permitted a conduit system of permanent character to be employed, since there would be periodical renewal of return condensate piping.

The tabulations and graphs embodied in the paper indicated that the officials were maintaining close records and studies; and left the impression of progress along sound lines. It would have added to the value of the paper if figures showing the transmission losses had been included; although it was admitted that such data might be difficult to obtain and might be actually misleading.

The system was fortunately initiated in an entirely new field, and without those handicaps under which so many systems of comparable size had started. These would have included, for example, being coupled with a prime steam power generating system, or falling heir to an established demand for steam outside of the usual heating system.

The absence of smoking chimneys, and trucking of coal and ash on the streets was now taken for granted and no longer noticed; but the reader's imagination could picture the nuisance and fire risk that would exist were the same amount of heat produced by individual furnaces in the area served.

The superimposed curves of steam and degree-days in Fig. 14 were of interest in that they showed the effect of the reduced hours of sunshine in the short days of the mid-winter months.

The list of sizes and lengths of mains and service lines gave a total of about 326,000 inch-feet serving two hundred and forty-six consumers with 725,000 square feet of steam radiation. This meant 2.22 square feet of radiation per inch-foot of piping. A recent study of a system serving a purely residential district with 1,200 customers showed only 1.375 square feet of equivalent radiation per inch-foot of mains, laterals and services.

This gave a comparison between the density and also the approximate relative capital costs and distribution losses of piping systems serving widely differing types of consumers.

The author was to be congratulated on the concise and well-arranged manner in which he had presented information which appearing in the records of The Institute should be of value to any who might be contemplating similar district heating projects, particularly where the use of large blocks of off-peak electrical energy was possible.

B. F. Haanel, M.E.I.C.[4]

Mr. Haanel stated that it was gratifying to know that seven years of operation had proved that the recommendation in favour of such a system was sound. The city of Winnipeg was also to be congratulated for having carried into effect so extensive a system of central heating, using entirely Canadian coal, with such great success.

He was especially interested in central heating plants, inasmuch as one of the investigations carried out by the Dominion Fuel Board in 1923 pertained to central and district heating—the possibilities of application in Canada. F. A. Combe, M.E.I.C., consulting engineer of Montreal, was entrusted with this investigation, and at that time there were many engineers who were sceptical that such a system could be introduced into Canada. As a result of this investigation the Dominion Fuel Board[5] drew up the following conclusions:

(1) That central heating of groups of institutional buildings and community heating of residential properties has shown the economics and benefits to be derived from these methods, and that such systems may and will be adopted profitably to an increasing extent.

(2) That while the increased use of district heating or the supply of heat as a public utility in sections of cities and towns may be looked for in the future, their introduction in any particular locality should be preceded by a detailed and careful study of local conditions and of all the factors bearing upon the problem in order that there may be a reasonable assurance of financial success; and that the benefits to be derived by consumers are not so much a saving in cost of service, but rather, a greatly increased value of service in respect to convenience, relief from the handling of coal and ashes, etc., the total value of which it is extremely difficult to determine in terms of dollars.

(3) The Fuel Board believes that for a full utilization of available resources, consideration must be given to possible co-ordination in production and use of different forms of energy such as the establishment of central stations acting in conjunction with hydro-electric developments for the supply of light, heat and power.

(4) The Fuel Board finally concludes that while the application of methods of centralized heating alone may not be looked upon as a considerable factor in the solution of the fuel problem in the provinces of Ontario and Quebec, nevertheless the replacement of small anthracite-burning units by centralized plants burning low-grade fuels will contribute towards the reduction in importation from the United States of high-priced anthracite coal which is so rapidly becoming a luxury fuel of indeterminate availability.

When the Fuel Board was created, one of the principal problems considered was means and ways of rendering Canada independent, or less dependent, on foreign sources for her fuel supply for all purposes, with special reference to anthracite, which was the principal fuel used over a large portion of Canada for domestic heating. Low grade fuels referred to in the Fuel Board report did not refer altogether to low rank fuels but to the lower grades of high rank fuels, and he believed that herein lay the possibilities for reducing cost of house heating and the heating of other buildings. Mr. Haanel stated that he had been interested in the central heating system of the city of Winnipeg from the time of its inception, when it was the intention to burn the Souris lignites. It would be exceedingly interesting, as well as instructive, to know just why the Souris lignites could not be burned successfully in this plant.

Regarding certain details of the paper, he wished to point out that the accepted method of measuring the degree days in the United States, for both gas and oil heating in domestic service was $(65 - 24.2) \times 30$, and not $(70 - 24.2) \times 30$, as stated on page 32 of Mr. Oliver's paper.

When an attempt was made to interest householders and others in any new system for supplying heat, the

[4] Chief Engineer, Division of Fuels and Fuel Testing, Mines Branch, Department of Mines, Ottawa, Ont.

[5] "Central and District Heating"—the Possibilities of Application in Canada, Mines Branch Report No. 628.

question was very often, if not generally asked: How did the cost of central heating compare with individual heating and how could one capitalize the freedom of worry, dirt and labour troubles?

He had on many occasions been asked to prepare a comparative statement regarding the cost of heating a house with electricity, gas, oil and coal. Many statements had been made, many of which were erroneous, regarding the cost of heating a house by the burning of coal in a hot water or other type of heater. Efficiencies as low as 40 per cent had been cited, whereas the tests carried out at the Fuel Research Laboratories, Ottawa, on various coals, had shown that 65 per cent might be expected, and in some cases as high as 70 per cent, when a furnace was properly handled. The human element determined to a large extent what efficiencies would be realized and this would also apply to central heating since, as already pointed out in the paper, many people were careless regarding the way they used heat, and for some psychological reason believed that health depended on living in a house with open windows. It would be interesting if the author could present some figures showing just how central heating in Winnipeg compared, as regards cost, with individual house heating using coal in the ordinary types of furnaces.

He was of the opinion that central heating would be applied in the near future to the heating of public buildings and even certain residential districts in eastern Canada, when the benefits of central heating were more generally known and understood. But it must not be forgotten, in estimating the value of central heating according to the method employed in Winnipeg, that manufactured gas would become a very serious competitor, especially for residential heating, when the cost of gas per thousand feet reached the proper level.

Regarding the use of gas for heating in individual houses, the tests which were being carried out in Ottawa indicated that gas heating might be a competitor in the near future with other methods of heating. Gas heating afforded the most excellent control, and so far as cost was concerned, was comparative with good coal, such as American and Welsh anthracite, when gas could be sold for 45 to 50 cents a thousand—assuming the gas to have a heating value of 500 B.t.u. per cubic foot, and the cost of coal about $16 a ton. This was the price which had been used as a basis for comparison.

In central heating plants, such, for example, as the plant in Winnipeg, a low rank coal could be burned with high efficiency, and under such conditions, with a heating load such as the climate in Winnipeg afforded, a central heating plant could be operated to advantage. If the same class of coal were burned in the ordinary types of heaters found in individual houses, an efficiency as low as 40 per cent might be all that could be expected, although when carefully handled, hot water heaters would give an efficiency as high as 70 per cent, but this was unusual.

Thermostatic control, which was installed with every appliance for gas heating, and also for central heating, such as the plant under discussion, permitted an even temperature to be maintained. The fluctuating temperatures which one found in residences heated with a coal fired furnace, were responsible for a large loss in heat and the consequent lowering of furnace efficiency.

Mr. Haanel remarked that he was informed the other day, regarding Saskatchewan lignite, that more therms could be laid down in Winnipeg for one dollar, than with other types of coal. When a steam generating plant was designed for the use of low rank coal it would appear that Saskatchewan lignite, for the price at which it was delivered at Winnipeg, could be burned as efficiently as any other type of coal, but where steam generating plants were installed for power purposes, or for processing, such as in paper mills, and where ratings as high as 300 per cent must be carried at times, then it could not be expected that as efficient results would be obtained from burning a low rank fuel as when burning a high rank fuel.

He wished to point out with regard to the question of burning northern Ontario lignite in existing boiler plants throughout northern Ontario that unless boiler installations especially designed for burning northern Ontario lignite were installed, this low rank fuel could not be used in those plants where the boilers were intended to be operated at a high rating when burning a high rank coal, and that the lignite would have to be beneficiated by carbonizing in order to increase its heating value, to permit it to compete in that type of boiler.

M. Barry Watson, A.M.E.I.C.[6]

Mr. Watson remarked that he did not propose to discuss all phases of the author's paper, but merely to raise some points on which he might have divergent views or required further information.

He noticed that the distribution network was operated at present apparently with the aim of steam at 40 pounds pressure at the ends of the lines, and that from 55 to 70 pounds pressure at the station with superheat up to 40 degrees appeared to be necessary to maintain this terminal pressure. However, extra heavy cast fittings had been used in the line and he would like to ask the author for what ultimate temperature and pressure the lines were designed, and what factors contributed most strongly in making this decision.

The details of duct construction, especially where extra insulated, were of interest. Were the possibilities of running the mains through the basements of consumer's premises to curtail capital outlay investigated, or were the mains kept off private property purely as a matter of policy regardless of first cost?

Also what features determined the different spacings of expansion joints for the various sizes of mains? In this connection the Winnipeg Hydro were fortunate in having a relatively level district to serve, where anchors could be placed at high points and expansion joints at manholes without going to extreme depths. Such even distribution of expansion joints and drip traps would be quite impossible in a hilly town.

In connection with consumers' services, had any difficulties been experienced due to the operation of the reducing valves at relatively small loads for much of the year, and had it been necessary to install large and small pressure reducing valves in multiple to control pressures successfully under both large and small flow conditions, without excessive wear and tear on the larger valve?

Regarding rates for service, the author did not state whether or not any service charge, apart from steam costs and the 12 per cent maintenance charge on the service equipment, was made to reimburse the Hydro for installing the services; or whether contracts were made for a guaranteed minimum consumption over a minimum period of time.

In the section on weather and consumption the degree-days had been calculated on the basis of an average indoor temperature of 70 degrees throughout the heating season. The extensive experience of the American Gas Association indicated that the average demand for heat varied almost directly with the difference between 65 degrees and the outdoor temperature. The probable reasons for this fact were—(1) No heat was required when outdoor temperatures were as high as 65 degrees, and (2) most buildings were cooled off at night, reducing the average twenty-four-hour heat loss. The author's statement in the third from final

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[6] Angus and Watson, Consulting Engineers, Toronto, Ont.

paragraph of his paper "...great savings can be effected by materially reducing the number of hours that steam is on..." indicated his realization of reason (2) above.

If the monthly percentages of annual degree-days were plotted from the last column of the author's Table 3, and also from a similar column of degree-days calculated on the 65 degree basis, it would be found that the proportionate monthly steam consumption, as shown in Table 2, agreed more nearly with the degree-day ratio figured on the 65 degree basis.

From degree-day records one could estimate very closely the heat requirements of any building whose heat losses were known. Care must be exercised however not to use the square foot of radiation as a basis for such calculations, because exactly similar buildings in different localities would have their radiation proportioned according to the maximum difference between indoor and outdoor temperatures, while the heat requirements would vary almost directly as the degree-days.

For example:—Some particular building in Winnipeg might be figured on the basis of a maximum difference between indoor and outdoor temperatures of 95 degrees, indicating a maximum hourly heat loss of say 1,000,000 B.t.u.'s, or requiring about 4,200 square feet of equivalent radiation, while an identical building in Toronto would likely be figured for a maximum difference of 75 degrees and would require 790,000 B.t.u.'s per hour, or about 3,300 square feet of radiation.

The annual steam consumption of these similar buildings would be in direct proportion to the respective degree-days in Winnipeg and Toronto, viz.—11,166 and 7,732.

Assuming about 400 pounds of steam per square foot per season in Winnipeg the total consumption there would be about 1,680,000 pounds for this building, while the same building in Toronto would use only about 1,163,000 pounds steam per year.

From the above it was clear that while the annual steam consumption per degree-day was about 150 pounds in both localities, the consumption per degree-day per 1,000 square feet of radiation would be about 36 in Winnipeg and 45.5 in Toronto. Thus the author's Table 1, while extremely interesting and useful in estimating relative steam requirements of different types of buildings, must not be used as an absolute measure for estimating consumption in climates different from that of Winnipeg.

The degree-day was originated by the American Gas Association on the 65 degree basis, and in this form had been adopted for general use by the American Society of Heating and Ventilating Engineers and by the National District Heating Association. For these reasons, as well as because of the closer proportional relationship with actual heat requirements, it would seem more rational to present data of this type in terms of the generally accepted definition of the unit.

Although the author mentioned that condensate in the mains was measured at typical sections of the lines, he did not give any idea of the proportionate loss of steam under various weathers from this cause, nor the proportion of the steam supplied into the mains which was actually delivered to the consumers. Such information would be extremely valuable.

The Winnipeg Hydro were to be congratulated from the point of view of maintaining the customers' good will on their attitude in giving advice gratis regarding elimination of heat losses, etc. There was however always grave danger, especially in publicly owned corporations, of extending such services to the point where some customers were obtaining individual professional engineering services, at the cost of the consumers in general, or in some cases of the tax-payers.

One point brought out deserved more extended publicity than it usually gets, viz.—"A very prevalent, but none the less mistaken, idea exists that because air is cool it is necessarily fresh and pure. The result is that far more windows are open than are necessary for proper ventilation, ..."

The author was to be complimented on the way in which he had covered the subject so fully and from so many different angles in limited space. Much of the information tabulated was bound to be of general usefulness, and the paper was a valuable contribution on a timely topic.

L. M. Arkley, M.E.I.C.[7]

Professor Arkley observed that perhaps the first question that presented itself to a heating engineer was why, in a plant of this size which was equipped for generating power, was live steam generated at 220 pounds per square inch then passed through pressure reducing valves and reduced to from 50 to 70 pounds for distribution in the mains.

It should be feasible to pass the steam through turbines and bleed steam from them at the pressure required, in other words let the turbines take the place of the reducing valves and use the power generated as a by-product of the heating system. The thermal efficiency of the most up-to-date super power plant equipped with all the enormously expensive apparatus such as water cooled walls, high pressure and high superheat equipment was not much over 30 per cent, the reason being that as soon as steam reached the condenser about 1,000 B.t.u.'s out of the original number contained in each pound of steam was lost.

Now if the exhaust steam from the turbine could be used for heating in place of live steam that would otherwise be required, it might easily be shown that the efficiency of such a plant would reach 60 per cent or over.

There was no doubt that when steam passed through a pressure reducing valve there was a loss due to unresisted expansion or wire-drawing.

This brought up the question of what to do with the exhaust during the summer months when no steam was required for heat. Winnipeg seemed to have no objection to the public ownership of utilities and he would suggest an absorption refrigerating plant to furnish the citizens with a good supply of ice during the summer months, so that the exhaust steam could be used economically the year round.

The question of using Alberta coal in Ontario had received a good deal of attention of late and he thought the answer to this was given where the author cited the analysis of the Alberta coal burned in the plant and gave the cost as $7 per ton delivered in Winnipeg. The important items in the analysis were the ash 15 per cent and the B.t.u. content 12,800 B.t.u. In Kingston bituminous slack was obtained from Pennsylvania or Virginia for less than $4 per ton placed on the dock at the power plant, and this coal would have less than 9 per cent ash and a B.t.u. content of 13,800 on a dry coal basis.

From this it was quite clear that the reason why coal from the south of the border was popular in Ontario was simply one of economics. If coal contained 15 per cent of ash instead of 9 per cent it had a considerable bearing on freight costs. It meant paying freight on 120 pounds of useless material per ton for a distance of 2,000 miles more or less.

He noticed that the plan of having coal bunkers holding 60 tons of pulverized fuel had been adopted rather than that of having unit pulverizers for each boiler, and it would be interesting to know what influenced this choice.

[7] Professor of Mechanical Engineering, Queen's University, Kingston, Ont.

Had there been any trouble from explosions either from the pulverized coal or in the electric boilers?

One of the chief preventable losses in this plant was the wasting of the return water from the radiators, but he presumed it was decided that it would cost more to return this to the plant than it would be worth as boiler feed. In the central plant at Queen's University every pound of return water from thirty different buildings was brought back to the plant at an average temperature of about 140 degrees F., this made an excellent boiler feed.

An important point was made under the heading "Limiting the Number of Heating Hours." There was no doubt but that the economical way to heat a building was to shut the steam off altogether where possible, let the building cool to a comparatively low point during the night when not in use, then heat it up quickly in the morning. As the heat transfer through the walls was proportional to the difference between the temperatures inside and outside the closer these temperatures come together the less will be the loss by conduction through the walls.

F. A. Combe, M.E.I.C.[8]

Mr. Combe stated that the Winnipeg Central Heating System was a good example of the economic possibilities of a combination of hydro-electric and steam plants.

The rates charged for steam heat were comparable to those of several large district heating utilities in the United States supplied from fuel fired stations, although in Winnipeg a large proportion of the steam was generated from surplus off-peak hydro-electric energy at practically no actual cost. Presumably the hydro department made a charge to the steam heating department for this electric power, and also presumably the steam heating department charged the hydro department for stand-by service. He would like to ask if the author was at liberty to give figures of the distribution of cost charges and revenues as it would appear to be a very profitable undertaking to both departments.

It was interesting to note that the tables of steam consumptions given in the paper bore out the findings of an investigation on district heating which he had carried out in 1923 for the Dominion Fuel Board, i.e., that in spite of the lower mean temperatures in Canada the steam consumption and cost of heating was actually less in Canadian cities than in the cities of the northern United States. One factor which he thought was contributary to this relatively low consumption in Winnipeg was the apparent care and supervision given in the usage of steam. Such advisory service was very valuable as experience showed that the tendency was rather towards wastefulness in the use of purchased steam, unless checked. It was surprising, however, to see the high consumption in hot water heated blocks, as in general hot water heating was more economical than steam heat, and he would like to hear an explanation of this.

The maximum peak of steam load was given as 230,000 pounds per hour. Of this a comparatively large part was carried by the electric boilers so that the load on the fuel fired boilers must be quite light. This no doubt accounted for the small maintenance expense on the furnaces. Would the author tell what rating was normally carried on the fuel fired boilers and the efficiency obtained?

Raw water was, of course, used for boiler feed. What was the nature of this water and the treatment given for impurities and air content?

Had any trouble been experienced from dissociation of steam or excessive wear of plates in the electric boilers?

The paper was particularly interesting in that it dealt with details and operating results of the first large public district heating system in Canada, and it would be of value if the author would amplify some of the data given and give further information regarding the points referred to.

[8] Consulting Combustion and Steam Engineer, Montreal.

J. G. Hall, M.E.I.C.[9]

Mr. Hall remarked that the author was to be congratulated on the interesting data, and deductions, presented in his paper.

Based on the operating statistics submitted, and assuming a feed water temperature of 200 degrees F., coal as specified and steam conditions of 240 pounds gauge, with 150 degrees superheat, calculations showed that in 1929 the plant operated at an average efficiency over the year of 73.5 per cent and in 1930 slightly over 74 per cent. It could also be shown that an increase of one per cent in boiler efficiency would have saved approximately $1,000 in coal in 1929, and $1,800 in 1930. Considerably greater savings than these would be necessary to justify any major capital expenditure.

Again using the 1929 figures, and assuming three units of 90,000 pounds actual continuous evaporation, the plant operated at a yearly load factor of 7.5 per cent. Even if all the steam had been generated by the coal fired units this would have been only 18 per cent. This would indicate rather clearly that in the design of such a plant fixed charges, operating, and maintenance costs, were the important items to be considered, with fuel of secondary importance. In other words ability to carry high capacities with safety, reliability and simplicity of operation, should receive first consideration.

The plant was designed in 1923 and the conditions surrounding the design were clearly set out in the paper. The electric boilers were given preference at all times, which meant that the coal fired units were very often practically floating on the line carrying the load in excess of the electric boiler capacity, but ready on short notice to pick up any, or all, of the load. In a standard steam generating unit of modern design approximately 6 per cent of the overall efficiency could be credited to heat recovery apparatus, so that this plant could be compared with a standard plant operating at 80 per cent efficiency, and this in spite of the abnormal conditions of load factor, etc. This meant that although the design was nine years old the plant was still holding its own, and could not be relegated to the class of obsolete equipment. This was also in spite of the fact that the companies reporting to the N.E.L.A. had set up a standard of not more than fifteen years life before a plant had become entirely obsolete.

The author mentioned that the total steam generated included that used by the turbines, but it would be interesting if he could have given information as to how much of the coal burned was used during the summer season when the plant was operated for stand-by purposes only, also it would be interesting if he could submit a typical twenty-four-hour chart showing the steam generated by the coal fired units only.

J. H. Fox, Jr.E.I.C.[10]

Mr. Fox remarked that the paper dealt with the actual cost to the company for the generation and distribution of steam and the cost to the various customers and the rate of consumption. The building owner or customer was primarily interested in the rate of consumption per square foot per season or per 1,000 square feet of radiation per degree-day since this was what determined his total heating cost.

Table 1 gave the steam consumption per season for various customers. The rate of consumption varied according to the type of building and this was shown

[9] Vice-President and General Manager, Combustion Engineering Corporation, Ltd., Montreal.

[10] Assistant Engineer, C. A. Dunham Company, Ltd., Toronto, Ont.

conclusively by the table. The rate of consumption would also vary for the same type of building depending upon the number of heating hours and the type of heating system installed. In order to keep the heating cost at a minimum, the steam must be turned off during a considerable portion of the occupancy period and the rate would be below the average shown in Table 1. On the other hand, if a constant pressure was maintained during the occupancy period, the rate would be materially above the average shown in Table 1. In order to maintain a continuous supply of heat and keep the heating cost to a minimum, a heating system must be installed which had the ability to regulate the heat emission of the system to just meet the demand for heat.

One office block in Winnipeg with a controlled system used 310 pounds of steam per square foot of radiation during the season of 1930-31 as compared with 348 pounds for similar office blocks listed in the table. The heating system installed in this office block circulated steam continuously but the temperature of the steam varied from 218 degrees down to 133 degrees, and at this low temperature the amount of steam was regulated so as to only partially fill the system.

It was evident that a heating system which had the ability to regulate the supply of heat to just meet the demand, not only reduced the yearly heating cost to the building owner to a minimum but permitted the central station company to sell more consumers at a higher rate.

J. R. W. Ambrose, M.E.I.C.[11]

Mr. Ambrose inquired, at what point did the consumer accept delivery of steam? At a point where the supply entered the building line, or—the consumer's side of the pressure reducing valve?

Also what evaporation per kilowatt-hour was obtained from these boilers and what was the cost of the steam per horse power at the generator?

J. G. G. Kerry, M.E.I.C.[12]

Mr. Kerry observed that everybody was aware that there were in the province of Ontario certain lignite beds, and he would like to repeat Mr. Haanel's request for information as to why the city of Winnipeg changed the fuel which was used in its heating plant from Souris lignite, as originally planned, to the present use of Alberta bituminous coal.

It would also be interesting to have information as to the capital cost of the municipal plant per unit of boiler horse power, because in the more recent Winnipeg heating plants no effort had been made to provide for the development of electrical power. To a casual inspector it would appear that the unit cost per boiler horse power of these private plants must be very much less than that of the municipal plant.

He might add that he was optimistic enough to believe that it was possible, as a provincial undertaking, to heat the city of Toronto from a central plant using Ontario's own individual supply of coal and at reasonable cost, but perhaps not quite as cheaply as this could be done with American bituminous coal.

Mr. Kerry stated he wished to add one remark for the information of the meeting. The latest heating plant which had been built in Winnipeg was being fired entirely with lignite coal. It had also been recent Winnipeg practice to return all the steam condensate to the central stations.

S. L. Fear[13]

Mr. Fear inquired if the author could give any information as to the use of untreated water in electric boilers and what maintenance rate was set up on the pipe line, and approximately the average outlet water temperature from the customer's meter.

W. H. Bonus[14]

Mr. Bonus remarked that in connection with the expansion of the pipe lines, he would like to know if the author had had experience with the distribution lines growing. In other words, with the turning on of the steam in the autumn the pipes expanded, which expansion was taken up in the traverse of the expansion joints but, with the shutting off of steam in the summer, the pipes did not contract the same amount as they had expanded. After this operation was repeated several times, the amount of the traverse of the expansion joint was so greatly reduced that the full expansion could not be taken care of unless a small section was cut out of the pipes in order to give the full traverse necessary.

C. Gottwald[15]

Mr. Gottwald stated that he had found the paper very interesting because the Winnipeg Central Heating Plant and the other three plants in Winnipeg operating in the residential district had been considered very carefully by the National District Heating Association.

On page 30 there was reference to an interesting experiment in conduit construction where it crossed a duct of electrical cables and he would like to inquire if any trouble with electrolysis had been experienced in their underground steam piping. He believed it would be interesting to repeat the experiment after a period of time, to find out if the conditions were permanent.

The statement had been made that none of the district heating systems operating in the United States used a return pipe for condensate returned to the boiler plant. If this was investigated it would be found that a considerable number used a return pipe system. The Consumers' Power Company of Jackson, Mich., and Kalamazoo, also the Ohio Edison Company of Akron and many other similar companies were using return pipes and had been doing so for many years. Some of them had had more or less trouble with the return pipe deteriorating but these difficulties had been overcome in one way or another and recent extensions had always included the return pipe, indicating that the results were justifying the extra expense.

Referring to page 34, he noticed in 1930 that 18,045 tons of coal were burned under the boilers and at $7 per ton this figured out to $126,315. Taking the electric boilers at 1/10c. per kilowatt the operating cost was $42,732 or a total for the coal and electric boilers of $169,047. Taking $1 per thousand pounds as the average selling price for the steam, the total income figures $297,417. This left a gross income over operating costs for boilers of only $128,370 out of which must be deducted all fixed charges, maintenance, etc., and the fact that this plant had shown profitable operation certainly indicated efficient management and low maintenance cost.

He thought the author's supplementary paper about the important points to be considered in the commercial aspect of a district heating system was excellent.

G. W. Oliver[16]

In reply to Professor Hall, the author observed that while it was not possible to determine the transmission line losses without considerable effort and expense, neither of which had been deemed necessary to date, yet the question could be answered if it was read to include all losses that occur between the meters in the plant and the meters in the

(11) Chief Engineer, Toronto Terminals Railway Company, Toronto, Ont.

(12) Kerry and Chace Limited, Toronto, Ont.

(13) Hydro-Electric Power Commission of Ontario, Toronto, Ont.

(14) University of Toronto, Toronto, Ont.

(15) Ric-wiL Company, Cleveland, Ohio.

(16) City of Winnipeg Hydro-Electric System, Winnipeg, Man.

customers premises. In this case, the losses ranged from a minimum of 19.07 per cent to a maximum of 27.28 per cent, with a mean of 24.12 per cent for all years.

In answer to Mr. Haanel's inquiry, while the burning characteristics of lignite left nothing to be desired, yet there were several other factors that indicated that a change to bituminous coal would be advantageous. Chief amongst these were:

(1) The cost of handling was excessively high. Three shifts were necessary to keep the plant supplied with sufficient lignite to meet the steam demand.
(2) Storing was hampered due to spontaneous combustion.
(3) Difficulties were experienced in reducing the moisture content of the lignite sufficiently low to overcome "arching" in the bunkers.

With bituminous coal, one shift was sufficient under normal conditions and one and a half shifts on peak loads, for handling. Furthermore, spontaneous combustion, arching and drier troubles had been completely eliminated.

As far as he was aware, no definite ruling was made as to the datum temperature for calculating degree-days. A rough check seemed to indicate that 70 degrees was used almost as frequently as 65 degrees. However, as Winnipeg had no desire to be isolated in this respect, the author would be much indebted to Mr. Haanel if he would be good enough to post him regarding some definite ruling.

Mr. Haanel had raised a question that was being asked continually, "how does the cost of central heat compare with that of the individual furnace"? Unfortunately no definite answer could be given, as so much depended on the human element and to the method of arriving at costs. Strictly speaking, central heat should be credited with, in addition to its actual heating value, the cost of ash removal, elimination of periodical cleanings due to coal dust, etc., the savings of a furnace attendant or the equivalent savings in owners time, and numerous other items such as furnace maintenance. Unfortunately, however, the cost of heating as computed by the average home only took into account the coal or fuel bill, and sometimes the cost of a furnace attendant. All other items entering into the cost of heating were apparently charged to general expenses. Furthermore, the coal pile in the basement was an excellent reminder to economize on heating. No such yard stick was available with central heat, and too often the window rather than the throttle valve was the method adopted for temperature control. Be that as it may, from the records available it was possible to say that central heating as conducted by the Winnipeg system, compared most favourably with the individual methods and in many instances it was below previous costs.

The author stated in reply to Mr. Watson that the distribution network was being operated at approximately its designed pressure. Extra heavy fittings had, however, been used at points where it was considered that large strains might take place, such for example as the elbows in the knuckle joint used on all service lines. Extra heavy fittings were also used on the 14-inch main between the plant and the corner of Portage avenue and Main street, via Louise and Rorie streets. This line was equipped thus to allow "high pressure" steam to be turned into the load centre for maintaining network pressure under large loads. To date, however, conditions had not warranted the use of this line as a high pressure feeder.

The running of mains through the basements of customers' premises, whilst undoubtedly reducing initial capital expenditure, had to be approached very cautiously, for while present tenants might be very friendly towards such a scheme, conditions might change that would involve the removal of the main thus doubling the capital expenditure of the lines. Because of this, the system only utilized customers' basements under the most favourable conditions.

The maximum spacing of expansion joints was governed by the available traverse of the joint itself. Spacings less than maximum were controlled by local conditions, such for example as the spacing of manholes.

No difficulties of a serious nature had been experienced with pressure reducing valves, in spite of the fact that only one valve was used for all loads.

No charges were made to the customer for laying a service line unless the premises were at a considerable distance from the "building line," or because some special work was required by the customer. In these cases the customers were charged for all work beyond the "building line" or for all work outside standard. Furthermore, should the premises be isolated, or a considerable distance from existing lines, then the customer had to bear a portion of the cost of laying the service, the proportion payable being governed by the available load and the nature of the district.

The standard contract for heat required that the customer would use heat for the current season, beyond this no guarantee was made. Should the customer discontinue the service after the season was completed, then the system had to bear the cost of that much idle capital.

While Professor Arkley's suggestion regarding the bleeding of turbines for central heating purposes would undoubtedly prove very beneficial to a station in which the steam demand of the turbines and that of the heating system were well balanced, and also where no anxiety would be experienced for the disposal of steam during the summer months, yet in the case of the Winnipeg station there were several factors that prohibited the adoption of such a practice, the chief of which were:—

(1) The turbines were designed and under course of erection before central heat was decided upon, hence to bleed these turbines would have been an expensive proposition.
(2) As there was but 11,000 kw. of installed turbine capacity sufficient steam could not be bled to supply the heating demand. Because of this, desuperheaters and pressure reducing valves would have had to be used as at present, thus introducing a multiplicity of operations which was contrary to the best central heating practice.
(3) The Hydro system had sufficient installed capacity to care for its electrical load, and therefore did not require the use of the steam turbines for other than emergency purposes.
(4) During the summer months a considerable amount of steam would have been wasted, since to utilize this in an absorption refrigeration plant would have been against the interests of the Hydro because of their interest in electric refrigerators.

No trouble had ever occurred from explosions either in the electric boilers or from pulverized coal.

Owing to the present low cost of water, it was not economical, financially, to return meter condensate to the boiler plant.

The relationship between the hydro-electric system and central heating system, whilst somewhat complicated, could be set out as follows:—

The Hydro maintained and operated the turbine room, purchasing both steam and labour from the heating system for this purpose.

The boiler room was maintained and operated by the central heating system, purchasing from the Hydro electricity for both power and light.

All heat returned to the boiler room in the form of condensate was credited to the Hydro, whilst the heating system received an annual payment from the Hydro for maintaining pressure in the boilers at all times for standby purposes.

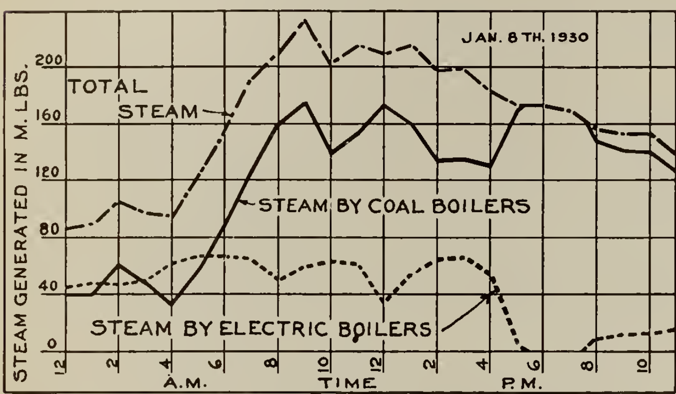

Fig. 17

There were one or two factors that entered into the hot water jobs of the system that materially affected the average consumption per square foot of radiation, viz.:

(1) There were only about ten such customers on the lines, so that any variation on one or two of the premises would materially affect the average.

(2) Several of these carried twenty-four-hour temperatures, whilst others carried high night temperatures.

(3) The majority of these customers carried excessively high condensate temperatures, due to inability to use economizers.

The loads carried by the fuel boilers could be seen from Fig. 17.

The analysis of the water used in the boiler plant was as follows:

Feed Water Analysis

Physical

Colour	16 (approx.)	Varying with season
Turbidity	Slight	
Odour	Very faint vegetable	
Taste	Slightly vegetable	

Sanitary

Ammonia free (as N)	0.068 parts per Million	
Ammonia Albuminoid (as N)	0.40	do.
Nitrites (as N)	Trace	do.
Nitrates (as N)	0.1	do.
Oxygen consumed 4 hrs. at 70 deg. F.	1.8	do.

	Parts per Million	Grains per Gallon
Total Solids	130	9.1
Calcium Ca	26	1.82
Magnesium Mg	7	0.5
Sodium Na	2	0.14
Chlorine Cl	1	0.07
Sulphate SO_4	2	0.14
Carbonic Acid CO_3	54	3.78
Alkalinity—Temp. Hardness	90	6.3
Incrustants—Perm. Hardness	Nil	Nil

This water was untreated, and while it was necessary to put a boiler out of service for cleaning, the cost of doing so had not warranted the installation of water treating equipment.

No trouble had been experienced either with dissociation of steam or excessive wear of plates in the electric boilers.

The author mentioned that Mr. Hall had raised a most important point, one that should receive far more consideration than was usually given to it, viz.: "...fixed charges, operating and maintenance costs were the important items to be considered, ..." The author felt that too much stress could not be laid on keeping these three items, especially "fixed charges," as low as possible without sacrificing reliability or safety.

The load curves for the peak day of 1930 were reproduced and show fairly clearly the preference given to the electric boilers. In 1930, practically all the steam was generated by the coal fired boilers.

It was general practice that the customer accepted delivery of steam on the customer's side of the pressure reducing valve.

The evaporation per kilowatt-hour from the electric boilers varied with the temperature of the feed water, but for all practical purposes, a factor of three pounds of steam was good.

Reading Mr. Ambrose's last question to mean the cost of steam generated by the electric boilers, this worked out at 33.33 cents per 1,000 pounds of steam for energy only. Labour and water would bring this figure up to some forty cents.

The capital cost per boiler horse power was just over two hundred dollars. This figure included land, building, stacks, boilers, coal handling and all auxiliary equipment. It was somewhat unfair to compare the municipal plant with the other heating plants of Winnipeg for several reasons:—

(1) The municipal plant was designed and built some nine years ago when prices were undoubtedly higher than they are today.

(2) The plant was designed originally as an electrical generating station, and for this reason it was perhaps somewhat more elaborate than would have been the case had it been designed purely as a heating station.

(3) It was only comparatively recently that the simple equipment as used in the latest of Winnipeg's heating plants had become commercially successful.

The water used in the electric boilers was entirely untreated, and while it was necessary to clean a boiler every 12 or 14 million kilowatt-hours yet it was found to be more economical to do so than to install a treating plant.

The maintenance rate on the distribution network was practically negligible, the only work necessary had been on repairs to leaks and the odd cleaning of traps and valves.

The outlet temperature of the condensate from customers' premises varied with the individual heating installation, and varied from below 100 degrees F. on a good installation, up to 170 degrees F. on a poorly equipped system.

In reply to Mr. Bonus he remarked that no trouble had been experienced with the "growing" of pipe lines, and as this was new to the author, he would be interested to hear the experience Mr. Bonus had had along these lines.

No trouble had been experienced to date with electrolysis in the distribution network.

While the scheme of laying pipe-lines as near the surface of the road as possible would undoubtedly result in a considerable reduction of capital expenditure, yet unfortunately conditions did not permit of this in Winnipeg, at least in the downtown area. Obstructions were very plentiful near the surface, and to avoid these it was necessary to run the pipe lines at a considerable depth below grade.

Received too late for inclusion in original paper:

City of Winnipeg Hydro-Electric System Central Heating System Statistics 1931

Plant

*Pounds of steam generated by	
Electric Boilers	120,808,500
Coal-fired Boilers	304,373,826
Kilowatt-hours to electric boilers	40,287,700
†Tons of coal burned under boilers	19,006
Peak load in pounds of steam per hour	235,000 (Feb. 6)
Max. output in pounds of steam per day	3,936,766 (Dec. 7)

Distribution

Pounds of steam sold to customers	292,011,140
Connected square feet of radiation	944,793
Number of customers	242

Mean temperature and steam sales

	Mean Tempr.	Monthly Sales
January	9.35	57,366,700
February	17.80	43,285,000
March	19.70	45,173,000
April	41.00	20,707,100
May	50.20	11,704,200
Summer		346,020
September	60.00	3,524,140
October	48.20	16,038,980
November	30.10	38,408,000
December	18.40	55,458,000
Mean	32.75	Total 292,011,140

*Includes steam to turbines, plant auxiliaries and horse power plant.
†Includes coal used for banking during summer months.

Distribution Network

	Size	Length
Mains	14″	5,443.32 lineal feet
	12″	5,609.65 "
	10″	1,055.35 "
	8″	12,147.65 "
	6″	3,944.36 "
	4″	240.00 "
Services	8″	58.00 lineal feet
	6″	1,034.75 "
	4″	4,000.75 "
	3″	2,655.96 "
	2½″	4,190.77 "
	2″	33.92 "
	1½″	12.92 "
	1″	57.67 "

Discussion on "Ice Thrust in Connection with Hydro-Electric Plant Design —With Special Reference to the Plant at Island Falls on the Churchill River"

Paper by Ernest Brown, M.Sc., M.Eng., M.E.I.C., and George C. Clarke, C.E., M.E.I.C.[1]

H. B. Muckleston, m.e.i.c.[2]

Mr. Muckleston observed that in view of the great care exercised in the experiments it was not likely that anyone would be disposed to dispute the accuracy of the observed results.

Towards the end of the paper, the authors noted that the observed rates of rising temperature recorded at Montreal might be exceeded in such regions as the chinook belt. There was a tradition of a record, at Calgary, of a rise of 40 degrees F. in 40 minutes and as he remembered it, the rise was followed by an equally rapid fall with no perceptible interval between. The Montreal records, and the Calgary tradition, referred to the atmosphere. It was hard to imagine that the ice sheet on any large body of water could possibly keep pace with any such rise as, even, the worst of the Montreal performances, let alone the Calgary exhibition. Even the temperature of the surface ice would lag behind the air temperature. At constant air temperature, the temperature gradient within the ice would fall from that of the air at the surface to freezing point at the bottom. In a rising air temperature, the point of minimum temperature within the ice would be somewhere below the surface and this point became lower in the sheet as the air temperature rose, until, when the air reached the melting point, the point of minimum ice temperature would be at the bottom of the sheet. The effect of this condition was a very pronounced lag in the rate of change of average ice temperature behind that of air temperature, and the magnitude of the lag must increase as the air temperature rose and probably also with the rate of rise.

If it was considered that rapid changes in air temperature were improbable in regions where very extreme low temperatures were experienced, with notable exceptions in the chinook belt, the allowance of 10,000 pounds per linear foot of ice should be considered safe, even conservative, for the dams at Island Falls, and that even for dams in the chinook belt it should be quite as large as a reasonable factor of safety would require.

R. F. Legget, a.m.e.i.c.[3]

Mr. Legget stated that it was to be hoped that the research described in the interesting paper by Professor Brown and Mr. Clarke would be made the more valuable by evincing, in the discussion, records of practical experience of ice pressures and temperature changes which might usefully be compared with the experimental results.

There were few published records of ice pressure on dams; it might be worth while to give two references of which he had taken note. N. Royen in an article entitled "Istryck vid Temperaturhöjningar" (Ice pressure due to increase of temperature) appearing in Hyllningsskrift Tillagnad F. Vilh. Hansen, Stockholm, 1922, showed apparently from theoretical reasoning, that the pressure due to a layer of ice would not exceed 5,000 pounds per linear foot for ice 40 inches thick, and 4,500 pounds per linear foot for ice 30 inches thick. This paper was quoted at the First World Power Conference, held in London in 1924.

In the Engineering News Record for November 10th, 1927, an ice pressure at Keokuk, U.S.A. on a gate structure which was broken by the thrust of expanding ice, was given as 7,400 pounds per linear foot, the thickness of the ice sheet not being stated. There had appeared various references to a system for preventing the formation of ice by means of bubbles of compressed air at Keokuk, and it would be interesting to know if there was any connection between this and the failure noted above.

The authors of the paper mentioned the temperature records which must be available for various localities across the Dominion. One such record was kept throughout the construction of the Upper Notch automatic hydro-electric plant in northern Ontario (about 20 miles from Cobalt), by the construction division of the Power Cor-

(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and published in the January, 1932, issue of The Engineering Journal.

(2) Consulting Engineer, Vancouver, B.C.

(3) 12 Amesbury Avenue, Montreal.

poration of Canada Limited. The temperatures there recorded were the maximum and minimum which occurred every 24 hours, and the maximum variation recorded in this way was 58 degrees F. in 24 hours.

As hourly records were not kept, it was regretted that the exact time taken for this change could not be given, but assuming (as was *not* the case) that the rise was spread over 24 hours uniformly, this gave a rate of change of almost 2.5 degrees F. per hour. The actual rate might have been as high as 4 degrees per hour. Changes of over 50 degrees F. in the 24-hour periods were common in the spring season and all occurred below the freezing point of water.

In a booklet recently published by the Department of the Interior, "Canada's Western Arctic," some interesting temperature charts plotted within the Arctic Circle were reproduced. These were daily temperatures, but whether average or minimum, was not stated. However, the charts suggested that some of the hourly rates of change must, of necessity, be higher than those quoted in the paper as occurring in Montreal.

The ice pressure adopted for the design of the dam at Island Falls, although smaller than that advocated in some quarters, was still sufficient to have had a serious effect on the designed cross section of the dam. He wished to suggest that the following factors would affect the pressure to some degree:

1. That the ice sheet over a reservoir or forebay would generally be formed starting at the face of the dam and slowly spreading upstream.
2. That even a thin covering of snow over the ice sheet would effectively protect it from changes of the air temperature.
3. That the specific heat of air, in conjunction with its specific gravity and the heat conductivity of ice, would have a very marked effect on the temperature gradient through the ice sheet.

All three factors would tend to reduce the pressure due to an ice sheet against a dam below the pressures suggested in the paper. Against them, however, must be set the possibility of the surface of the ice sheet cracking, under severe changes of temperature, the cracks later being filled with melted snow and ice which would expand in due course and cause what might almost be called a "secondary pressure."

Although so many factors influenced the final pressure required for design purposes, there were definite grounds for hope that in the future the present arbitrary and seemingly conservative values for this pressure would be checked against practical values, and the paper under discussion certainly supported this view.

W. S. Lee, M.E.I.C.[4]

Mr. Lee considered that the paper presented in an admirably direct and effective manner, a rational approach to the problem of ice pressure exerted on dams. While the physical properties of ice had been the subject of tests and studies by scientists for a long time, but little emphasis was placed on the property of plasticity or non elastic flow which was a function of both pressure, time and temperature, and which limited the pressure which ice could exert, due to rise in temperature.

In connection with the design of the Isle Maligne station structures, in 1923, Mr. Lee had made a study of the available literature on the subject and found that the methods of estimating ice pressure, then in vogue, were based on either of the following assumptions:

(1) Ice pressure against a dam was equal to the crushing strength of ice. This assumption was, of course, safe enough but the values for crushing strength, as reported by various experimenters, varied from a maximum of 1,120 pounds per square inch on a 2-inch block of ice to a minimum of 108 pounds per square inch on an 18-inch block.

(2) Ice pressure was equal to the crushing strength of ice, as modified by the "column" action of the sheet of ice in front of the dam. A study of this "column effect" showed, however, that it would result in a reduction only if very high values were assumed for the crushing strength of the ice.

(3) Ice acted as an elastic material with a constant modulus of elasticity and a constant coefficient of linear expansion. The values of E, however, as reported by different investigators, varied from 250,000 pounds per square inch to 1,300,000 pounds per square inch.

A search of foreign literature brought to the writer's attention the studies and tests made by Professor Kruger and Mr. N. Royen for the Swedish Board of Waterfalls, in 1921 and 1922. They fully recognized the plastic nature of the material and made tests to determine the effect of pressure, time and temperature on the plastic deformation. Based on these tests and on similar tests made on another plastic substance, paraffin, Mr. Royen derived the following formula, expressing the "law of plastic deformation":

$$e = \frac{cs\sqrt[3]{h}}{t+1} \text{ where}$$

e = coefficient of plastic deformation
c = constant (varies from 0.00060 to 0.00090)
s = unit stress in kg./cm.^{2}
h = time in hours
t = mean temperature below 0 degree C. — used as a positive quantity.

Assuming the least favourable value for the constant "c" Mr. Royen also derived the following formula for the maximum limit of ice pressure:

$$s \text{ max.} = 1640\, a\, (t_o + 1) \sqrt[3]{\frac{t_o}{h_s}(t_o + 1)^2}$$

where

s = max. ice pressure in kg./cm.^{2}
a = coeff. of linear expansion per degree C.
t_o = mean temperature of ice before expansion – degree C. (used as positive quantity)
h_s = time in hours, for increase of temperature from t_o to 0 degree C.

In applying this formula for the value of ice pressure to be used in the design of the Isle Maligne station structures, the following values were considered:

"a" = 0.000053 per degree C. = (0.000029 per degree F.)
t_o = 10 degrees C. (in the middle of a 2.5-foot thick ice sheet. This corresponds to an air temperature of at least −20 degrees C. or −4 degrees F.)
h_s = 18 hours.

For these values "s" was 3.9 kg./cm.^{2} or 55 pounds per square inch. This was equivalent to 20,000 pounds per linear foot for a 2.5-foot thick ice cover. This value was used in the design.

Applying the curve given in Fig. 8 of the authors' paper to the assumed Isle Maligne station conditions, the pressure per linear foot was only 2,500 pounds, considering a linear variation of temperature in the 2.5-foot thick ice sheet. While Mr. Royen's formula was intended to give an upper limit for ice pressure, based on unfavourable assumptions, the difference in results was greater than one would like to see. It would be interesting to have the authors apply their detail experimental data to check the validity of Mr. Royen's formulae. It was to be noted that a "factor of safety" of about 2 was applied to the results of the authors' experiments in adopting the value of 10,000 pounds per linear foot for the design of the Island Falls station dams.

[4] Vice-President and Chief Engineer, Duke Power Company, Charlotte, N.C.

As the authors pointed out, the selection of a proper value for ice pressure was of great importance in the economic design of low and medium height dams, especially when the maximum flood water level was assumed at the same elevation as the top of the ice. This was the assumption made by the authors. In many cases, however, the maximum high water level was from 2 to 10 feet or more above the maximum winter, or top of ice, level. This tended to reduce or even to eliminate the ice pressure as a controlling factor in the design of the dam. Thus at the Isle Maligne station, the maximum flood water level was considered 8.5 feet above the top of ice and for this condition, even the 20,000 pounds per linear foot value of ice pressure passed out of the picture as a controlling factor in the design of the structures for a height of dam above 70 feet. (Design assumptions included uplift.) For the full height of the Isle Maligne station bulkhead of 116 feet an ice pressure of even 30,000 pounds per linear foot could have been assumed without requiring additional masonry, and without reducing the stability factors below the values for the maximum high water condition.

Professor R. W. Angus, M.E.I.C.[5]

Professor Angus remarked that an interesting thing about the two graphs in Figs. 4 and 6 was that in the first case, Fig. 4, the mean temperature of the loading blocks was about 10 degrees less than the mean temperature of the air space, and in the other graph, Fig. 6, the mean temperature of the air space was about 5 degrees less than the mean temperature of the loading blocks. He could not understand why that should be, because in the Department of Mechanical Engineering at the University of Toronto a great number of tests had been made on the flow of heat through different substances, and it was invariably found, in a case like that of Fig. 1, where the transfer of the heat was from the outside air through the sides of the container, then through the ice to the cooler in the metal blocks *A* and *B*, that the air in the space near the ice was considerably warmer than the ice, and also than the blocks *A* and *B*.

There was a definite temperature drop at each of the surfaces and there was a temperature gradient in the air near the ice, so that if the heat was passing into the ice through the sides *D* to melt it, there would be a considerable difference between the temperature of the inside air and of the ice, and it would appear that the relative position of the curves shown on the lower part of Fig. 4 was correct.

In both figures the flow of heat was in the same direction; the ice was being heated by the air surrounding the box and the temperature of the loading blocks should always be lower than that of the air between the sides *D* and the ice.

Another very interesting thing was observed by comparing the two "average trend" lines of temperature rises, shown on Fig. 7, as there seemed to be a lack of agreement between them which was disconcerting; perhaps the authors could explain that.

On the top half of Fig. 7, the authors had shown the rise of pressure with temperature, but plotted on a time base, and on the bottom graph had shown two different rates of rise of temperature with time. The curves showed, on the bottom graph, that the temperature of 25 degrees was reached at 9.20 p.m. and again at 2 a.m., and that the pressure as shown on the upper curve was the same following the slow rise of temperature as it was for the faster rate of heating. In the upper graph, taking the same temperature of 25 degrees, the pressure was 310 pounds for the slow rate of heating, and practically the same for the fast rate of heating. It was true that there was a slight difference, but not very much.

However, if the pressure for the lower temperatures on those two graphs were examined, there was a definite difference between them. For instance, taking the temperature of 5 degrees below zero, which occurs at 3.40 p.m. and again at 11.15 p.m., the pressure as shown on the upper graph for the slow temperature rise was quite different from that for the higher rate. Thus, at 3.40 p.m., when the record showed 5 degrees below zero and the temperature was rising at a rate of 5.25 degrees F. per hour, the pressure was 180 pounds, but later on at 11.15 p.m., when the temperature was again at 5 degrees below zero, and the rate of heating corresponded to 10.9 degrees F. per hour, the pressure was only 20 pounds or one-ninth of what it had been for the same temperature earlier in the day.

There was also another thing which seemed important, and that was the rate of temperature change in the ice, and he would ask if that had been taken into account. When ice was on top of the stream the lower face of it was in contact with the water, which was normally at 32 degrees, and the upper surface was in contact with the air, which might be minus 30 degrees. Had the authors made any measurements to find out the actual temperature of the ice during the tests, and how it varied with the temperature indicated on Fig. 7? Information of this kind would help to clear up the question raised above.

The work was particularly interesting, and he thought The Institute was to be congratulated upon receiving a paper of this kind, and he hoped the authors would continue with their investigations.

J. M. Fairbairn, A.M.E.I.C.[6]

Mr. Fairbairn observed that it seemed to be assumed throughout the paper and from the discussions heard that if the top layer of ice expanded and exerted a pressure, the pressure would be resisted entirely by the face of the dam.

Now, in a thick sheet of ice a sudden rise in temperature did not reach or affect the lower portion of the ice for some time and the lower portion never had as great a rise in temperature as the upper layers.

Therefore, it would seem that when the top layers of ice attempted to expand quickly and exert an expansion pressure, this large lower portion of the ice sheet which was not expanding would, in effect, go into tension and counteract to a great extent the effort of the top layers to expand.

This, of course, would not apply to any extent with a slow rise of temperature, but would be of considerable moment when sudden rises occurred above the ice sheet and, as there was a tendency for the ice to flow under continued pressure, it was the more rapid rises that were supposed to create greatest pressure against the face of the dam.

He thought, therefore, that the thickness of the ice sheet and the resistance of the lower layers of ice to any expansion of the top layers in sudden temperature rises would considerably reduce the effective pressure against the face of the dam.

J. H. Ings, A.M.E.I.C.[7]

Mr. Ings stated that some years ago he had entered into a discussion on ice pressure against a dam, and the line of argument taken was somewhat different from those set out in the paper. That is, most of the tests discussed today had been taken with the ice block between two fixed points, and he was wondering if the author could throw any light on the question of ice pressure on dams in long reaches of lakes, and what was the effect of the ice against the dam when moved by the wind, whether it was a purely crushing strength, or whether the sheet would bend. That was one

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of the points which had struck him as possible, as compared to tests purely on a restricted block.

Harold S. Johnston, m.e.i.c.[8]

Mr. Johnston stated that the experiments described in this paper showed the relation between the temperature change in a three-inch cube of ice, the time during which such change took place and the resulting increase in pressure. Although the actual temperatures of the ice were not recorded, still on account of the small size of the cubes and the manner in which the changes of temperature were brought about, the temperature of the ice would be very close to those given.

Concerning rapid changes in atmospheric temperature, there had been experienced west of Calgary a change of 80 degrees F., from 40 below to 40 above in four hours.

To apply the results of the experiments and the knowledge of changes in atmospheric temperature it was necessary to know in what manner the temperature of the ice responded to changes in that of the atmosphere. The temperature of the ice would be affected to a much greater extent by that of the water than by that of the air. A hot iron cooled much more quickly in water than in air of the same temperature. For equal volumes, the capacity for heat was approximately three thousand times as great in the case of water as in that of air. There was also the loss of heat which was taken up by the formation of ice, which would also tend to equalize the temperature of the ice sheet.

In view of the influence of the water and of ice formation on the temperature of the ice sheet it was doubtful if the mean temperature would vary much below 32 degrees. Any changes would be much slower than those in the atmosphere and if the fluidity of the ice was considered the resulting changes in pressure would be small.

There was a condition not mentioned in the paper which might conceivably result in the maximum overturning moment on a dam. With the water at a constant level a sheet of ice of considerable thickness might freeze fast to the face of a dam. The water level might then drop and remain at a lower level for sufficient time for the ice sheet to become set to the changed conditions. On the water rising, a force might be exerted on the dam which might be of considerable magnitude and could also be combined with the force due to the expansion from a rising temperature. Such a condition was given consideration by John R. Freeman, in the design of a dam in 1910. The actual pressure against the dam would depend largely on the shape of the lake or pond and on the nature of the shore. Abrupt banks of an unyielding nature would cause the maximum force on the dam. If the shores adjacent to the dam were of a different nature they might assist in relieving the pressure on the structure.

Cases were known in which flashboards, designed to go out with a depth of six inches over this type, have withstood the pressure of ice during a winter in Nova Scotia.

J. W. Tyrrell, m.e.i.c.[9]

Mr. Tyrrell remarked that his chief experience with ice pressure had been met with when travelling with dog teams on the Great Slave Lake, or even on Lake Winnipeg, where the party was suddenly confronted by what appeared from a distance to be a range of hills of broken ice, extending across the lake. At certain periods of the day, if one attempted to cross, he would meet open water. The channel due to the contraction and expansion of the ice which was open at certain times and at other times was closed. As the ice expanded it threw up a great ridge of broken ice, and as it contracted again due to the fall in the temperature, it opened up.

Professor E. Brown, m.e.i.c.[10]

Mr. Brown observed that it must be understood that the results submitted referred solely to pressures due to the resistance offered to the expansion of ice due to rising temperature, and had nothing to do with conditions arising in long open stretches of water in which ice might be moved against a dam by wind.

Many speakers had emphasized the necessity of obtaining information about the changes of temperature in a sheet of ice when the temperature of the air rose. This was most essential if the results found in the laboratory tests were to be applied rationally. Many interesting speculations could be made, and had been made in the discussion, as to what occurred in a sheet of ice when the temperature of the air rose, and as to how pressures might be developed or relieved. Laboratory experiments, in themselves, could not lead to final conclusions. They must be used in conjunction with information accumulated in other ways, and in the light of the experience and judgment of the engineer. The authors hoped that additional information would be accumulated which would aid engineers in making rational estimates of ice pressure against hydraulic structures.

Professor Angus had referred to the flow of heat between the loading blocks and air space surrounding the ice, and the ice itself. His difficulty in picturing what was happening might arise from his attempt to correlate the records shown, with some of his own tests on the steady flow of heat through different substances under definite temperature gradients. In the tests described, the problem was to get a piece of ice to some definite temperature and then allow the temperature to rise at a specified rate. The average line drawn through points showing temperatures of air space and loading blocks must not be understood to give the exact temperature of the ice, but rather an estimate of its temperature. Considerations of heat transfer such as Professor Angus had in mind might not be reconcilable with a line so drawn, but the line probably represented the temperature of the ice within two or three degrees, which was as close an approximation as the authors hoped for. The block of ice could not be expected to follow closely and quickly the changes of temperature of the metal loading blocks when pieces of dry ice were put into, or taken out of, the spaces provided. The thermometers were used to give a reasonably good idea of the temperature of the ice, and to determine the average rate of rise of temperature. It was believed that with slow changes of temperature, and having in mind the relatively small size of the block of ice, this procedure was justified. The results showed that the rate of increase of pressure for a given rate of rise of temperature was constant, so that the question of the exact temperature of the ice at a given time was relatively unimportant in considering the object of the tests. Minor departures from the degree of control aimed at were inevitable, but were of no special significance, having in mind the main object in view. Had a larger block of ice been used, there would have been much more doubt as to the temperature of the ice. It was assumed, rightly or wrongly, but probably with a reasonable degree of certainty, that the temperature of the ice at any instant was not far from that shown in the curves. The authors believed that many uncertainties would arise in a laboratory test if a large block of ice were used. The closeness with which the temperature of the block would follow a rate of rise of temperature of its surroundings, corresponding to rates which occurred in nature, would be in doubt. The same uncertainties would arise as those referred to by many of the speakers in regard to the rate of rise of temperature through a cover of ice abutting against a dam, and the results of such tests would be more difficult to interpret

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(9) J. W. Tyrrell and Company, Hamilton, Ont.

(10) Dean of the Faculty of Engineering and Professor of Applied Mechanics and Hydraulics, McGill University, Montreal.

than those for a small block which could more readily respond to the changes of temperature of its surroundings by reason of the smaller ratio of volume to surface area. It was possible that some more elaborate method of temperature control could be devised, but the authors questioned both the necessity and the value of such a procedure in view of all the conditions.

Mr. Lee and Mr. Legget had drawn attention to the results of an investigation by N. Royen on the probable maximum pressures which could occur under given conditions. Reference to the original paper showed that the work was undertaken at the instigation of the Swedish Board of Waterfalls. The conclusions reached were based on some tests on ice, supplemented by tests on the plasticity of blocks of paraffin. Mr. Royen recognized that "plasticity" or "flow" was of the greatest importance. He submitted an interesting mathematical analysis in which he applied the ideas gained from tests on paraffin blocks—which he found to be more easily handled than ice—to forecast the probable maximum pressure under the worst conditions likely to occur. He recognized the effect of plasticity in relieving pressure due to expansion resulting from rise of temperature, and his ideas and results generally were in line with those submitted by the authors. Later on it might be possible to check some of his conclusions with data found in the series of tests on ice given in the appendix to the Report of the St. Lawrence Waterways Board.

It was interesting to note that Mr. Lee applied Royen's results in the design of the dam at Isle Maligne, and did not find that the ice pressures were a serious factor in determining the section required. This dam was much higher than those at Island Falls.

Professor Angus had referred to a difference of pressure shown in Fig. 7 for the same temperature at different times. This was probably due to change in state of the ice, which "flowed" during the earlier period of the test. It was sometimes difficult to dissociate one's ideas from those which applied to an elastic substance. Ice had peculiar properties, and having been once loaded, it was not the same as before. The more rapid rise of temperature during the latter period shown in Fig. 7 was used to determine point *C* in Fig. 8. It was possible, of course, that the temperature of the ice did not follow this gradient so closely as the lower gradient. The fact that points *D*, *E*, *F*, *G*, *H*, and *I*, located from different temperature gradients lasting for short periods in the earlier part of the test, lay fairly well with points *A*, *B*, and *C*, gave ground for believing that the results indicated were reasonably correct. Ice was subject to variable conditions in nature, and the authors felt that the results of tests along the lines described were the proper starting point in considering the question of ice thrust.

G. C. Clarke, M.E.I.C.[11]

Mr. Clarke stated that Professor Angus had pointed out the difference between Figs. 4 and 6 in that in Fig. 4 the mean temperature of the loading blocks was considerably less than that of the surrounding air space, whereas in Fig. 6, the air space was lower in temperature than the loading blocks. This was an interesting difference which had not occurred to the authors, but which it was thought could be explained as follows:

Fig. 4 was the result of one of the earliest experiments during which the method of handling the dry ice was being studied for the future more accurate tests. It would be noted in the description of the "preparation of specimens for tests" that the air space in which the thermometers for reading the air temperature were set, was enclosed by an inch of insulating board. Undoubtedly, there were two paths of travel for the heat from the room to the test piece of ice. One which Professor Angus mentioned, through the insulating board to the air space surrounding the ice, and the other, which he neglected, through the head and base of the testing machine to the loading blocks.

During the earlier experiment the rise in temperature was rapid and the larger part of the heat undoubtedly passed through the air space, accounting for the temperature of that space being higher than that of the loading blocks.

During the later and more detailed tests shown on Figs. 6 and 7, a quantity of dry ice was placed about the outside of the insulating board in order to retard the passage of heat through the air space and thus to decrease the rate of rise of temperature of the test piece. Undoubtedly, under these conditions more heat passed through the loading blocks from the head and base of the machine than through the insulating board, thus causing the reversal of the relation between the temperatures of the loading blocks and the air space which Professor Angus noted.

No attempt was made to determine the actual temperature of the test piece during the experiment. First, because it was thought that any device attached to or embedded in so small a piece would alter its reaction to change in temperature and produce a much greater error than that caused by any slight difference which existed between the average temperature of the test piece and the recorded temperature. Secondly, because the result which the experiments were after was, not to determine qualities of the ice at any given temperature, but to show the effect of rising temperature in the ice in producing pressure.

Another point of interest which Professor Angus pointed out was with regard to Fig. 7 in which he showed that at 2 a.m. when the temperature was the same as at 9.30 a.m., the pressures were practically identical, while at 11.15 p.m. when the temperature was the same as at 3.30 p.m., there was a wide difference in pressures; the former being 20 pounds whereas the latter was 180 pounds.

This was a clear demonstration of the plasticity of ice. If ice were a purely elastic substance and the changes of temperature applied to the test piece were insufficient to cause the pressure to exceed the elastic limit, then the pressure at 11.15 would have been the same as that at 3.40 when the test piece was at the same temperature, but owing to the plasticity of ice the chart showed a condition similar to that which would occur in an elastic substance when the pressure applied greatly exceeded the elastic limit.

The fact that the pressure noted at 2 a.m. was the same as the pressure noted at 9.30 p.m. when the temperatures were the same, was a mere coincidence and was the only point on the graph where the temperatures and pressures on the second half of the graph coincided with those on the first half. The pressure in the second half of the graph reached the same value as shown in the first half of the graph though beginning at 160 pounds less, by reason of the fact that it was rising much more rapidly in the latter than in the former, due to a more rapid rise in temperature, thereby permitting less flow.

It might be well to point out an error in Mr. Legget's statement as to the pressures given by N. Royen in his article on ice pressure. Mr. Legget had confused pressure per linear foot with pressure per square foot. A translation of N. Royen's statement was as follows: "It may be considered as proven that under the climatic conditions in Sweden, the ice pressure cannot under the most unfavourable conditions exceed 30 tons per linear meter with ice of 1 m. thickness or about 20 tons per linear meter with ice of 0.75 m. thickness."

It might be of interest to quote the concluding sentence of Mr. Royen's paper as follows: "It is probable that more complete investigations will show a further reduction in the above given limits of the ice pressure."

In conclusion the authors expressed appreciation of the interest shown in the tests, and thanked those who had contributed to the discussion.

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Aircraft Instruments

Notes on their Construction, Testing and Maintenance

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Paper presented on November 13th, 1931, before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada (Ottawa Section, Royal Aeronautical Society).

SUMMARY.—Peculiar difficulties arise in the case of instruments for measuring pressure, velocity, etc., in aircraft due to the very trying conditions under which they must operate. The author describes the difficulties of adjustment and maintenance, the effect of such adverse influences as vibration, wide range of temperature, etc., and discusses the sources of error in altimeters, airspeed indicators, revolution indicators and compasses.

The object of the aircraft instrument designer is to give a maximum amount of information to the pilot with a minimum number of dials. While these ends are somewhat conflicting, the first has now progressed to the extent that flying by the aid of instruments alone has been demonstrated to be possible. This entails, of course, the use of novel devices rather beyond the scope of the present paper, which is concerned with the more common aircraft instruments dealt with regularly in a laboratory and repair shop. Even with this restriction the instruments tend to increase in variety and the experimental devices of today are the standard equipment of tomorrow. While it is obvious that there is a limit to the number of dials a pilot can efficiently use, this number has tended to increase, and there is a growing desire to make use of instruments as these become more reliable.

The modern tendency is for a marked decrease in the dial and overall size of instruments, particularly in the case of instruments from the United States. This renders closer grouping possible but involves neater design and more careful construction, particularly as in some cases the forces actuating the indicating mechanism are also reduced.

Many of the problems encountered in dealing with aircraft instruments are common to other instruments, but some factors assume a relatively greater importance. These are, in the main, due to the conditions of exposure, vibration, elevation, motion and temperature under which aircraft instruments are required to operate.

Vibration, for instance, is now receiving more attention. In some American specifications a three-hours' vibration run is included amongst other tests to which the aircraft instruments are subjected before acceptance. This test is made by mounting the instruments on a vibration board producing circular vibrations in a plane inclined at 45 degrees to the horizontal.

Temperature Effects

The effect of temperature is one of the most important considerations in instrument design. In this connection the requirement of the British Air Ministry is instructive, i.e. instruments should function without derangement between temperatures of − 60 degrees C. and + 60 degrees C. Usually thermal effects show themselves in the form of expansion and change of elasticity. The latter is particularly important in those instruments which contain some form of spring for measuring the forces upon which the indications depend.

If the load on the spring is small at zero indication the error at any reading with change of temperature will not be so great as in the altimeter, for instance, where the spring supports a considerable load throughout its working range. Moreover, in general, the error will vary with the reading, as each indication corresponds to a different load on the spring.

Thermal linear expansion affects the multiplication mechanism, and by suitable design may be utilized to offset elastic thermal errors, as when invar or bimetallic elements are employed for certain parts.

Change of temperature, besides giving rise to errors of a regular or reversible nature, frequently introduces trouble due to the consequent dimensional changes producing interference between parts of the mechanism. In some cases this results in an instrument ceasing to function at extreme temperatures. Lubricants also may freeze at low temperatures, or become so viscous that the performance of the instrument is seriously affected. In one instance oil was used in a small dashpot to damp out vibrations in a special instrument. Under test this oil became so viscous at low temperatures that the dashpot prevented the pointer from functioning at all.

Similar trouble is experienced at low temperatures with the fabric diaphragms fitted to some airspeed indicators. The forces acting on an airspeed indicator diaphragm are very small at low speeds and an oiled fabric diaphragm pressing against a light spring produces a very sensitive instrument. But at low temperatures a stiffening of the diaphragm takes place producing the effect illustrated in Fig. 1 which reproduces the calibration curves obtained at various temperatures for an airspeed indicator of this type.

The thermal expansion of air being considerable, the temperature errors of such instruments as the confined air statoscope are large. It can easily be computed that the change in pressure of the confined air produced by an increase or decrease of one degree C. is equivalent to nearly 100 feet change in altitude at 5,000 feet elevation.

One can readily illustrate the small amount of heat required to change the pressure of the confined air in this type of level flight indicator by simply holding the hands around the instrument, when the indicator will begin to move after a few seconds.

The plan which has been tried of using a vacuum flask for the confined air is not so efficacious as would be expected on first thoughts. Taking the specific heat of air as 0.24 and the density as 0.0012, it is seen that for a given rise in temperature only 0.0003 times as much heat needs to pass into the contents of the flask when it is filled with air as when it contains water. Consequently while a vacuum flask will maintain a comparatively steady temperature over an extended period when it is filled with a liquid of high specific heat, the temperature will change much more quickly when it is air-filled.

One of the problems in compass design is to find a suitable liquid whose viscosity does not vary over much with change of temperature. Alcohol is used by the British Air Ministry as the most satisfactory, but even a water content as small as ten per cent is sufficient to produce sluggishness in the compass at low temperatures.

In the best instruments the thermal effect on the indication is reversible, but cases arise where the act of taking the instrument through a cycle of temperature changes results in a deviation in the reading which persists after return to the initial temperature. Frequently too, an appreciable time is required for an instrument to attain the temperature of its surroundings, and cases are not unknown where, during the period, the error of the indications is much greater than the error at the final temperature. Consequently the actual errors of instruments exhibiting this characteristic may be quite serious under operating conditions although they are apparently well compensated.

Some temperature effects in aircraft instruments can be overcome more or less perfectly by compensation. In

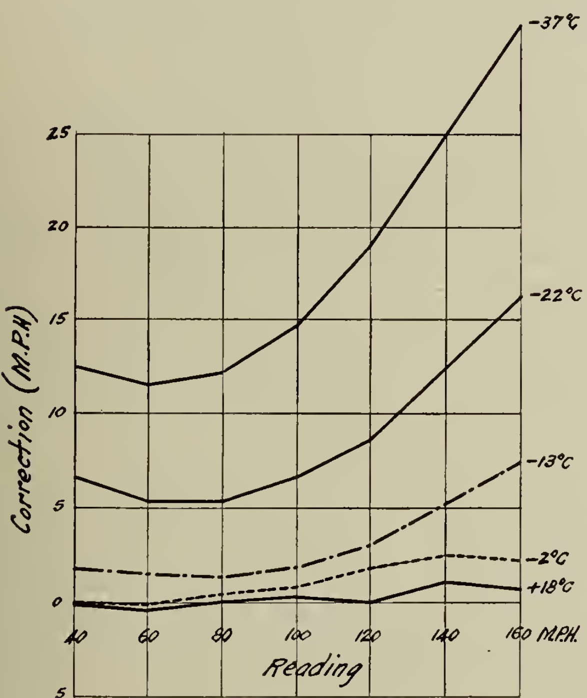


Fig. 1

certain cases a bi-metallic lever is incorporated in the indicating mechanism and adjusted to produce a deflection opposite in sign to that due to temperature. Generally the amount of the effect produced is more or less independent of the reading, but it is possible to fit a bimetallic element arranged to alter the effective length of a lever and so compensate the thermal action on the magnification factor.

Some of the latest British altimeters are compensated by a bimetallic helix on the hand arbor, which forms the connecting element between the arbor and the hand. The result is very good and Fig. 2 gives calibration curves at temperatures of − 30 and + 35 degrees C. for one of these instruments and for an average service altimeter.

It is easy to see that this form of compensation is suitable for an altimeter, if it be assumed that the source of thermal error is in the main spring, and that equal increments of height on the dial subtend similar angles.

Let P = the barometric pressure.
H = the indicated height.
E = the elastic modulus of the spring material.
α = the temperature coefficient of E.
K and C are constants.

The deflection of the spring corresponding to P at a given temperature is:

$$K\frac{P}{E}.$$

If the temperature rise t degrees, this becomes

$$K\frac{P}{E(1-\alpha t)}$$

i.e. changes by an amount $\frac{-K\alpha tP}{E}$ .... (1)

if we neglect small quantities.

By the convention assumed in graduating altimeters

$$H = C \log P \quad \text{.................. (2)}$$

Hence a small change of P, δP, produces a change in the indication $\frac{C\,\delta P}{P}$ .... (3)

Thus the small change (1) due to temperature change will move the instrument hand by the amount

$$\frac{-K\alpha Ct}{E} \quad \text{.................. (4)}$$

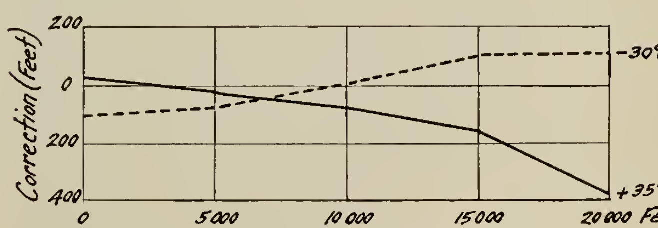
which depends on the temperature only.

It is seen, therefore, that a bimetallic helix which produces an equal and opposite hand movement should compensate the error due to the effect of temperature on the spring.

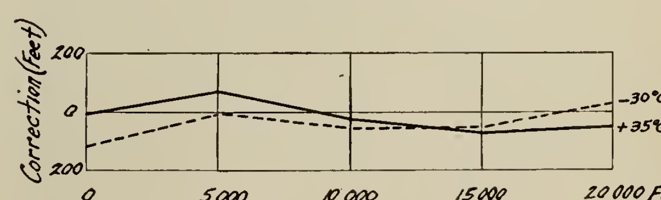
Advantage may be taken of air confined in capsules to compensate for temperature, and in special cases liquid filled capsules are employed.

In the mercury-filled distance thermometers, made by Negretti and Zambra, besides compensating the mechanism of the pressure gauge by means of a bimetallic helix, when long connecting tubes are used a portion of the tube is partially filled with an invar rod, the proportions being adjusted so that expansion in the space between the rod and the wall of the tube will compensate for the expansion of the mercury between the bulb and pressure gauge.

Compasses are usually provided with elastic capsules to take care of expansion of the liquid. These should exert such a pressure that bubbles do not form at low temperatures, although they sometimes occur at higher altitudes from another cause, the presence of air dissolved in the alcohol.



Service Altimeter



Mark VII C Altimeter

Fig. 2

Enough has been said on this subject to show that temperature effects are many and various. Temperature tests therefore assume an important rôle in standardizing aircraft instruments and in some cases at least, a test at extreme temperatures is desirable for every individual instrument. In all cases types or samples of each consignment should be given such tests before acceptance.

Elastic Effects

If all materials were perfectly elastic, i.e. if strain were strictly proportional to stress and absolutely reversible, it would be easier to make satisfactory instruments. Actually, imperfect elasticity gives rise to inaccuracies of a troublesome nature.

Fig. 3 reproduces the calibration curves of a Mark V. altimeter obtained by subjecting it to a rate of pressure change corresponding to a rise of 1,000 feet in five minutes and on reaching the end of the scale, returning to atmospheric pressure at the same rate. The difference between the curves obtained with rising and falling pressures is, in the main, due to imperfect elasticity of the exhausted capsule which is coupled to the measuring spring. It may, in part, also be due to imperfect elasticity of the spring itself, yield in the supports of the mechanism and excessive tolerances at hinge joints, etc. Fig. 4 illustrates the effect of imperfect elasticity in a more striking manner. It is the curve obtained from plotting on a time base the errors of an altimeter which has been subjected to a pressure equivalent to 10,000 feet altitude and allowed to remain at this pressure. The characteristic revealed explains why, when returning to the ground after a long flight, an altimeter may show an appreciable elevation, even if the barometer pressure is the same as at the time of take off.

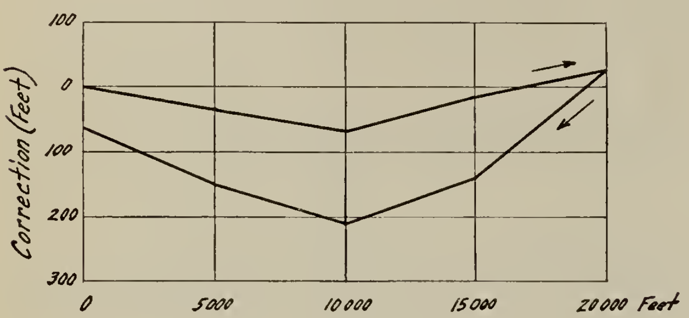


Fig. 3—Altimeter Reading.

It has been found that the solder used in the mechanism, when subject to change of stress, is one cause of the creep illustrated in Fig. 4. In altimeter capsules it has been considerably reduced by using a minimum of solder and designing the capsule so that the parts at soldered joints are deformed by a minimum amount. By improved design the amount of creep has been reduced to ten per cent or less of that found in war-time instruments.

Corrosion

Corrosion is responsible for some of the problems encountered in the use of aircraft instruments. Steel parts for pivots, ball bearings and hairsprings, for instance, are desirable in many instances but are very liable to rust from exposure or accidental immersion in water. The rusting in these cases may be so serious as to put the instrument entirely out of action. If instruments can be salvaged shortly after being accidentally immersed in water they should be dismantled and dried at the earliest possible moment.

While non-rusting materials are used in some quarters they are not so good as steel for many purposes. Phosphor bronze, for instance, is the next best material for hairsprings but does not give the service or performance of steel.

Mechanical Principles

Some of the more common aircraft instruments depend for their operation on small displacements which are magnified by a suitable linkage system and communicated to a hand moving over a graduated dial. The magnification ratio between the initial displacement and the movement of the end of the pointer may be considerable, perhaps two or three hundred times. If the linkage be poorly fitted with excessive clearances there will be a range of uncertainty in the magnification ratio due to variation of the effective lengths of the various levers.

On the other hand if the energy required to overcome friction in the mechanism is large compared with the available energy operating the instrument, it may exhibit sluggishness; although, in aircraft, the vibration may be an important factor in overcoming this tendency. It is not possible to construct all instruments with knife-edges, jewelled pivots and other devices to give increased sensitivity, but the difference between good and bad workmanship is readily seen during instrument-testing.

Adjustment

As a rule a freshly assembled instrument will not indicate correctly on a standard dial. Usually dials are graduated with equal increments of the indicated quantity subtending similar angles, but in many cases the movements of the actual indicating mechanism will be non-uniform. The force acting on an airspeed indicator gauge is proportional to the square of the airspeed, and if a water column were employed as gauge the indicated displacements would be very small at low speeds and inconveniently large at high speeds. Therefore, in airspeed indicators, altimeters and other instruments where the indicated quantity is not directly proportional to the forces producing the indication the mechanism has to be designed to give an approximation, at least, to a uniform scale.

Most instruments contain means by which the average magnification factor may be readily adjusted. To make the magnification ratio variable within some desired range it is usual to change the angle between the links and levers. In Fig. 5, AB is a crank turning about A, and actuated by a link BC. If the movement of the spring or other measuring element is in the direction of BC it is readily seen that δl, a given small displacement of C, will produce a small rotation of the crank $\frac{\delta l}{AB \cos \theta}$, where θ is the angle between AB and the perpendicular to BC. Hence by adjusting the length of AB and the range of θ corresponding to the total movement of the indicating hand it is possible to utilize a wide range in the relation between the linear movement of C and the rotation of AB.

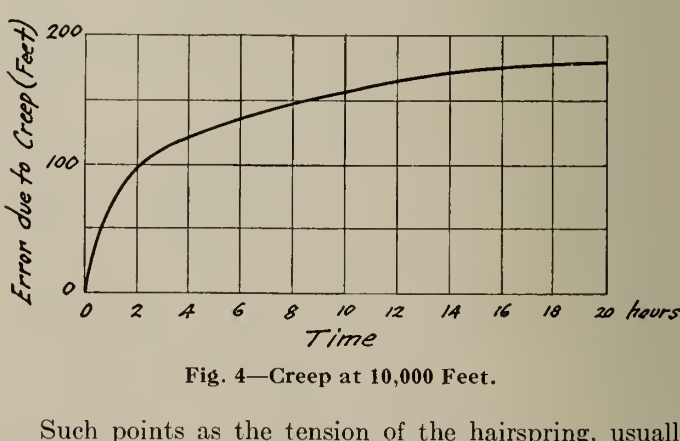


Fig. 4—Creep at 10,000 Feet.

Such points as the tension of the hairspring, usually fitted to take up backlash in the linkage, may affect the scale indications, and a skilled adjuster can, as a rule, make the calibration errors of an instrument quite small after one or two attempts.

From what has just been said it will be realized that even a small repair to an instrument may seriously affect the calibration errors, and may necessitate the whole process of calibration adjustment being repeated.

Effects Peculiar to Aircraft

Some effects which are absent in terrestrial use appear when instruments are employed in aircraft. The vapour pressure type of radiator thermometer is a case in point. This instrument is good for aircraft use in that, when the bulb is hotter than any other part of the thermometer, its indications are independent of the temperature of the capillary connecting the bulb and the pressure indicator.

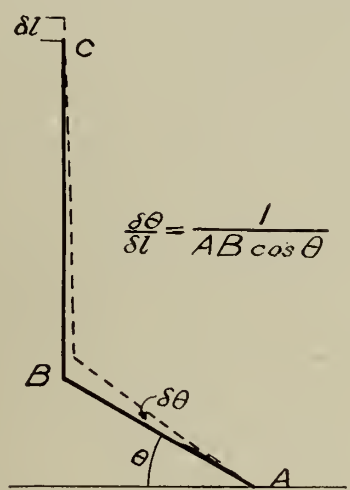


Fig. 5

The gauge, however, really measures the pressure difference between the vapour within and the atmosphere without, hence at each altitude the same temperature will correspond to a different position of the indicator. Consequently mercury-filled thermometers are coming into use. In these the mercury is under high pressure and the readings are practically independent of altitude.

A somewhat similar error to that just mentioned in connection with the vapour pressure thermometer, is introduced in the indication of some instruments by the movement of the plane through the air. This usually causes a reduction of pressure in the cabin or cockpit sufficient to produce an appreciable error in the altimeter readings. To obtain true altimeter readings it is necessary to seal the case of the instrument and connect it to the static element of an airspeed indicator pitot head. Some experiments carried out by the British Air Ministry have shown that for true static pressure to be indicated the static head should be 30 feet away from the plane. Experiments made in a cabin plane by the Royal Canadian Air Force at Ottawa showed a difference of 60 to 100 feet at 6,000 feet elevation between the indications of an altimeter when sealed and connected to a static head and secondly when in communication with the atmosphere of the cabin. No appreciable change was detected in the error for various positions within the cabin, but the error was smaller when the cabin windows were all opened. Naturally, it is to be expected that the error in question will be affected by the airspeed, design of aircraft, etc.

The compass is liable to give false indications in aircraft under certain conditions. Due to the quick turns made and the effects of banking and other manœuvres the heavy cards of the older compasses rendered them quite unreliable in aircraft, and even a source of danger during turns. Modern compasses have very light cards, heavily damped, and are an improvement, at the least, over the older ones.

Magnetic fields from various sources in the aircraft are also very troublesome, particularly as the compass, like other instruments, should be close to the pilot, who usually sits in a very poor position from the point of view of magnetic disturbance. Mirrors are sometimes fitted which enable a ready view to be obtained of a compass set some distance behind the pilot. Cards with reversed figures are used in this case, to compensate the inversion of reflection. The earth inductor compass can be placed in zones of minimum interference, but is not without troubles of its own. The practice is growing of supplementing the compass by a turn indicator which usually works on the gyroscopic principle and shows at once when the aircraft deviates from its previous straight course. This gives the true sense of the deviation and in that way supplements the magnetic compass.

Illumination

Another important requirement for aircraft instruments is that they should be visible by night, when the instrument indications may be of much greater importance to the pilot than in the daytime. Electric illumination is used to some extent but suffers from the drawback that a fault may cause the lights suddenly to go out, perhaps at a critical moment. By far the most widely employed method is to luminize the hand and some of the graduation marks by means of radium compound.

Radium acts on zinc sulphide, producing phosphorescence and the usual luminous compounds consist of zinc sulphide containing a minute quantity of radium salt. Unfortunately the zinc sulphide decays rather rapidly so that the effective life of a luminous instrument dial is usually limited to a period depending on the permissible decrease in illumination allowed before renewal.

Richer compounds, moreover, decay at a faster rate than weaker ones and unless it is desired to produce intense illumination for a limited period only, there is no advantage in increasing the strength of the luminous compound beyond a certain figure.

Experiments made by Messrs. Paterson Walsh and Higgins,* of the National Physical Laboratory, England, showed that the most efficient compound is one containing 0.4 milligrams of radium bromide per gram of compound and this strength is the standard adopted by the British Air Ministry. In the United States considerably weaker compounds are used. It should be noted that the application of luminious compounds requires special technique, and the use of poor adhesives or excessive varnish will seriously impair the luminosity. Patterson, Walsh and Higgins state that even under favourable conditions the luminosity of the figures on a dial is only one fourth that of the dry powder before application. The brightness of a luminous dial, although it seems so brilliant by night, is really very small compared with daylight, being only of the order of a one-hundredth part of the brightness of a newspaper illuminated for comfortable reading by artificial light.

The Functions of Aircraft Instruments

The Altimeter.

It may be well to consider for a moment the quantities which the more common instruments measure and the means by which they operate.

At present there is no satisfactory instrument for measuring the height of aircraft directly from the aircraft itself, and the best that can be done is to determine atmospheric pressure and convert the reading into equivalent height by a suitable convention. Hence it is that the ordinary altimeter reading is very much affected by variations of atmospheric pressure at the ground level and by the changes in air density due to temperature.

Two conventions are in general use. Most older altimeters are graduated in the isothermal scale, in which the temperature of the atmosphere is taken as 10 degrees C.

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*Proc., Phys. Soc. (Eng.) 1917, XXIX, 215.

at all heights. Later practice employs the I.C.A.N. scale in which the air temperature is assumed to be 15 degrees C. at ground level decreasing at a constant rate of 6.5 degrees C. per kilometre (2 degrees C. per 1,000 feet) up to a height of 11 kilometres.

In general, actual conditions will, of course, differ from the convention and if the highest possible accuracy is desired in determining the height of aircraft, account must be taken both of the atmospheric pressure at ground or zero level and of the true temperature of the air in the strata between the aircraft and the ground. Even when these factors are determined under the most favourable conditions and the derived corrections applied to the altimeter readings it is difficult to obtain heights with an error of much less than one per cent.

The instrument itself is really an aneroid barometer consisting of an exhausted capsule extended by a spring. Changes in atmospheric pressure alter the load on the spring, the deflection of which is communicated to the hand.

In photography and other operations where it is desired to fly as nearly horizontally as possible the ordinary service altimeters do not have an open enough scale to reveal small changes of altitude without close study, and special open-scale instruments are therefore provided. The confined air statoscope is much used, but as already explained is subject to considerable temperature error. A better instrument is an altimeter mechanism with a high magnification factor. Some are now made with the hand rotating through twenty revolutions over the range of the instrument. This is no great drawback as the altimeter is used to indicate deviations from a given height rather than the height itself.

Apart from the effect of temperature on the instrument, it should be realized of course that the use of a level flight indicator is subject to errors that may arise from variation in air pressure at a given altitude due to temperature and other changes which may occur during flight.

This point is of some importance and might be emphasized in connection with the use of the altimeter, particularly where it is desired to fly at a given height. Calibration sheets, such as are issued for altimeters from the testing laboratory, indicate the errors of the instrument at various instrument temperatures. If the actual conditions of the atmosphere were the same as assumed for the convention, Isothermal or I.C.A.N., for which the instrument had been adjusted, then no further corrections would be needed. The corrected reading of the altimeter would be height above sea level. The corrections which have to be applied due to air temperature have no connection with the instrument other than the assumptions used in forming the convention, and should be treated as belonging to the atmosphere only. We may be pardoned for dwelling on this point, but it has been found frequently that many concerned have difficulty in distinguishing between the two sets of corrections needed in computing heights from altimeter and thermometer readings.

The Airspeed Indicator

The airspeed is usually measured from the differential pressures obtained in a static head and a Pitot tube pointing in the direction of flight. The simple $P = \frac{1}{2} \rho V^2$ formula applies to these heads for the usual speeds encountered, although a small compressibility factor is now generally applied at the higher speeds.

Venturis were formerly used to some extent, to develop a greater pressure difference than that given by a Pitot tube for the same velocity and so facilitate the design and construction of the measuring mechanism. Unfortunately Venturis cannot be readily made sufficiently interchangeable for practice and suffer from other defects so that they are now rarely used with airspeed indicators. On the other hand Pitots are simple and interchangeable, and it is not necessary to consider the head and indicator as units which must not be separated.

The density ρ, decreases with height and consequently the reading of an airspeed indicator is less for the same airspeed at a height than at ground level. Hence a factor depending on the altimeter reading, has to be applied to the indicated airspeed if true velocity through the air is desired. From a safety point of view, as the supporting forces exerted by the air on the plane also vary with the density, the safe limit to which the airspeed may fall will correspond to the same indicator reading whatever the height.

Airspeed indicators of the types usually referred to as anemometers have been used to a limited extent. These give true airspeed, being practically independent of density. For rough measurements, a flat plate acting against a spring is sometimes fitted to aeroplanes—the deflections of the plate being a measure of the airspeed.

As the pressure difference concerned with the Pitot type head is relatively small (1.2 inches of water at 50 m.p.h., 4.9 inches at 100 m.p.h. and 11.2 inches at 150 m.p.h.), the pressure gauge which forms the actual indicating element has to be sensitive. In one form, widely used, the case of the instrument contains two compartments separated by a diaphragm of oiled silk, the static and pressure tubes from the head leading to opposite sides. The measuring element is a flat spring the deflections of which are communicated to the hand by a simple magnifying linkage system. This type is very sensitive but oiled silk is not an ideal material. Besides the effect of low temperatures, which have already been mentioned, it deteriorates with time and becomes porous. Moreover it would appear that sometimes this porosity is temporarily self sealing so that a defective instrument may indicate correctly under a single test, but fail afterwards.

Indicators in which the pressure is measured by the deflection of a thin wall corrugated metal capsule are finding more favour. This type can be compensated and its temperature errors are small, but it is difficult to make as sensitive as the fabric diaphragm type.

Engine Revolution Indicators

The quantity measured by the revolution indicator is simple, but it is somewhat difficult to find a satisfactory instrument. The revolution indicator is subjected to much more wear than most of the other aircraft instruments, as some part of it is usually rotating constantly while the engine is running, whereas the altimeter and airspeed indicator mechanism for instance, only move in response to changes in the quantities they measure.

The centrifugal type, in which a mass moves away from the axis as the revolutions increase, is the most widely used. A spring forms the controlling element and the deflection of the rotating mass is communicated to the pointer.

In the chronometric type a clock escapement is used, and by means of an ingenious system of cams and gears the hand is placed periodically in gear with the engine-driven shaft for a definite period of time. During this time the hand is deflected by an amount proportional to the number of revolutions occurring. By fitting more than one cam the instrument is designed so that the hand will not fly back to zero after each period but is held at the previous reading until the completion of the next period. These instruments depend for accuracy on the escapement but they are somewhat complicated, and any defect or failure in the mechanism usually results in the hand remaining at zero. As a rule, in practice, they are accurate as long as they indicate at all.

Both these types of indicators suffer from the drawback that a rotating shaft is necessary to connect the engine and the indicator. This is especially troublesome in multi-engined aircraft. The ideal instrument would only need a cable or tube between the engine and the instrument board and several models have been developed, but do not yet appear to have been widely adopted. Electric and magnetic instruments are used to a limited extent and the British Air Ministry have developed a pneumatic type. The main element is a rotating drum operated by the engine. A Venturi in communication with the interior of the drum produces suction. On the rim of the drum there is a valve, held to its seat by centrifugal force in opposition to the suction. The pressure at which the valve lifts will therefore vary with some function of the speed. The indicator is a gauge which measures the differential pressure between the two sides of the valve. It is graduated to show engine revolutions.

The Standardization and Testing of Aircraft Instruments

The equipment required for standardizing and testing aircraft instruments is in several respects of a somewhat special nature. To reproduce the effects of the low temperatures and reduced atmospheric pressures met in aviation, a refrigerating chamber together with containers capable of being evacuated are required. As previously mentioned a vibration board of variable period and amplitude is desirable as well as a slow moving turn table, and a photometer for testing luminous dials.

At the National Research Laboratories, Ottawa, the refrigerating chamber used in aircraft instrument tests can be cooled down to a temperature of −40 degrees C. A vacuum and pressure system is also provided with outlets at each testing point in the aircraft instrument laboratory. While instruments should be tested at low temperatures for the reasons given previously, it is only in special cases (with the exception of course of altimeters) that both low pressure and low temperature are used together.

Pressure is the most common quantity measured, e.g. in the altimeter, airspeed indicator, pressure gauge. Standards of pressure take the form of the mercury barometer, the water manometer and the dead weight tester, for these three instruments respectively.

Testing-barometers are usually of the cistern type, with a primary standard for reference purposes. For testing airspeed indicators a reservoir type of indicator is used with a large dial. This instrument is not self checking and is calibrated by reference to a standard precision water manometer.

A tuning fork forms the reference standard for testing revolution indicators. It operates a neon lamp which illuminates the disc of a stroboscope on the shaft of a variable speed motor driving the indicator. The pattern is such that multiples of 100, 200 and 300 revolutions per minute are indicated.

The Servicing of Aircraft Instruments

The requirements of aircraft instruments being severe, all instruments should be subjected to test before passing in to service. In fact, the British Air Ministry has established the practice of submitting instruments to a second test before issue if they have lain in stores for three months or longer since the original test. In the same way a rough test, at least, should be given periodically during service, especially to altimeters and airspeed indicators. Portable calibrators are available for this purpose.

Instruments should not be taken down, if at all avoidable, except by competent instrument-makers, and even then a recalibration is necessary.

The proper repair and reconditioning of aircraft instruments can only be carried out with the aid of test equipment, as, in the course of assembling and adjusting instruments, frequent recourse must be had to the standards of measurement. Consequently there must be close liaison between the testing laboratory and the shop, and the mechanics concerned need to be specially equipped for the work and capable of interpreting the results of tests, and making the requisite adjustments. Anyone who has been in the works of an instrument-making firm will have been struck by the laboratory type apparatus in regular use for adjusting the instruments.

The practice at Ottawa is to give all reconditioned instruments an independent test after they have been adjusted and completed in the instrument shop. Then they are certified fit for service.

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The Institute and Radio Engineering

Those members of The Institute who are interested in the highly specialized branch of the profession known as communication engineering, will welcome an arrangement for co-operation between The Engineering Institute of Canada and the Institution of Electrical Engineers (Great Britain) which has just been concluded in regard to the formation of joint local radio sections in Canada, as described in the following paragraphs.

This agreement is in general similar to that which has already been made with the Royal Aeronautical Society in regard to aeronautical engineering, particulars of which were announced some eighteen months ago,* which has resulted in the formation of several active aeronautical sections in connection with Institute Branches. This experience has shown that the local Branch organization of The Institute affords facilities in our larger centres for the formation of technical sections which can act as local engineering societies, each dealing with a special branch of engineering work and constituting a local centre for engineers interested in work of that kind. The formation of the local radio sections contemplated in the agreement which now becomes effective will enable us to provide in this way facilities for radio engineers who will also have the advantage of affiliation with two important national engineering societies and will be able to meet, read and discuss papers and have access to important radio engineering literature through interchange of publications. Such a scheme if actively carried out cannot fail to awaken and maintain an added interest in radio engineering work in this country.

It will be noted that the sections proposed are open under certain conditions to persons who are not members of either society.

It is not necessary to enlarge on the high standing of the Institution of Electrical Engineers, the leading electrical technical society in Great Britain, or on the interest and attention which that Institution has always given to radio work, as evidenced by the wide recognition given to the papers published in its Wireless Proceedings.

*The Engineering Journal, Dec. 1930, page 696.

The Institution, like The Institute, is a professional body requiring high educational and professional qualifications from its members, and, as in the case of the Royal Aeronautical Society, it is a matter for congratulation that The Institute has been able to form a close connection with a British institution of this kind.

The address which was given by the President of the Institution of Electrical Engineers in January, 1931, to a meeting of the Montreal Branch will be long remembered, as being the first occasion on which, by the aid of two-way radio communication, a speaker in London addressed an audience in Montreal and took part in the Canadian discussion on his paper.

The agreement has been arrived at as a result of lengthy discussion between the officers of the two bodies concerned, and in its present form has received the approval both of the Council of the Institution of Electrical Engineers and of the Council of The Engineering Institute of Canada.

Its leading provisions are as follows: A joint local wireless or radio section of The Engineering Institute of Canada and the Institution of Electrical Engineers may be formed in connection with any of the Branches of The Institute and will function both as a Radio Section of a Branch of The Institute and as a local Wireless Section of The Institution of Electrical Engineers. Further:—

1. A local Radio Section will consist of the following persons:

(*a*) Members of any class of The Institution of Electrical Engineers residing in Canada and/or The Engineering Institute of Canada, who apply for membership in such a section and satisfy the Executive Committee of the local Branch of The Engineering Institute of Canada that they are actively engaged in the study, design, manufacture or operation of apparatus for communication by wave radiation or for high-frequency engineering.

These members would not pay any further subscription beyond the one they already pay to the parent body to which they belong.

(*b*) Such other persons as may wish to become members of the local Radio Section and are approved for the purpose by the Executive Committee of the local Branch of The Engineering Institute of Canada.

These members will be known as "co-opted members of the local Radio Section" and would pay an annual subscription to the section, to be fixed by the Executive Committee of the Branch and not exceeding Five Dollars.

2. Membership of a local Radio Section will confer no technical or professional status in either parent body and such membership will not entitle a member to represent himself as being a member of either parent body.

3. The affairs of each local Radio Section will be managed by a committee appointed by the Executive Committee of the local Branch of The Engineering Institute of Canada and will include, as far as possible, an equal number of corporate members of The Institution of Electrical Engineers and/or The Engineering Institute of Canada.

4. The annual subscription to a Radio Section will be decided by the Executive Committee of the Branch, and will be payable by all members of the section who are not corporate members or Juniors of The Engineering Institute of Canada or members of the Institution of Electrical Engineers. Thus membership in a Radio Section involves no additional expenditure on those who are already members either of The Institute or the Institution.

5. The object of such sections being the advancement of radio science and engineering, papers and communications on these subjects will be presented before the sections, and such papers will be published in a special section of The Engineering Journal so far as space permits.

The Institution of Electrical Engineers will supply to each local Radio Section one copy of its Wireless Proceedings for each corporate member of The Engineering Institute of Canada belonging thereto, and, similarly, The Engineering Institute of Canada will forward monthly one copy of The Engineering Journal for each member of The Institution of Electrical Engineers who has joined a section. In addition, The Institution of Electrical Engineers and The Engineering Institute of Canada will each supply one copy of its Wireless Proceedings, or Journal, as the case may be, for each ten persons joining the section under Clause 1 (*b*).

The cost of the above services will be shared equally by the two parent bodies.

6. A local Radio Section, organized in accordance with the above requirements, will be recognized as a Canadian local section of The Institution of Electrical Engineers, and will be referred to either as the Radio Section of the Toronto (or Ottawa, etc., or as the case may be) Branch of The Engineering Institute of Canada, or as the Toronto (or Ottawa, etc.) Wireless Section of The Institution of Electrical Engineers.

7. All the foregoing provisions are subject to annual reconsideration by the Councils of The Engineering Institute of Canada and The Institution of Electrical Engineers, and the arrangement is terminable by one year's notice on either side.

The Council of The Institute is entering into this agreement in the confident expectation that it will meet with the approval and support of all radio engineers in Canada, whether members of The Engineering Institute of Canada, members of other engineering societies, or at present unattached. It is felt that with the help and assistance of all engaged in radio engineering in this country, the co-operation of the two bodies cannot fail to benefit the profession. It will enable all radio engineers resident in Canada to get together and carry out more effectively the purpose of all professional societies, namely the interchange and dissemination of professional knowledge.

Steps are being taken to bring this development to the notice of members of The Institute, members of the Institution resident in Canada, the Executive Committees of all The Institute's Branches and also the radio engineers of the country.

NOTICE TO MEMBERS
The Engineering Institute of Canada

The attention of the Council of The Engineering Institute of Canada has been drawn to efforts made to induce consulting engineers to authorize the publication of monographs descriptive of their work and supported by the advertisements therein of contractors or manufacturers of engineering equipment or materials. The following notice is published for the information of members regarding the view taken by Council of this method of obtaining publicity.

Engineering Monographs Supported by Advertising

A consulting engineer should not advertise in a self-laudatory manner, nor should he countenance the obtaining of advertisements or other support towards meeting the expense of any publication illustrating his work.

The Past-Presidents' Prize 1932-1933

The subject prescribed by Council for this competition for the prize year July 1st, 1932, to June 30th, 1933, is **"The Relations of Economics to Engineering."**

The following quotations may be of assistance to intending competitors, but should not be taken as restricting the scope of the papers in any way.

"At the root of all economic investigation lies the conception of the standard of life of the community."

"The modern industrial system has brought with it an immense variety of practical problems which nations must solve on pain of industrial and commercial ruin."

—*Hewins.*

"If the engineer leaves for a moment his preoccupation with the material requirements of mankind and begins to look round, he is struck with the fact that our industrial and scientific advance has not been accompanied by an equally satisfactory development of our economic organization."

—*The Engineering Journal.*

"As the present economic crisis widens and deepens, it seems increasingly clear that it is no mere pause in the march of society, but a prelude to revolutionary changes. As yet there are no signs on our horizon that science will be dethroned or that society will lose its faith in technology as a means of social progress. It is fairly certain, however, that the scientist and the engineer of tomorrow will confront new social ideals and new economic standards. While the results of this revolution are not yet clearly indicated, clues may be discovered in the social trends of to-day."

—*Wickenden.*

The rules governing the award of the prize are as follows:

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved, as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received during the prize year by the General Secretary of The Institute, either direct from the author or through a local branch.

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, June 21st, 1932, at eight o'clock p.m., with President Charles Camsell, M.E.I.C., in the chair, and six other members of Council present.

The Past-Presidents' Prize Committee for the year 1931-1932 was appointed as follows:

E. P. Fetherstonhaugh, M.E.I.C., Chairman.
W. B. Cartmel, M.E.I.C.
C. V. Christie, M.E.I.C.
A. Frigon, M.E.I.C.
A. C. R. Yuill, M.E.I.C.

The chairmen of the Medal committees were appointed as follows:

Gzowski Medal Committee—P. L. Pratley, M.E.I.C., Chairman.

Leonard Medal Committee—L. H. Cole, M.E.I.C., Chairman.

Plummer Medal Committee—H. J. Roast, M.E.I.C., Chairman.

Discussion took place as to the location for the Annual Meeting of 1933, and Council received with appreciation an intimation that the Ottawa Branch would like to have the meeting there. During discussion it was pointed out that under existing conditions it would be desirable to carry the meeting out in as inexpensive a manner as possible, and with this understanding it was unanimously resolved to accept the proposal of the Ottawa Branch.

The President reported that in accordance with the wish of Council he had taken an opportunity of representing to the Minister of Immigration the desirability of protecting Canadian engineers against the introduction of foreign engineers for work in Canada. He was able to state that the Minister was entirely in sympathy with this position, and was taking steps to refer to competent authorities all applications for entry to Canada on the part of foreign engineers for work in Canada. This statement was noted with appreciation.

A report was presented from the committee appointed to consider the suggestions made by the various branches for the subject for the Past-Presidents' Prize essay for the coming year, and it was decided that the subject for that essay for the year 1932-1933 should be "The Relations of Economics to Engineering."

The chairman of the Finance committee, in presenting the monthly statement, commented on the financial position of The Institute, and discussion ensued as to the possibility of holding a Plenary Meeting of Council this year. It was noted that a number of members of Council had recommended the omission of this meeting, and after further discussion it was resolved that no Plenary Meeting of Council should be held this year, it being felt that this action would meet with the general approval of the membership.

Attention was drawn to the effect of the amendment recently passed to Section 37 of the By-laws upon the cases of members in arrears at present in financial straits, and the Secretary was directed to send out to all members in arrears a copy of the new by-law. It was further decided that with reference to the powers of Council as to remission of the penalties established by the new by-law, a special letter, to be approved by Council, should be forwarded to all members in arrears on October 1st.

Letters were presented from the Secretary of the Institution of Electrical Engineers and Colonel W. A. Steel, A.M.E.I.C., relative to the formation of joint Radio Sections, and the text of the agreement with the Institution of Electrical Engineers regarding these sections was submitted for approval, it having already received the approval of the Council of the Institution of Electrical Engineers. This agreement was approved, and the Secretary was directed to proceed with the necessary steps in connection with the formation of such sections.

Eight resignations were accepted, five members were placed on the Suspended List, three Life Memberships were granted, and two special cases were considered.

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

Elections		*Transfers*	
Assoc. Members	4	Assoc. Member to Member	3
Juniors	4	Junior to Assoc. Member	1
Students Admitted	2	Student to Assoc. Member	5

The Council rose at twelve twenty a.m.

OBITUARIES

Joseph Horace Philibert Beaudoin, A.M.E.I.C.

Deep regret is expressed in recording the death at Montreal, Que., on July 8th, 1932, of Joseph Horace Philibert Beaudoin, A.M.E.I.C.

Mr. Beaudoin was born at Montreal on October 4th, 1892, and during the years 1909-1911 studied at the Ecole Polytechnique, Montreal.

From June 1912 to November 1913 he was an instrumentman and draughtsman on municipal improvements for the city of Maisonneuve, Que., and from that time until April 1914 was chief of party on land surveys with the late F. C. Laberge, M.E.I.C., of Montreal. Later in the same year Mr. Beaudoin was assistant to the city engineer in charge of surveys for the city of Maisonneuve. He was overseas on active service from August 1914 until September 1916, and, returning to Canada, was until June 1917, chief of party on a topographic survey for power development on the St. Francois river, in the province of Quebec. Mr. Beaudoin was next employed as assistant engineer in charge of the design and installation of waterworks and sewerage system in Montreal South. From 1918 until 1925 he was in charge of design and supervision of construction of waterworks, sewers, highways, highway bridges, filtration plant, street improvements, etc., for the town of Hawkesbury, Riordon Pulp and Paper Company, Ltd., the united counties of Prescott and Russell and neighbouring municipalities, and in charge of design and supervision of construction of bituminous pavements in the town of Rockland, Ont. In 1928 Mr. Beaudoin was appointed town engineer of Hawkesbury, Ont., and in 1930 became connected with L. J. Beaudoin Limited as construction superintendent.

Mr. Beaudoin joined The Institute (then the Canadian Society of Civil Engineers) as a Junior on October 17th, 1916, and became an Associate Member on October 24th, 1922.

J. H. P. BEAUDOIN, A.M.E.I.C.

Edwin Harrison McHenry, M.E.I.C.

Members will learn with regret of the death of Edwin Harrison McHenry, M.E.I.C., which occurred at Ardmore, Pa., on August 21st, 1931.

Mr. McHenry, who was born at Cincinnati, Ohio, on January 25th, 1859, was educated at the Pennsylvania Military College.

He entered the service of the Northern Pacific Railway Company in 1883, remaining with the company until 1901, almost continuously, holding positions as rodman, chainman, leveller, transitman, resident engineer, assistant engineer, division engineer, and principal assistant engineer. He was chief engineer of the Company from 1893 to 1895, receiver in 1895-1896, and resumed the position of chief engineer, after the reorganization of the company, in 1896, resigning in 1901. In 1902, Mr. McHenry was appointed chief engineer of the Canadian Pacific Railway Company, Montreal, and held that position until 1904, when he became fourth vice-president of the New York, New Haven and Hartford Railroad, in charge of construction and maintenance. In June, 1911, Mr. McHenry was also appointed to a similar position on the Boston and Maine Railroad, but retired from railway service in 1913, and practised as a consulting engineer until 1927.

Mr. McHenry became a Member of The Institute (then the Canadian Society of Civil Engineers) on December 18th, 1902.

Frank Nicol Rutherford, A.M.E.I.C.

By the death of Frank Nicol Rutherford, A.M.E.I.C., at his home at St. Catharines, Ont., on July 17th, 1932, The Institute loses a member of long standing.

Mr. Rutherford was born at South Monaghan, Ont., on November 6th, 1881, and graduated from the University of Toronto in 1905 with the degree of B.Sc. The following year he received a commission as Ontario Land Surveyor.

During the year 1905-1906, Mr. Rutherford was assistant city engineer of Niagara Falls, and in 1906-1907 was resident engineer for the Niagara, St. Catharines and Toronto Railway at St. Catharines. In 1907 he became engineer and manager of the Concrete Pole Company, Ltd., St. Catharines; later, he became senior member of the firm of Rutherford and Ure, of St. Catharines. About nine years ago he was appointed county engineer and road superintendent for the county of Lincoln and engineer for the St. Catharines-Lincoln Road Commission.

Mr. Rutherford's interest in public affairs took a tangible form in the service he gave for ten years as a member of the St. Catharines Board of Education, being chairman several times, and holding that office at the time of his death.

Mr. Rutherford joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on October 24th, 1907.

PERSONALS

E. S. Braddell, S.E.I.C., of Winnipeg, Man., received his B.Sc. in electrical engineering from the University of Manitoba in the spring of this year.

V. L. Richards, S.E.I.C., who graduated from Queen's University this spring with the degree of B.Sc., has been awarded a research fellowship in Industrial Engineering at McGill University.

L. E. Kendall, A.M.E.I.C., has joined the staff of the Abitibi Power and Paper Company at Fort William, Ont. Mr. Kendall was formerly groundwood mill superintendent for the Manitoba Paper Company at Pine Falls, Man.

Andrew F. Macallum, M.E.I.C., former commissioner of works of the city of Ottawa, has opened an office in Ottawa as a consulting engineer in municipal and general engineering. Mr. Macallum is a specialist in arbitrations, valuations and appraisals.

Horace L. Seymour, M.E.I.C., who has, for several years, been director of town planning in the province of Alberta, has recently been appointed by order-in-council, provincial town planning consultant. Mr. Seymour is also engaging in a general consulting practice in engineering and planning, and expects to open offices in Edmonton and Calgary. He will continue to lecture on town planning at the University of Alberta.

Everett Thomas Cain, A.M.E.I.C.

The portrait shown herewith was unfortunately received too late to be published with the obituary notice of Mr. Cain

THE LATE E. T. CAIN, A.M.E.I.C.

which appeared in the June issue of The Engineering Journal. It will be recalled that Mr. Cain, an energetic and valued member of The Institute, took a leading part in the activities of the Moncton Branch, of whose Executive Committee he was a member at the time of his death.

Leonard E. Schlemm, M.E.I.C., who has been acting in the capacity of town engineer of Hampstead, Que., for the past 20 years, has resigned, but will continue to act as consultant. Mr. Schlemm is a member of the Montreal Town Planning Board, and planned the townsites of a number of places including Mount Royal, Que., Kippawa, Ont., Leaside, Ont., Gatineau, Que., Westmount, Que., Pine Falls, Man., Beaupre, Que., Iroquois Falls, Ont., etc.

J. A. L. Waddell, D.Sc., LL.D., M.E.I.C., has become associated with Messrs. Parsons, Klapp, Brinckerhoff and Douglass, New York, N.Y., as consulting engineer to the bridge department. Dr. Waddell enjoys an international reputation as an expert in bridge design and economics, having to his credit in Canada and the United States hundreds of bridges of all kinds. He has also designed and constructed many important bridge structures in Mexico, Japan, New Zealand, Russia and Cuba.

R. B. Winsor, Jr.E.I.C., formerly on the engineering staff of Canadian Industries Limited, Montreal, has been appointed assistant production manager at the company's cellophane division, and is located at Shawinigan Falls, Que. Mr. Winsor graduated from McGill University in 1927 with the degree of B.Sc., and in 1928 was office engineer with the International Pulp and Paper Company at Corner Brook, Nfld.

An interesting ceremony took place at the luncheon held on the last day of the recently-held summer meeting of the American Society of Mechanical Engineers at Bigwin Inn, Lake of Bays, Ont., when President C. N. Lauer presented to Professor R. W. Angus, M.E.I.C., Head of the

Department of Mechanical Engineering, University of Toronto, an address, expressing the Society's appreciation of Professor Angus' services to the Society and to its Ontario Section. Reference was made in the address to Professor Angus' contribution to the profession as a practising engineer and as an educator of engineers.

W. Martin Veitch, A.M.E.I.C., has been appointed city engineer of London, Ont. Mr. Veitch, who is a graduate of the Royal Technical College, Glasgow, Scotland, came to this country in March, 1913, and becoming attached to the sewer department of the city of Toronto, was placed in charge of the design of the special storm sewer system for West Toronto. In 1914 he became associated with the firm of Paterson, Veitch and Watson, contracting engineers. From 1914 to 1919 Mr. Veitch was on active service overseas, enlisting with the 2nd Field Company, Canadian Engineers, and gaining his commission in the Royal Engineers in 1917. He was awarded the Military Cross in March 1918, and received a bar to the Cross in September 1918. Returning to Canada in 1919, Mr. Veitch joined the staff of the Soldiers' Civil Re-establishment, and a few months later he was moved to London, Ont., to take charge of the Industrial survey for the Department in western Ontario. In January 1921, Mr. Veitch again joined the designing staff of the sewer department in Toronto, and while there designed the preliminary layout for the combined sewer system for North Toronto. In the fall of 1921, he became assistant in charge of sewage disposal at London, and held that position until his recent appointment.

BOOK REVIEWS

Symposium on Effect of Temperature on the Properties of Metals

Published jointly by the American Society for Testing Materials and the American Society of Mechanical Engineers, New York, 1932, 6 x 9 in., 829 pp., figs., tables, $4.50 (members).

Reviewed by Dr. Alfred Stansfield, M.E.I.C.*

Comparing metals and their alloys such as iron, steel, copper and brass, with non-metallic materials of construction such as stone and brick, one is struck by the enormous superiority of the former class in mechanical strength, ductility, thermal conductivity and similar properties; our modern mechanical age is in fact dependent on the properties of metals. One serious defect of metals in general is that these valuable properties are not retained at high temperatures and that moreover, at these temperatures, metals are subject to serious changes of dimensions and in many cases to corrosion by air and other furnace gases. On account of these defects metallurgical and other designs of furnaces are obliged to employ brick and similar material for retorts, muffles and other parts of furnaces for which metals would be greatly superior.

Even in the much lower range of temperatures employed in steam-engineering, the use of increasingly higher pressures of steam involves the use of temperatures and pressures for which ordinary steel is unsatisfactory, and metallurgists are being asked for varieties of steel and other alloys which shall retain their strength at temperatures in excess of 1,000 degrees F. and shall not suffer seriously from corrosion or from creep

In 1924 the demand for information on the properties of metals at high temperatures caused the American Society of Mechanical Engineers and the American Society for Testing Materials to hold a symposium in which the available data were presented and discussed, and a Joint Research Committee on the Effect of Temperature on the Properties of Metals was appointed to collect information and conduct researches on behalf of the two societies. After seven years of work, a second symposium was held at a joint meeting of these societies in Chicago on June 23rd, 1931, and the proceedings of this symposium, containing 27 papers with discussion and a bibliography, form a volume of 829 pages.

The information presented relates to the physical and corrosion-resisting properties of metals and alloys at high temperatures and can be divided into two classes: (1) the demands made on metals and alloys for use in various branches of modern engineering, (2) the extent to which these demands have been met by recent advances in the production and treatment of metallic materials. The following is a digest of the subjects discussed:

*Professor of Metallurgy, McGill University, Montreal.

I. Trends in the Requirements for Metals at High Temperatures for the following Branches of Engineering:—Power Plant Industry; Steam Turbines; Steam Piping; Oil Industry; Chemical Industry; Metallurgical Smelting and Refining; Automotive Industry, and Ceramic Industry. Also Progress in the use of Metals at High Temperatures in Great Britain, and the Mechanical Properties of Metals at High Temperatures.

II. Properties of Available Metals for High-and Low-Temperature Service, including the following classes:—Zinc Alloys; Aluminum and Magnesium Alloys; Bearing Metals; Copper and its Alloys; Carbon and Low-Alloy Steels; Gray and Malleable Cast Iron; Wrought Austenitic Alloys; Iron-Chromium-Nickel Alloys; Nickel and Nickel Alloys; High-Chromium Steels; Rare Metals, and Nitrided Alloys. Also the Effect of Low Temperatures on Metals and Alloys, and the Thermal Expansion and Thermal Conductivity of Metals.

The bibliography contains references to 615 papers and is supplementary to the bibliography published with the symposium of 1924.

Elements of Curve Design for Road, Railway and Racing Track

By F. G. Royal-Dawson. E. & F. N. Spon, London, 1932, 5 x 7½ in., 230 pp., figs., tables, 8/6 net.

Reviewed by C. S. Gzowski, M.E.I.C.*

The author's aim to place before the engineer or student a theoretical study and practical application of the use of transition curves in railway and highway work, has been carried out with clearness. The procedure followed of developing his formulae, followed by the application of the formulae to practical problems on alignment gives the student a clear insight into the different types of problems as they arise. The use of both the British and Metric System of linear measurement in the formulae and tables makes the work adaptable to countries using either system.

The author's attempt to base the amount of superelevation and design of transition curves upon the physiological sensation of the passenger rather than upon the principles of dynamic stability, is an unwarranted refinement in railway practice. No doubt in highway practice where curve radii are generally much shorter than in railway practice, considerations of physiological sensation may outweigh those of dynamic stability, and in that connection the author's treatment of the problem is interesting and instructive.

The use of the lemniscate transition curve is shown to be superior to the ordinary spiral in this field. The problems selected for discussion are representative of what the engineer would encounter in the course of his practice, and their solution is clearly explained.

The author develops methods whereby field work may be carried out either by the offset or deflection method.

The method of laying out highways between certain points where a uniform speed is required is well worthy of note.

The tables at the back of the book form an integral part of the text and should be of great advantage to the practising engineer.

For this country where engineering practices are slightly different from Great Britain, the book has its greatest value as a book of reference rather than a text book.

*Chief Engineer, Construction Department, Canadian National Railways, Montreal, Que.

Amerikanische Heizungs-und Lüftungspraxis

By Karl R. Rybka, A.M.E.I.C. Julius Springer, Berlin, 1932, leatherette, 6¼ x 9¼ in., 174 pp., figs., tables, R.M. 18.

The author prepared this account of North American practice in heating and ventilation at the suggestion of some of his European friends. It deals principally with features or details of transatlantic practice which are likely to be of special interest to those who are familiar with the methods adopted on the continent of Europe.

Mr. Rybka's book covers briefly North American methods in practically all the leading divisions of the field of which it treats, and it makes no claim to be a complete handbook of the art. Beginning with the calculation of heat losses and radiator surfaces, the author discusses central heating as applied to dwelling houses, apartment houses and public buildings, and gives an interesting sketch of the progress made in the application of low pressure steam heating in high buildings, a field in which European engineers have had comparatively little experience. Some forty pages are devoted to ventilation, and due emphasis is laid on the necessity for humidity control, recent developments in air-conditioning, and the investigations of the American Society of Heating and Ventilating Engineers regarding these matters. The book is a useful summary of recent progress, and should provide many timely suggestions for the European readers to whom it is addressed.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Society of Naval Architects and Marine Engineers: Index to Transactions, 1893-1930.

Canadian Institute of Mining and Metallurgy: Transactions, vol. 34, 1931.

Institution of Mechanical Engineers: List of Members, May, 1932.
Corporation of Professional Engineers of Quebec:
Tariff of Fees, 1932; Code of Ethics, 1932; List of Members, June, 1932.
Institution of Mining and Metallurgy: Transactions, vol. 40, 1930-31.

Reports, etc.

Geographical Section, Dept. of National Defence, Canada:
Topographic Map, Peterborough Sheet, 1932.
Geological Survey, Canada:
Economic Geology Series No. 9: Oil and Gas in Eastern Canada.
10: Gold Occurrences of Canada: Summary Account.
Mines Branch, Dept. of Mines, Canada:
The Clay and Shale Resources of Turner Valley and Nearby Districts.
Department of The Interior, Canada:
Publications of the Dominion Observatory, Vol. 10: Bibliography of Seismology, No. 13, Jan., Feb., and March, 1932.
Bureau of Mines, United States:
Technical Paper 517: Transportation of Gasoline by Pipe Line.
Building Codes, By-laws and Ordinances
Toronto, Ont., Saint John, N.B., Winnipeg, Man., Regina, Sask., Vancouver, B.C., District of Columbia, U.S.A., Detroit, Mich., Pittsburgh, Pa., Boston, Mass., Philadelphia, Pa., New York, N.Y., New England Building Officials Conference, Los Angeles, Calif., Chicago, Mich.
Air Ministry, Aeronautical Research Committee, Great Britain:
R. and M. No. 1421: Spinning of a Single Seater Fighter with Deepened Body and Raised Tailplane.
R. and M. No. 1443: Wind Tunnel Tests on Aileron Loads.
R. and M. No. 1449: Anchors for Use on Flying Boats.
Kenya and Uganda Railways and Harbours:
Report of the General Manager on the Administration of the Railways and Harbours, 1931.
Purdue University:
Engineering Bulletin No. 27: How to Avoid Faulty Concrete in Small Structures.
Engineering Bulletin No. 39: Bibliography of the Vibration of Shafts, Vibration Measurements and the Design of Crankshafts.

Technical Books, etc.

Presented by the Canadian Institute of Steel Construction:
Canadian Steel Construction, 1st ed., June 1932 [96 pp.].
Presented by R. DeL. French, M.E.I.C.:
Snowfall in Montreal, by R. DeL. French [10 pp.].
Presented by D. Van Nostrand Company:
Unit Processes and Principles of Chemical Engineering, by John C. Olsen, 1932.
Presented by E. & F. N. Spon, Ltd.:
Graphs for Engineers and Architects, by D. H. Lee. 1932.
Presented by Sodium Silicate Manufacturers Institute:
Curing Concrete with Silicate of Soda [62 pp.].
Presented by Federation of British Industries:
Fuel Economy Review, vol. 11, 1932.
Purchased:
American Society of Civil Engineers. Manuals of Engineering Practice:
No. 1: Code of Practice of the A.S.C.E., adopted Jan. 18, 1927.
No. 5: Charges and Methods of Making Charges for Professional Services . . . adopted July 7, 1930.
No. 6: Charges for Engineering Services . . . adopted September, 1930.

Catalogues, etc.

Specification Data, Limited:
Building and Engineering Catalogue, 1932.
Canadian Sheet Piling Company, Ltd.:
Nickel Alloy Steel Castings [12 pp.].
William Hamilton, Limited:
American Flexible Couplings [12 pp.].

Industrial Standardization at the Ottawa Conference

The possibility of Inter-Empire agreement on industrial standards received some preliminary attention at the 1930 Conference, and forms one of the items to be considered at the Imperial Economic Conference which is now sitting at Ottawa. Fortunately practically all the delegations include members who are qualified to take part in discussions on this difficult subject, to which attention has recently been directed in Australia, New Zealand and Canada during the visit to those countries of Mr. C. LeMaistre, the Director of the British Standards Institution.

The line along which definite progress seems most likely at present is in regard to specifications for important industrial engineering materials, on which a good deal of preliminary work has already been done, particularly in Canada and Australia, largely due to the activity of industrial bodies like the British Steel Export Association and the Engineering Standards Associations in the various Dominions.

BRANCH NEWS

London Branch

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

The summer trip of the members was held on June 18th, and took the form of a visit to St. Thomas, on the invitation of W. C. Miller, M.E.I.C., city engineer, for an inspection of the new water purification plant and sewage disposal works.

The first visit was made to the sewage disposal plant situated in the Kettle Creek valley some little distance below St. Thomas. It is a complete installation of the activated sludge type and is capable of dealing with a flow of 1,500,000 gallons per day.

This consists of a grit chamber and grease trap of the elongated flume type, and on leaving this the sewage is conveyed along a central main and diverted into a group of aeration tanks. After leaving the aeration process the sewage enters the clarification tanks, two in number, and after a period of four and a half hours for settlement the effluent runs off into the creek. A sample of the effluent taken up in a scoop was examined by the visitors and to all appearances it had the look of clear water much clearer than the water of the creek. Tests have been taken of the water in the creek both above and below the effluent outlet which proves the water below to be purer than that above.

The sludge is collected in clarification tanks and part is returned to the aeration tanks for redigestion while the balance goes to the sludge bed. The new plant has been built partly on the site of the old sedimentation tanks and one of these (all covered in and grassed over) is used as a storage sludge bed.

The party then drove several miles north of St. Thomas to the reservoir in the Kettle Creek valley from which is drawn the water supply for the city of St. Thomas. The outstanding feature of this reservoir is the reforestation park comprising 500 acres of city owned lands on the banks of the creek. Advantage has been taken of the government's offer to any municipality who provides a tract of land for this purpose, of not less than 500 acres, to supply and plant the area with seedling trees free of cost. The young trees are flourishing and those in their fourth year are about 4 or 5 feet high. All kinds of trees are planted with the exception of poplars: it is said the roots of these will taint the water.

The result will be a beauty spot with the added utility of timber for cutting after thirty years' growth.

The party finally proceeded to the water purification plant nearer St. Thomas and which has been remodelled with new, up-to-date units installed. The water is first treated with chlorine and aluminum sulphate, and from this installation the water is pumped to conditioning tanks at the top of a hill. Before entering the building the water is oxidized in the open air and after passing slowly through a series of conditioning tanks flows to the filtration plant.

This installation consists of four sand and stone filters with elaborate control mechanism for regulating the flow and pressure.

A large underground storage reservoir is provided so that the city has several days supply on hand in case of emergency.

The visit concluded with supper at the Empire hotel, at which thanks were accorded Mr. Miller for the trouble and time he had expended in taking the party around.

The whole outfits are a tribute to the judgment and engineering ability of Mr. Miller and to the progressiveness and foresight of the municipality of St. Thomas.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.

A dinner meeting was arranged on June 27th at the Welland House to meet R. J. Durley, M.E.I.C., General Secretary of The Institute, who was visiting the western Ontario Branches on his way to attend the convention of the American Society of Mechanical Engineers at Bigwin Inn.

As it was the first meeting to be held since the spring elections, chairman E. P. Murphy, A.M.E.I.C., took occasion to introduce the members of the new Executive committee and also thanked the Branch for the honour conferred in appointing him to the responsible office of chairman.

Mr. Durley briefly reviewed the present activities and financial standing of The Engineering Institute. Despite unfavourable conditions there had been practically no decrease in the numerical strength of The Institute and expenses had been curtailed to meet the reduction in The Institute's income from publications and from members in difficulties.

The Headquarters committee on unemployment was looking to the Branches both for assistance and suggestions. Circulars had been sent to all members in an effort to find out exactly how serious the situation might become. Returns from some of the Branches were now available and showed wide variations. For instance, one Branch had reported practically no unemployment among engineers whereas the report from another showed about 30 per cent, based on the questionnaires returned.

The question of helping unemployed engineers was one of great difficulty. Boston and Cleveland had organized committees which investigated all fields of probable activity with the object of prevailing upon industrial and municipal concerns to proceed immediately with surveys, mapping and research work. Various municipal ordinances and codes were being revised and some success was obtained in getting translations of foreign technical publications.

The Montreal Branch had also sponsored a similar movement but difficulties had arisen due to the lack of a salaried manager or at least someone permanent in responsible charge.

The discussion which followed Mr. Durley's remarks was quite general and showed a willingness to co-operate in every way possible with any feasible scheme which might be outlined by the committee. W. Jackson, M.E.I.C., stated that in his opinion financial assistance was not necessary in the Peninsula and he was doubtful as to whether the district was large enough to offer much opportunity for "made work."

M. B. Atkinson, M.E.I.C., agreed with him but suggested that nobody knew exactly how long the present state of affairs might continue and another two or three similar years would throw an intolerable strain upon those of our members who were so unfortunate as to be out of employment. One solution might lie in taking advantage of the governmental land grants and financial assistance to form an engineering community settlement for those who might reach the end of their tether or wish to take advantage of this kind of life until conditions improved. He suggested that The Institute inquire of the Federal government and various provincial governments as to what aid they were offering to those who would establish themselves in a permanent way upon farms, as he understood that the various governments had so established many thousands of families.

E. G. Cameron, A.M.E.I.C., believed that the Branch might be of immediate and practical assistance were a small committee to be formed which would provide introductions to industrial managers. In these times particularly, men who are not working find that the arranging of a satisfactory interview is almost impossible. The manager's viewpoint is understandable, it is self defence against debating with anyone the possibility of employment which he does not believe to be feasible. On the other hand engineers have a commodity to sell which is of value in either good or bad times. As a matter of fact this commodity, consisting of the ability to make one dollar do the work of two, is often of the greatest value in times of depression. Now if a Branch committee can prepare the ground and enlist the manager's sympathetic consideration he might be very willing to talk matters over on this basis with our members and in many cases mutual benefit should be the result.

The meeting debated these suggestions at some length and before adjourning W. D. Bracken, S.E.I.C., moved, seconded by J. C. Street, M.E.I.C., that a committee be formed composed of Messrs. Murphy, Cameron and Jackson to prepare a workable plan which should be submitted to the next meeting of the Executive.

Saguenay Branch

W. P. C. LeBoutillier, Jr.E.I.C., Secretary-Treasurer.

At Riverbend, on June 2nd, the Saguenay Branch of The Engineering Institute of Canada gave a luncheon in honour of a party of members of the Federal Government, who were visiting that district.

The party included the President of The Institute, Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines, the Hon. W. A. Gordon, Minister of Mines and Labour and Acting Minister of Immigration, the Hon. George Black, Speaker of the House of Commons, the Hon. John Sullivan, Member for St. Anne, Montreal, and Mr. J. Cullen, private secretary to Mr. Gordon.

J. L. Grenon, A.M.E.I.C., chairman of the Branch, presided at the luncheon, and thirty-one members of the Branch were present. Dr. Camsell and the Hon. W. A. Gordon gave short addresses on the mineral resources of Canada, including a sketch of the development of the mining industry in the past two decades and the prospects for future development of these resources.

Vancouver Branch

W. O. Scott, A.M.E.I.C., Secretary-Treasurer.

Stockholm, Sweden, and Its City Hall

A dinner meeting of the Vancouver Branch was held on May 30th, 1932, at the Georgia hotel, at which the speaker was Major T. V. Scudamore, whose address was entitled "Stockholm, Sweden, and Its City Hall."

The speaker gave a short talk first and then followed it with forty or fifty lantern slides, illustrating points of interest mentioned previously.

Major W. G. Swan, M.E.I.C., moved a vote of thanks to the speaker for his very able address and the illustrations that followed.

The chairman, P. H. Buchan, A.M.E.I.C., then in a few minutes briefly outlined the tentative programme for the Fall, which included generally—

(1) At least one meeting on a current economic subject of general interest.

(2) Meeting of November to be conducted by University of British Columbia students. Branch papers to be supplied by the students.

(3) A paper on materials of construction, testing, etc.

(4) Four papers, tentatively arranged, descriptive of engineering projects.

(5) It is hoped to have at least two visits to projects or plants.

The meeting was then thrown open for discussion, the Chairman welcoming any ideas, criticisms, etc.

C. E. Webb, M.E.I.C., thought the committee should be commended on the capable manner in which the last few meetings had been arranged.

A. Peebles, S.E.I.C., suggested getting information on foreign engineering projects, either by engineers associated with same or data collected by one of our own members.

A. C. R. Yuill, M.E.I.C., thought a joint meeting of the Vancouver and Victoria Branches, say in Nanaimo, with some trip or work in view of mutual benefit, would prove interesting.

W. G. Swan, M.E.I.C., proposed looking into a trip to the mouth of the Fraser, to see the improvements on the Sampson, through the co-operation of Messrs. Worsfold and Brydone-Jack.

J. Robertson, A.M.E.I.C., invited the Committee to look into possible trips of inspection to some of the present works now in hand, during summer months if necessary, before they are too far towards completion.

W. H. Powell, M.E.I.C., suggested a paper by H. B. Muckleston, Esq., on forms of ancient engineering, for a future meeting.

The chairman thanked the members, referred the suggestions to J. E. McKenzie, A.M.E.I.C., of the Papers committee, and called a ten minute recess before continuing the programme.

Through the courtesy of Mr. R. T. Stewart, Department of Explosives, Canadian Industries, Limited, two films were loaned for presentation. The first, called "The Story of Dynamite," showed the making, transportation and modern uses of dynamite; the second, "Power and Industry" (courtesy Aluminium & Beauharnois Corporation), showing the use of explosive in the Chute-à-Caron development on the Saguenay river.

E. E. Brydone-Jack, M.E.I.C., proposed a vote of thanks to the energetic committee in putting the dinner meeting over and the entertaining programme.

The meeting adjourned at 10.15 p.m.

Attendance, 46.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.

The regular meeting of the Winnipeg Branch of The Institute was held on Thursday, April 21st, 1932. Attendance fifty-seven.

In the absence of the chairman, T. C. Main, A.M.E.I.C., C. T. Barnes, A.M.E.I.C., introduced the speaker of the evening, H. M. White, A.M.E.I.C., chief engineer, Western Division, Dominion Bridge Company, who delivered an excellent address on the new Main Street and Norwood Bridges in the city of Winnipeg.

Design and Construction of the Superstructure of Norwood and Main Street Bridges, Winnipeg

Mr. White gave a brief history of the old bridges describing their design and general features. He then referred to the appointment by the provincial government and the city councils of Winnipeg and St. Boniface of the boards of engineers which studied the scheme and finally took charge of the construction of the bridges. The paper was illustrated by a number of lantern slides which were of great interest.

The new Norwood bridge is 544 feet long and the Main street bridge is 373 feet long. Both are of plate girder construction, all supporting members being below the deck and provide 50-foot roadway with double track street car lines, also two 8-foot sidewalks. The deck of the fixed spans is reinforced concrete slab, that of the bascule is creosoted plank with 1½-inch asphalt plank surfacing on the roadway.

Norwood bridge includes a bascule span giving a clear channel of 80 feet. The bascule is of the trunnion type operated by single pinion and rack, counterweight being connected to the rear end of the main girders. The steelwork was all fabricated in Winnipeg as was also a large part of the bascule operating machinery.

The bridges were formally opened by Federal, provincial and civic officials on November 19th, 1931.

At the close of the paper the discussion took place, among those taking part being Wm. Walkden, A.M.E.I.C., J. N. Finlayson, M.E.I.C., J. P. Fraser, A.M.E.I.C., J. W. Porter, M.E.I.C., A. J. Taunton, A.M.E.I.C.

A hearty vote of thanks was accorded the speaker who was congratulated by the members on the excellence of his paper.

Moved by J. W. Porter, M.E.I.C., seconded by J. N. Finlayson, M.E.I.C., that the secretary be instructed to write to C. H. Attwood, A.M.E.I.C., who was operated on for appendicitis, conveying to him the sympathy of the Branch and wishing him a speedy and complete recovery. Carried.

Mr. D. B. Gow, district chief engineer of the Dominion Government Water Power Service, then at the request of the acting chairman spoke on the resolution of the Saskatchewan Branch with regard to continuance and extension of hydrometric service in the western provinces. The matter was then referred to the Executive committee for further consideration.

Open Letter

TO ENGINEERS IN ALL PARTS OF THE WORLD:

The Committee on Dams of the American Society of Civil Engineers is making a study of hydrostatic pressure both within and under the Bases of Dams. In this connection the committee invites the co-operation of engineers in every country who are designing or constructing dams.

The committee desires facts as noted by careful observation, and not opinions or theoretical discussions. Present knowledge regarding actual uplift under and within dams is limited. Therefore, we ask engineers, when designing a dam, to incorporate in their plans methods of observing the hydrostatic pressures which will develop when the structure goes into service. All useful information that comes to the Committee will be published for the benefit of the profession and full credit will be given to those who furnish reliable data.

Each engineer may design a method to measure uplift to suit his local conditions. The simplest installation for observing uplift is a system of pipes in which the pressure at the lower end may be measured by gauge or in a riser pipe. All pipes should be built into the dam as it is being constructed, with their lower ends open. For measuring hydrostatic uplift under the base, the pipes should terminate in suitably arranged cavities, filled with granular material, at the base of the structure. The pipes should be spaced at intervals along the length of the dam, and at each location there should be not less than three pipes in an up and down stream direction, this number increasing with the width of the base. If a rock foundation has extensive or nearly horizontal stratifications, other pipes should be carried down below the base to some of the rock joints. The locations and elevations below the base should be governed by the character of the foundation material, whether rock or soil, and the purpose should be to locate the pipes systematically in both longitudinal and transverse directions with the view to developing all possible conditions.

For measuring hydrostatic uplift within the structure, similar pipes should be arranged with their open lower ends at different elevations above the base, as the design of the structure will permit. It would be well to have their lower ends open into horizontal construction joints.

The pipes may be led to one or more central observing points as found convenient, so long as the grade is always upward. The size of the pipes is not important, but should be such as to permit observations of the water levels within them.

The cost of installing such pipes will be small when a dam is under construction, while the benefits to be derived may be very great. The public has a direct interest in the safety of dams.

We urgently request that the following procedure be carried out:

1. Observe the water level or water pressure in each pipe at intervals which should be practically simultaneous for each cross section, recording also the levels of the reservoir and tail water surfaces. The observation intervals should be frequent as the reservoir is filling. Thereafter every week or every month will suffice. At least a year's observations should be recorded.

2. Observe the temperature of the water, both in the reservoir and in the pipes. There is some evidence that uplift pressure may be affected by temperature.

3. Send us the observations at intervals. Also drawings of the dam showing the pipe locations, and necessary cross sections, all to scale. The drawings should illustrate the details of the cut off and the drainage system, if any, and show all other pertinent data. Also describe the character of concrete or masonry, and methods employed to secure bonding and to obstruct flow of water through the structure.

4. Send a detailed description of the foundation material, presenting all of its known characteristics, together with geological sections, both longitudinal and transverse showing joint systems, faults, bedding, etc. Photographs of the foundations also will be useful.

5. Repeat the observations asked for in paragraphs 1 and 2, sufficiently often so that seasonal variations will be disclosed. These repeated observations should be sent when made. Do not hold back the data asked for in 1, 2, 3 and 4, as its receipt may suggest the securing of other information that may be highly important.

6. Send all communications to H. de B. Parsons, 26 Beaver Street, New York, U. S. A., who will acknowledge for the Committee.

The committee would be glad to correspond regarding details should any one so desire.—*Committee on Dams, Am.Soc.C.E.*

British Standard Specifications

The following new and revised British Standards have just been issued and may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W. 1, England and from the Canadian Engineering Standards Association, Central Chambers, 46 Elgin street, Ottawa, Ont.

Springs and Spring Material for Railway Rolling Stock—B. S. S. No. 24, Part 3—1932.—The revision of the series of B. S. Specifications for Railway Rolling Stock Materials which has been in hand for some years has now been completed by the issue of the revised edition of Part 3 of Report No. 24, *Laminated, Volute and Helical Springs and Steel for Laminated, Volute and Helical Springs.* The changes in the chemical composition of the steel are among the principal modifications that have been made in the revised issue.

Specification for Machine Cut Gears. (A.) Helical and Straight Spur —B. S. S. No. 436—1932.—The question of the standardization of gearing has received a good deal of attention during recent years. The Specification for *Machine Cut Helical and Straight Spur Gearing* now issued deals in a more comprehensive manner with the dimensions and tooth form of helical gearing than has hitherto been attempted.

British Standard Screws—Bright Countersunk, Round and Cheese Head Screws—B. S. S. No. 430, and Bright Square Head Set Screws—B. S. S. No. 451.—The benefits that result from the standardization of such small engineering details as are in everyday use are often overlooked in the assessment of the value of standardization to the community. The case of screw threads is an outstanding example of this class of work.

Colloidal Fuels for Marine Service

On the return of the Cunard steamship "Scythia" to Liverpool on July 5th, after a successful round trip to New York, it was learned that the colloidal fuel, which was used experimentally in four of the furnaces of a single-ended boiler, was burned without any hitch. The results obtained seem to bear out the claims made for the efficiency and adaptability of the new fuel. It consists, it may be recalled, in a mixture of 60 per cent of crude oil with 40 per cent of pulverized coal by weight so intermixed as to create a solution which will remain stable for some months. The tests made by Mr. A. W. Perrins of the Cunard Steamship Company and Mr. A. M. Wood of the Wallsend Slipway and Engineering Company, Ltd., who accompanied the ship, seem to confirm this stability, as no trouble was experienced with the pumps, strainers, heaters or burners, and the emptied fuel tanks were found to be quite clean. About seventeen tons of fuel per day were burned and there was, it is understood, no undue smoke, while the only deposit was a free brown ash taken from the smoke boxes. The burners were cleaned a little more often than is necessary with ordinary boiler oil, but there was no tendency to slagging. The experiments also indicated the possibility of changing over quickly from boiler oil to oil-coal fuel, or vice versa, without incurring any extra expense. The steaming appeared to be quite good and somewhat better than with ordinary oil fuel. The specific gravity of the fuel, which remained constant throughout the trials, has been given as 1.1, compared with about 0.96 for ordinary boiler oil, which means that it will not float when discharged into the sea, while in case of leakage or fire, it can be easily flooded with water.

—*The Engineer.*

Speed with Safety in Transportation

A technical paper presented at the annual meeting of the American Society of Mechanical Engineers held in New York in November and December 1931, was entitled "The Air Resistance of High-Speed Trains and Inter-urban Cars." According to the paper, speeds of 65 and 75 miles an hour were recorded on railroads more than eighty years ago, and this has not been improved. To meet bus competition, the rail carriers can obtain speeds of 100 miles an hour by decreasing the train resistance rather than by increasing the motive power and this can be done without appreciable sacrifice of either safety or economy, according to Dr. Oskar G. Tietjens and K. C. Ripley, the authors of the article in question, who recommend light weight, streamline designs and probably other radical departures from present practice as the solution. Streamlining of fast trains and high speed inter-urban cars is justified on present operating schedules. Assuming a straight level track, train resistance is divided into frictional and air resistance. Wind tunnel tests show that a saving of about 40 per cent in power at a speed of 50 miles an hour is produced by partially streamlining an interurban car. At 35 miles an hour, this saving is about 30 per cent. According to the computations of the authors, the additional cost of 100-mile speed over 40-mile speed to a day coach passenger on a train should be 0.2 of a cent per mile. By comparison, the same item for bus travel at 30 miles an hour is given as 2.2 cents a mile, that on a limited train at 40 miles an hour at 3.6 cents, that on a 100-mile streamlined train as 3.8 cents a mile and that on an airplane at 100 to 120 miles an hour at 6.5 cents a mile per passenger.

William Hamilton Limited, Montreal, Que., and Peterborough, Ont., have recently issued a 12-page bulletin describing and illustrating "The American Flexible Coupling." A price list and data sheet is included. Copies of the bulletin may be obtained upon application to the company.

The Superheater Company.—A superheater, easy and economical to attach to horizontal return tubular boilers, has recently been developed by this company, and is described in their bulletin T-22. The equipment is of simple construction, is standard for all horizontal return tubular boilers and may be installed readily without changing the boiler setting.

Preliminary Notice

of Applications for Admission and for Transfer

July 15th, 1932

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, 1932.

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

O'BRIEN—FREDRIC GORDON, of 4982 Queen Mary Rd., Montreal, Que., Born at Windsor, N.S., March 2nd, 1896; Educ., B.A Sc., Univ. of King's Coll., 1921. B.Sc. (E.E.), N.S. Tech. Coll., 1923; 1916-19, overseas, Can. Engrs.; 1921 (summer), shift engr., Marconi Transatlantic Stn., Louisburg, N.S. Also on inventory of equipment, N.S. Tram. & Power Co., Halifax, N.S. June 1922, rodman and chainman, Canadian Gypsum Co., Windsor, N.S.; 1922 (July-Oct.), sold and demonstrated radio sets, Windsor Vulcanizing Co., Windsor, N.S.; June 1923 to June 1924, radio officer, Lieut., R.C.C.S., Camp Borden, in charge of radio station and storage battery charging hut, and of courses on line telegraphy, motors and generators, and radio; 1924-26, engrg. dept., Dubilier Condenser and Radio Corpn., New York City, on research and design of paper condensers; 1926-28, radio engr., transmission engrg. dept., Northern Electric Co. Ltd., Montreal, on development and design of radio receivers, and on public address and broadcast operational work; May 1928 to Sept. 1931, with same company, as chief sound engr., and head of research products engrg. dept. (resigned due to illness).

References: H. J. Vennes, W. A. Steel, W. C. Adams, W. B. Cartmel, J. R. Fenwick, B. H. Steeves, E. C. Hague.

PATERSON—RAYMOND GORDON, of 718-6th Ave. West, Calgary, Alta. Born at Melbourne, Australia, June 27th, 1903; Educ., 1917-20, Royal Australian Naval College; 1923-24, elect'l. engrg. course (evenings), Swinbourne Technical College, Victoria, Australia; 1928, wireless course, Melbourne Technical College, obtaining Australian Govt.'s license to operate experimental wireless stations; 1921-22, 2 years at sea as midshipman, R.A.N.; 1923-30, 7 years with Melbourne Electric Supply Co., as ap'tice, fitter, dftsman., on substation and switchgear design, erection and mtce. of machines; 1929, one year in wireless lab. of Melbourne Technical School on research work; 1930 (3 mos), elect'l. dftsman., Can. Gen. Elec. Co., Peterborough, Ont.; 1930 to date (18 mos), map dftsman., geological dept., Canadian Western Natural Gas Light Heat & Power Co., Calgary, Alta.

References: W. M. Cruthers, F. Bowness, A. B. Gates, V. S. Foster, E. R. Shirley, E. W. Bowness, F. J. Heuperman, J. E. Duncan.

YORGAN—WILLIAM JAMES, of Montreal, Que., Born at Buncrana, Co. Donegal, Ireland, July 31st, 1881; Educ., 1886-96, Irish National Schools; 1898-1902, constrn. of Letterkenny to Burtonport and Carndonagh Extension Rlys., Co. Donegal, Ireland, for Pauling & Co., contractors, London, England; 1902-05, Northbolt to Wycombe Extension, Great Western Rly. Co., England; 1905-06, foreman on Ashendon to Aynho Extension, Great Western Rly. Co.; 1906-07. contractor's engr. on Camerton to Limpley Stoke Extension, Great Western Rly. Co.; 1907-13, engrg. inspr., Dept. Rlys. and Canals; 1917 to date, supt. of gas mains, Montreal Light, Heat & Power Cons., Montreal, Que.

References: J. J. Humphreys, E. J. Turley, D. O. Wing, R. N. Coke, L. A. Kenyon.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

FINDLAY—REGINALD HUDSON, of Montreal, Que., Born at Glasgow, Scotland, Oct. 29th, 1885; Educ., Associate, Royal Technical College, Glasgow. 1909; Two years additional study at Glasgow University; 1903-04, machine and electr'l. shop work; 1909-11, on teaching staff, Royal Technical College; 1911-30, and 1931 to date, with the Dominion Bridge Co. Ltd., Montreal, as follows: 1911-16, dftsman and checker, struct'l. dept.; 1916-18, dftsman and checker, mech'l. dept.; 1919-20, and 1921-22, chief mech'l. dftsman., in charge of drawing office handling cranes, hydraulic control gates, grain car unloaders, hoisting machinery, etc.; 1920-21, production engr. on above; 1922-25, engr. on design of above; 1926-28, in charge of estimating and design of hydraulic control gates; 1929, same as 1926-28, also of cranes and general mech'l. work; 1930, asst. mech'l. engr. in charge of above; 1931 to date, mech'l. engr. in charge of mech'l. engrg. and design. (1930-31, mech'l. engr., Riverside Iron Works, Ltd., Calgary, Alta.) (*A.M. 1920.*)

References: F. P. Shearwood, F. Newell, D. C. Tennant, R. S. Trowsdale, P. L. Pratley, J. A. McCrory.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CLEVELAND—HARRY ROLAND, of 1254 MacKay St., Montreal, Que., Born at Danville, Que., Jan. 9th, 1899; Educ., B.Sc. (E.E.), McGill Univ., 1924; 1923 (summer), electrn's helper, Canadian Johns-Manville; 1924-25, studying French; Jan. 1926 to date, cable design and sales engrg., Northern Electric Co. Ltd., Montreal, Que. (*S. 1923, Jr. 1928.*)

References: N. L. Dann, N. L. Morgan, T. Eardley-Wilmot, B. C. Nowlan, W. G. Tyler.

CYR—SERAPHIN ADELARD, of 4395 St. Andre St., Montreal, Que., Born at Montreal, March 11th, 1899; Educ., Has passed E.I.C. examinations under Schedule "B" (1931) and "C" (1932) for admission as Associate Member; 1915-16, dftsman., P. E. Bourassa & Son, cabinet makers; 1916-20, arch'l. dftsman., J. A. Godin, Architect; 1920 to date, with Eastern Steel Products, Ltd., Montreal, as estimator and (since 1924) asst. supt., duties consisting of design of light steel structures, design and estimating of sheet metal specialties such as library bookstacks, concrete moulds, conveyor casings, etc., field superintendence of grain spouting, ventilation, etc. (*Jr. 1931.*)

References: H. Fortier, G. B. Mitchell, E. W. Wall, E. V. Gage, C. A. Norris, C. H. Gordon.

JONES—JOHN HUGH MOWBRAY, of Liverpool, N.S., Born at Sault Ste Marie, Ont., Aug. 24th, 1905; Educ., B.A.Sc., Univ. of Toronto, 1927; 1924-25 (partial), hydraulic dept., Spanish River Pulp and Paper Mills, Ltd., field engr., constrn. of storage dams, office work, estimates; 1927, dftsman., engrg. dept., Soo Mill, Spanish River Company; 1928, cost engrg., etc., Abitibi Power and Paper Company, Soo Divn.; 1928-29, engr., and 1929 to date, res. engr., Mersey Paper Co. Ltd., Liverpool, N.S., present position held during constrn. of Mersey Paper Mill, and since commencement of operation in full charge of all engrg. work in connection with mill. During last three months. in addition to engrg. duties, held position of asst. general operating supt. (*S. 1925, Jr. 1930.*)

References: G. F. Hardy, G. H. Kohl, C. H. L. Jones, J. L. Lang, A. C. D. Blanchard, R. R. Murray, R. L. Seaborne.

FOR TRANSFER FROM THE CLASS OF STUDENT

CHANDLER—EDWARD SAYRE, of Charlottetown, P.E.I., Born at Charlottetown, July 17th, 1901; Educ., B.Sc., N.S. Tech. Coll., 1931; 1917-20, meter reader, 1925-29 (vacations) and 1929-30, asst. to supt., Maritime Electric Co., Charlottetown; 1931-32, engr. in charge of revamping Wolfville Electric Commn. distribution system; at present, provincial electrical inspector, Charlottetown, P.E.I. (*S. 1930.*)

References: F. R. Faulkner, G. H. Burchill, W. A. McLaren, H. E. Miller, H. F. Laurence.

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The Service is operated for the benefit of members of The Engineering Institute of Canada, and industrial and other organizations employing technically trained men—without charge to either party.

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The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

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REPRESENTATIVE WANTED. The advertisers are desirous of forming a connection with some reliable firm or individual in Ontario to handle an entirely new piece of equipment for the permanent removal and prevention of mud and scale in steam boilers. Applicants must be familiar with boiler plant operation and have facilities for contacting all users of portable and stationary boilers in Ontario. This is an opportunity for some progressive firm or individual to obtain an exceptionally good and profitable agency. Kindly reply to No. 857-V.

YOUNG ENGINEER, 25 to 30 years of age, required for Montreal office by specialist civil engineer. Must have degree and good general practical construction experience. Apply to Box No. 859-V.

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MECHANICAL ENGINEER, Jr.E.I.C. Univ. Toronto '22. A.A.S.M.E. Diversified experience, one year teaching, three years Canadian Westinghouse Co., past four years in charge of mechanical laboratory of leading manufacturer in U.S.A. Sound technical knowledge and good organizing and executive ability. Wishes to return to Canada. Position with industrial or commercial laboratory. Apply to Box No. 138-W.

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CIVIL ENGINEER, A.M.E.I.C., married, thirty years experience in municipal engineering, highway and pavement work, also qualified sanitary engineer. For the past twenty years engaged as construction engineer on large works, including buildings, sewerage and water systems. Experienced executive and up-to-date methods used. Permanent position desired as engineer or superintendent. Location immaterial. Available at once. Apply to Box No. 336-W.

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CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, A.M.E.I.C., University graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

CHEMICAL ENGINEER, graduate of McGill University, B.Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in design, manufacture, sales and installation of pulp and paper, also mining machinery, seeks association with firm as sales engineer. Apply to Box No. 633-W.

CIVIL ENGINEER, A.M.E.I.C.; R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, A.M.E.I.C., Canadian. Fifteen years experience since graduation, manufacturing, testing, erecting and operating electrical equipment of all kinds. Six years power house and substation design and layout. Thoroughly familiar with automatic and supervisory control equipments, and industrial control. Available immediately. Anywhere in Canada. Apply to Box No. 681-W.

ELECTRICAL ENGINEER, B.Sc., '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

MECHANICAL ENGINEER, Jr.E.I.C., G.I. Mech.E. Ten years practical experience—design and construction—elevating, conveying and transporting machinery—contractor's stone and woodworking machinery. Recently mechanical engineer with pulp and paper company. Will develop and design machinery to suit individual requirements pending full time employment. Available immediately. Apply to Box No. 704-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

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CIVIL AND CERAMIC ENGINEER, A.M.E.I.C., university graduate '24. Experienced in municipal engineering and general surveying, also clay products, plant construction and operation. For past three years employed as engineer in charge of general plant operations by large clay products manufacturer. Desires position in either civil or ceramic engineering. Location immaterial. Married. Age 30. Available immediately. Apply to Box No. 717-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

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CIVIL ENGINEER, B.Sc., '32. Two years experience in municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

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ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

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Pressure Vessels of Welded Construction

J. C. Hodge,
Babcock and Wilcox Company, Barberton, Ohio.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, November 12th, 1931.

SUMMARY.—The extent to which welded joints may be safely used in pressure vessels, such as boiler drums, has been a matter for discussion for years, and this method of construction is now permitted under proper restrictions as to the welding methods employed. The paper describes the properties of satisfactory welded seams of pressure vessels, as regards tensile strength, resistance to impact and fatigue, chemical composition, etc., and describes the testing procedure for such joints and the precautions which must be taken in relieving the stresses set up by the welding process.

Two years ago the joints of all pressure vessels manufactured by the company with which the author is connected were riveted; today approximately 90 per cent of those in process of manufacture are of welded construction. To those who have not been in close touch with the development of welding in recent years, the magnitude of this change in pressure vessel construction may not be readily appreciated, and a casual examination of the two types of construction may not suggest the very serious problems which presented themselves in the development of welded pressure vessels.

About five years ago it became evident that the riveted joint had been developed to its limit and that riveted pressure vessels could no longer meet the demands for increased sizes and increased pressures for units of steam generation and of industrial processing. At that time the first serious consideration was given to the application of a welding process in the construction of boiler drums and similar pressure vessel equipment. The purpose of this paper is to give a brief statement of the state of development of the various welding processes at the inauguration of our welding programme, to give an outline of the welding process, to describe the numerous tests to which welded joints made by this welding process were subjected, to outline the application of non-destructive testing to the welded seams of the completed welded pressure vessels, to describe briefly the final acceptance of welded pressure vessels under the unfired pressure vessel code and the boiler code of the American Society of Mechanical Engineers, and also to show a few examples of welded pressure vessels recently constructed under these rigid specifications which assure the reliability of welded vessels under widely varying service conditions.

The service conditions of pressure vessels for steam generation and pressure vessels for the oil industries and chemical processing industries are quite severe. Temperatures of 900 to 1,100 degrees F. and pressures of 1,000 to 1,600 pounds per square inch and even higher are not uncommon. Changes of pressure and of temperature during the life of a vessel produce cycles of stress within the structure, and chemical conditions within the pressure vessel further complicate the problem by introducing the varying element of corrosion. Fusion welded joints as main members of a structure with an efficiency close to 100 per cent must be able to withstand the same conditions, stress, temperature and corrosion, as the parent or base material of the structure.

A little consideration of the above brief statement of operating conditions in one type of welded product immediately points to the importance of a complete understanding of the mechanical, physical and physical-chemical properties of the welded joints, which in turn involves an intensive study of the fundamental properties of the welded joint such as the metallurgy and chemistry of welded seams.

Five years ago when our welding programme was originated the known state of the various welding processes was briefly as follows:

(1) *Forge and Hammer Welded Drums.*

Forge and hammer welding was being used for boiler drums and pressure vessels of the oil industry. The boiler code accepted this type of welding but several disastrous failures of this type of welded joint due to lack of complete fusion had occurred in the oil industry. The process had reached its maximum and could not be looked to for the successful construction of thick walled vessels as the maximum thickness of plate which can be successfully welded commercially by this process is two inches.

This welding process is limited to the joining of plate of low tensile strength, as the base material to be of good weldable quality must be low in carbon and other strengthening alloying elements.

(2) *Electrical Resistance Welding*

Electrical resistance welding was coming into use for the welding of small sections such as the joining of tubes end to end as in superheaters and similar constructions. In the boiler code this type of welded joint was considered equivalent to a forge-and-hammer welded joint as it is fundamentally the same, electrical resistance being used as the heating agent in place of a furnace or forge, and the same allowable working stress was permitted with this method of welding. This welding process gave excellent joints of 100 per cent efficiency and presented possibilities in its application to boiler construction. However, due to the required excessive investment in equipment and excessive power consumption in the welding of heavy sections, this method was eliminated from consideration for the welding of the main joints in pressure vessels. For example, 25 kv.-a. of transformer capacity and 5 tons of force are required for the welding of one square inch of joint section. To weld a circumferential joint on a drum 48 inches in diameter by 2-inch wall thickness would require approximately 7,500 kv.-a. of transformer capacity and 1,500 tons of push-up force. Pipe 14 inches diameter by 1¼-inch wall thickness, has been welded across sectional area of 52 square inches. It is only a question of equipment for the successful welding of the main joints of pressure vessels by this method.

(3) *Autogenous Welding.*

The conditions pertinent to autogenous welding, including both acetylene and arc welding, were less easily defined. The advocates of this type of welding were making enormous claims without having any substantial data to support those claims. In the main therefore autogenous welding had been applied to the repair of broken parts and to the manufacture of minor constructions, subject only to static loads of small intensity. Both of the autogenous processes, however, presented possibilities for pressure vessel welding.

The arc welding process and particularly metal arc welding, presented definite advantages: (1) Automatic welding machines were being developed for the deposition of the metal. (2) The heating of the work was kept at a minimum due to the extremely local heating of the arc. (3) Dangers from distortion of the finished work were not excessive. (4) The reasons for the defects in metal arc welding were gradually being brought to light, and with the causes of the defects understood it was only a question of developing methods for the elimination of these causes to produce good sound welded joints. Their elimination did not seem insurmountable and development and research work was therefore concentrated on the metal arc welding process.

Advantages of Welded Pressure Vessels

Provided a welded joint of excellent and unquestionable quality could be produced, welded pressure vessels possessed decided advantages over the riveted vessel:

(1) The welded joint could be made to give a higher joint efficiency. This is extremely important in those classes of vessels where the wall of the vessel is not weakened by a large number of openings. Vessels of this type are largely used in the oil and chemical process industries.

(2) Due to the elimination of buttstraps, of rivets and of the lap of drum heads within the shell, and due to the higher joint efficiencies, a considerable saving of plate material and a large reduction in the weight of the finished drum would result—an extremely important consideration for marine work. Comparative weights for the drums now being constructed for the United States navy are as follows:

Welded Drum........	10,000 pounds
Riveted Drum.......	13,000 "
Saving in weight.....	3,000 "

(3) Due to the elimination of buttstraps, of the inside lap of drum heads and rivet heads, the volume of a drum is slightly increased, and in constructions serving for the transport of fluids as in a penstock, wall friction is considerably reduced, thus increasing the rate of flow through the vessel.

(4) Although the use of inside caulked riveted joints had eliminated caustic embrittlement from the riveted joints of steam drums, the use of welded joints presenting a smooth surface on the interior of a drum would entirely eliminate the possibility of caustic embrittlement of the connecting joints. Dangers from local corrosive attack around the more highly stressed rivet holes would be eliminated.

However, in spite of the advantages of welded pressure vessels enumerated above, there existed very definite drawbacks to the application of autogenous welding to pressure vessels and boiler drums in particular. Probably the most serious drawback at that time was the attitude of the Boiler Code Committee of the American Society of Mechanical Engineers and other groups of engineers towards the application of fusion welding to pressure vessels. It could be foreseen that the commercial application of a welding process, granted a good one could be developed, to welded boiler drums would prescribe an elaborate research programme and a large amount of educational work in swinging over engineering opinion in favour of welded pressure vessels.

This hostile attitude towards welded construction was largely based on the three following conditions:

1. The average bare electrode weld as used in constructions which operate under conditions not relatively severe could not be used because the weld metal, even when free from major defects, is characteristically brittle.

2. There has been a lack of agreement regarding the desirable physical, chemical and other properties of welded joints. This was particularly true regarding the behaviour of welded joints under repeated applications of stress and was also true regarding the behaviour of welded joints under high temperature conditions.

3. The greatest objection to the use of welded pressure vessels was undoubtedly the absence of a definite testing procedure which would assure the reliability of the completely welded drum.

With the above three objectional conditions in mind, the experimental work was planned to eliminate condition one by the developing of a metal arc welding process which would give metallurgically sound welded joints; to eliminate condition two by publishing reliable data on the physical, chemical and other properties of all types of welded joints; and to eliminate objection three by proposing a definite testing procedure which would assure the reliability of a welded drum.

Fig. 1—Welded Joint Illustrating Defects.

Properties of Welded Seams of Pressure Vessels

Ordinary arc weld metal, i.e., weld metal deposited from bare electrodes, usually contains a large number of major defects such as porosity, slag, incomplete fusion, etc. (Fig. 1.) Even when by chance ordinary arc weld metal is deposited free from these defects, the weld metal is brittle due to the contamination of the molten metal by the oxygen and nitrogen of the surrounding atmosphere in its transfer through the arc, resulting in the presence of embrittling oxides and nitrides in the deposited metal. Fig. 2a is a typical photomicrograph (magnification 500 diameters) of bare electrode weld metal, showing oxides and nitrides. The oxides are small rounded inclusions, nitrides are elongated needle-like inclusions. Due to the presence of the above gross defects and embrittling constituents of microscopic dimensions, this bare electrode arc weld metal is extremely brittle and is not satisfactory for the welded seams of pressure vessels.

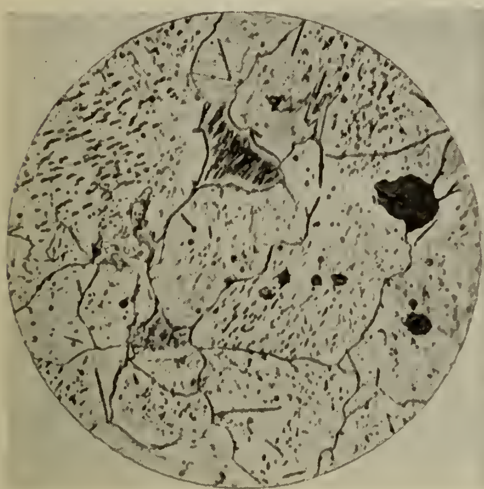

Fig. 2a

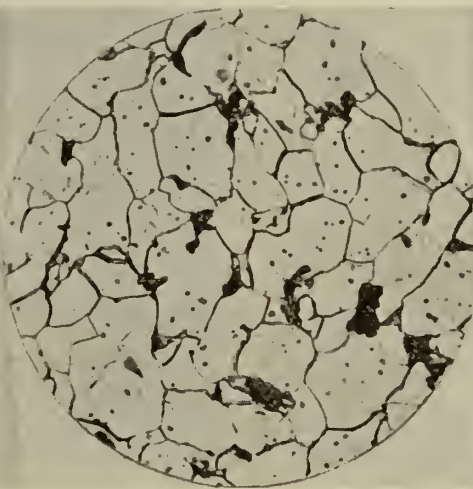

Fig. 2b

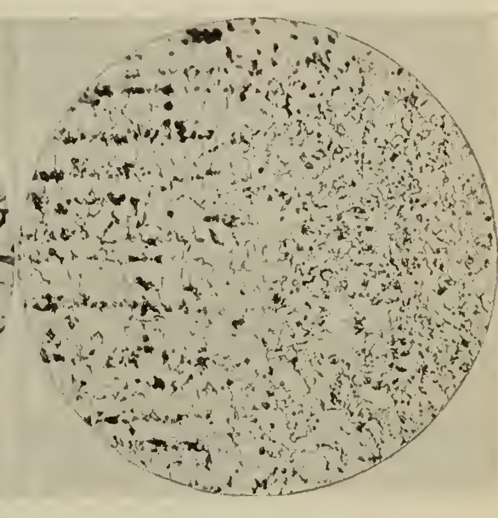

Fig. 2c

The physical properties of this weld metal are as follows:

Ultimate strength........	50,000 pounds per square inch
Elongation in 2 inches....	5 to 18 per cent.
Reduction of area........	15 per cent.
Charpy notched impact value..................	1 to 8 foot-pounds.
Per cent elongation of outside fibres of bend test.	5 to 10 per cent.

The above statement regarding the embrittlement of bare electrode weld metal should not be construed as a condemnation of the bare electrode welding process for all classes of fabrication. For certain types of engineering structures, joints welded by the bare electrode arc welding process can be successfully used.

Weld metal suitable for the welding of pressure vessels must be free from major defects and free from microscopic defects such as nitrides and oxides. Figs. 2b and 2c illustrate typical photomicrographs on fusion welded joints suitable for pressure vessels. Fig. 2b shows the freedom from nitrides and oxides of pressure vessel weld metal (magnification 500 diameters), Fig. 2c the zone of fusion between weld metal and boiler plate. No coarse overheated structure exists in the affected zone of the boiler plate. This metallurgically sound arc weld metal can only be deposited under conditions which give complete protection to the molten metal during its transfer through the arc. This metallurgically sound weld metal should be at least as strong as the materials joined; it should possess ductility and notch toughness to a degree comparable with that of the plate. The welded joint should possess an endurance limit equal to that of the base or plate material. Fig. 3 is a sample of a section through pressure welded joints on a 2-inch thick plate, showing absolute freedom from major defects; complete absence of defects along line of fusion in each case should be noted.

The following physical and chemical properties of welded joints are presented as characteristic of the welded joints which were finally developed as suitable for the welding of pressure vessels. In each case, this special weld metal has been compared with bare electrode weld metal and A.S.M.E. firebox quality plate.

Tensile Properties

Two types of tension test specimens are used in the testing of a welded joint. The first type of specimen is cut transverse to the welded joint. The testing of this type specimen therefore determines not only the strength of the weld metal but also the degree of fusion existing between the weld metal and the plate material, and also determines the strength of the affected zone of the plate material.

The second type of tension test specimen is an all weld metal specimen of standard dimensions, .505 inches diameter by two inches gauge length, cut through the weld so that the axis of the specimen is parallel with the axis of the joint. This type of specimen is used not only to determine the strength of the weld metal, but also the ductility of the weld metal as measured by the elongation and reduction of area. Fig. 4 shows transverse tension test specimens taken from a welded joint suitable for pressure vessels. Specimens failed in boiler plate until section through the weld had been reduced by drilling holes in the weld metal until the effective cross sectional area through the weld was about 70 per cent that of the plate.

Fig. 3—Welded Joint Showing Freedom from Defects.

Bend Tests

The bend test specimen is transverse to the welded joint and is of considerable value in determining the ductility of the weld metal. The specimen is bent under free bending conditions and the ductility of the weld metal is expressed as the per cent elongation of the outside fibres of the weld metal during bending.

Table I

	A.S.M.E. Fire-box plate	Pressure Vessel Weld Metal	Bare Electrode Weld Metal
Transverse Specimens:			
Ultimate Strength, pounds per square inch.			
Minimum	55,000	65,000	......
Maximum	65,000	74,500	56,000
Average	......	67,500	50,000
Yield Point, pounds per square inch.			
Minimum	½	47,000	......
Maximum	Ultimate	58,900	50,000
Average	Strength	51,000	42,000
All Weld Metal Specimens:			
Yield Point, pounds per square inch.			
Minimum	Not	40,000	35,000
Maximum	Specified	65,000	40,000
Average		52,000	42,000
Ultimate Strength, pounds per square inch.			
Minimum	Not	60,000	40,000
Maximum	Specified	72,000	63,000
Average		67,000	52,000
Elongation in 2 inches.			
Minimum	Not	20.5	5.0
Maximum	Specified	38.0	18.0
Average		28.0	8.0
Reduction of Area.			
Minimum	Not	32.0	10.0
Maximum	Specified	65.0	25.0
Average		40.0	15.0

Impact Resistance

Impact tests give a measure of the ability of a steel to resist the growth of a crack once started in the metal; in other words the measure of the degree of brittleness or the absence of brittleness in the steel tested. Table II gives comparative impact values for the three different materials.

Fig. 4—Transverse Tension Test Specimens.

Table II

	Min.	Max.	Average.
A.S.M.E. boiler plate, as rolled	19	33	20 foot-pounds
Weld metal—made with bare electrodes.	1	8	5 "
Pressure vessel weld metal	20	45	28 "

Laboratory Fatigue Tests

While developing our welding process, the endurance limit or fatigue value of the welded joints was the most elusive property encountered in bringing the quality of welded joints to equal those of the boiler plate. This was due to the presence of extremely small defects and their effect on this property of metals. A weld metal was finally developed with an endurance limit equal to that of the base material. The endurance limit of this weld metal is compared with the endurance limit of boiler plate in Table III.

Table III

Type	Endurance Limit	Nitrogen	Authority
B & W Arc Weld	30,000 pounds per square inch. (Approx.)	.020 per cent	Prof. Moore
B & W Arc Weld	28,800 pounds per square inch	.045 per cent	Prof. Thornton
Firebox Plate	28,000 to 32,000 pounds per square inch	.0033 per cent	

Specific Gravity

The density or specific gravity of various weld metals offers a very convenient method of determining the relative amounts of voids or porosity present in weld metals.

	Specific Gravity Min.	Max.	Ave.	Average Density Pounds per Cu. Ft.
Bare electrode weld metal	7.44	7.68	7.59	473
Pressure vessel weld metal	7.80	7.85	7.83	488
A.S.M.E. firebox plate	....	....	7.84	489

Assuming the theoretical value of the specific gravity of solid rolled low carbon plate as 7.85, the above values correspond to the presence of 3.3 and 0.12 per cent voids respectively in ordinary weld metal and the special pressure vessel weld metal. The minimum value of 7.44 for bare electrode weld metal corresponds to the presence of 5.2 per cent voids.

Chemical Analysis

The chemical composition of pressure vessel weld metal as compared with boiler plate and with bare electrode weld metal is given in Table IV.

Table IV

	Firebox Plate	Pressure Vessel Weld Metal	Bare Electrode Weld Metal
Sulphur	Less than .04	Less than .045	Less than .045
Phosphorus	Less than .04	Less than .040	Less than .040
Manganese	.30 to .60	.30 to .60	Less than .20
Carbon	Not over .30	.08 to .15	.02 to .08
Nitrogen as iron nitride	Not specified. Will not usually be over .009	Less than .02	.10 to .14

A comparison of the above values (particularly the nitrogen contents and the manganese contents) indicates that the weld metal suitable for pressure vessel welding was deposited under conditions which gave the greatest protection to the molten weld metal from the gases of the atmosphere.

Fatigue Tests of Welded Pressure Vessels

Starting with the premise that the riveted boiler drums had given eminently satisfactory service over a long period of time it was decided to subject a full sized A.S.M.E. standard riveted drum to repeated applications of pressure at 1½ times the working pressure, until either failure by fatigue developed or a sufficiently great number of applications had been applied to multiply manifold the applications of pressure encountered in boiler drum service. The results of the test on this riveted drum were to be taken as a yard-stick by which the performance of various types of welded joints could be judged. The standard riveted drum withstood over 1,000,000 applications of pressure at 1½ times the working pressure without failure when the test was discontinued. Stress in plate at riveted joint 16,500 pounds per square inch at maximum test pressure. A large number of welded shells welded by different processes and a large number of welded drums with joints suitable for pressure vessels as previously described, were subjected to this fatigue test. Fig. 5 shows the fatigue test assembly used for the testing of welded shells under repeated applications of pressure. Construction consists of one outer shell which is the test shell and one inner shell with an hydraulic space between them. Packing glands at ends are held in place by end plates. Outer test shell contains one or more longitudinal welded seams. Fig. 6 illustrates a section through a welded joint of welded test shell containing bare electrode weld. Failure occurred through

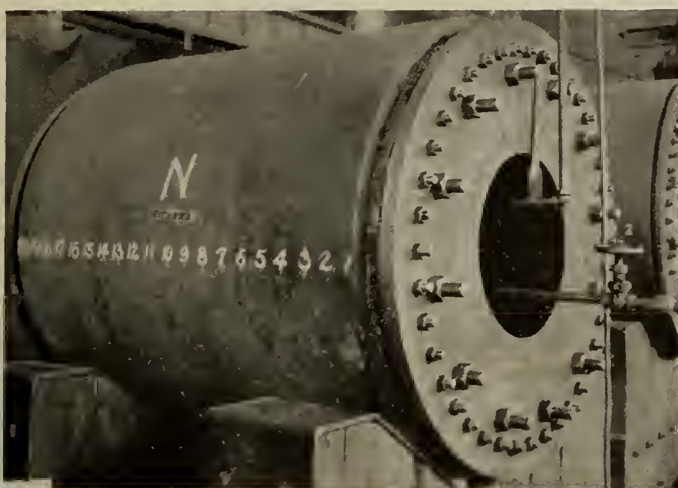

Fig. 5—Welded Shell Fatigue Test Assembly.

weld after 5,530 applications of pressure equivalent to a stress of 16,500 pounds per square inch. Failure developed through defects along the line of fusion between weld metal and boiler plate. After several attempts the welding process which gave physical properties as previously described gave a welded test shell which withstood over 2,000,000 applications of pressure at 1½ times the working pressure without failure. These results could be duplicated at any time, and it was considered that this welding process could be used in the manufacture of safe boiler drums provided suitable control was applied to the process.

Testing Procedure for Welded Pressure Vessels

The testing procedure proposed for the testing of production welded drums was based on experimental work and was made up of the following fundamentals:

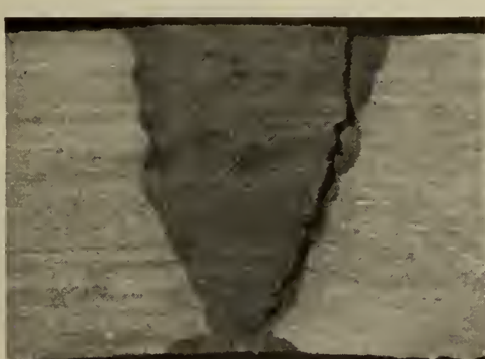

Fig. 6—Failure Through Defects along Line of Fusion.

1. The securing of welded test plates, which are obtained under conditions as near as possible to the conditions under which the main welded joints in the pressure vessel are produced. The determination of the tensile properties, the ductility under bending, the impact values, the macro- and micro-structural characteristics and the chemical analysis of the weld metal on specimens obtained from the above test plates. These properties must comply with the values of a rigid, yet reasonable, specification which will guarantee a high quality of weld metal.

2. The exploration of the main longitudinal and circumferential welded joints of the finished welded drums by an approved non-destructive test which would determine quantitatively the size and location of a defect within the welded joint. (Fig. 7.)

3. The subjection of the completely welded drum or pressure vessel to a hydrostatic test pressure of some value considerably higher than the working pressure of the drum or vessel.

Fortunately the Boiler Code Committee of the American Society of Mechanical Engineers presented to the public in March 1930 proposed specifications for fusion welding of shells or drums of power boilers which were based on such fundamentals of testing procedure as given above. In the December 1930 issue of Mechanical Engineering the Boiler Code presented proposed specifications for fusion welding of unfired pressure vessels, these being based on the earlier specifications proposed for power boilers. In July of 1931 the American Society of Mechanical Engineers formally adopted specifications for the fusion welding of unfired pressure vessels and specifications for the fusion welding of power boilers, as recommended by the

Fig. 7—X-ray Apparatus.

Boiler Code Committee after consultation of all people interested in this field. This welding code has now been applied to the construction of welded vessels for six months and a large number of vessels have been constructed under its provisions.

Under these specifications representative welded sample test plates are obtained and from these test plates coupons for tension and bend test and coupons for the specific gravity determinations are removed. The results obtained on these test specimens must comply with minimum values set up in the welding code. After the completion of the welding of a drum or vessel, the main welded seams are prepared for x-ray examination. The main joints are then subjected to x-ray examination. Any defects revealed by the x-ray are removed by chipping and rewelding, and the joints again x-rayed if necessary. Fig. 7 is a view of an x-ray apparatus for the production examination of main welded joints. Fig. 8a is a radiograph of a defective welded joint. The defects consist of elongated bodies of entrapped slag along the walls of the joint. Fig. 8b is a section through this same joint showing two slag pockets one on each side of the joint. Nozzles and other attachments are welded on. The welded drum is then stress-relieved at approximately 1,200 degrees F. After this stress-relieving treatment the drum is then ready for hydrostatic test and for the machining of tube holes and other openings.

Even before the final adoption of the welding specifications by the American Society of Mechanical Engineers, the Bureau of Engineering of the United States Navy gave first official recognition to the proposed specifications of the Boiler Code Committee, and in the latter part of 1930 authorized the construction by welding of the joints of

Fig. 8a

Fig. 8b

drums for twenty-four boilers now being built by the Babcock and Wilcox Company for the new scout cruisers *Minneapolis*, *New Orleans* and *Astoria*. The specifications under which navy welded boiler drums were built were slightly more rigid than the specifications finally adopted by the Boiler Code Committee but the two sets of specifications do not differ in principle. In both specifications no attention has been paid to details of the welding process, i.e., all details of the welding process are left to the judgment of the manufacturer. Both specifications, however, stress the final testing of the completed welded pressure vessel along the lines previously suggested under testing procedure.

Hydrostatic Test of Welded Pressure Vessels Built in Accordance with the Specifications

The results of a hydrostatic test on a welded pressure vessel built in accordance with the specifications may now be examined. A welded test drum 47⅛ inches O.D. by one inch thick by 14 feet 1 inch over-all length was built in accordance with the specifications adopted by the Bureau of Engineering of the United States Navy. The drum possesses one longitudinal seam and two circumferential or girth welded seams for attachment of the heads to the shell. The welds were of the same thickness as the plate, i.e., all excess weld metal had been ground off flush with the plates. During the hydrostatic test the drum was subjected fourteen times to a pressure of 2,830 pounds per square inch, the pressure in each case being raised from zero. Failure of the drum did not take place but a straight edge along the shell of the drum showed severe distortion. The shell elongated circumferentially 14 inches in a circumference of 148 inches corresponding to a mean circumference elongation of 10 per cent.

Based on a factor of safety of five and considering that the plate material had an ultimate tensile strength of 55,000 pounds per square inch, according to the formulae of the A.S.M.E. Boiler Code, the working pressure of the shell is 489 pounds per square inch, and the working pressure of the manhead is 487 pounds per square inch. Assuming that the yield point of the plate material was 33,000 pounds per square inch, the pressure at which the yield point of the shell was reached was 1,021 pounds per square inch. The above maximum test pressure of 2,830 pounds per square inch corresponds to a maximum hoop stress in the shell of 63,450 pounds per square inch, based on the original diameter of the shell, and corresponds to 69,864 pounds per square inch based on the final diameter of the shell.

Stress-Relieving Treatment

The welding specifications specify a stress-relieving treatment of the completely welded vessel, this stress-relieving treatment consisting in heating the drum uniformly to a temperature in the neighbourhood of 1,200 degrees F. and holding at that temperature for a sufficient length of time to remove the residual welding stresses left in the drum after the completion of the welding operations. Inclusion of this requirement in the specifications is one of the most important considerations in the aspect of fusion welding of pressure vessels. A stress-relieving furnace recently built has an arch roof with inside dimensions 14 feet 6 inches wide by 14 feet 6 inches high to the spring of the arch. The furnace has an inside length of 60 feet, but the design will permit additional length being built on at a later date, when and if this becomes necessary. In cross-section this furnace is large enough to receive the largest vessel that can be transported on present railroad equipment. Specially constructed cars operated on three rails

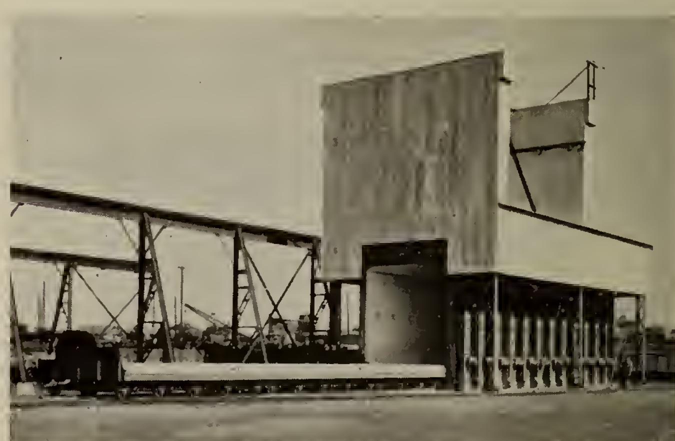

Fig. 9—Stress-Relieving Furnace.

transport the drums and other vessels from the welding shop directly into the furnace. (See Fig. 9.)

Recently constructed welded pressure vessels show that the new welding codes may be applied in the production of welded pressure vessels of widely varying sizes and for widely varying service conditions. Having successfully passed the rigid requirements of the specifications, these pressure vessels can be expected to withstand the conditions of intended service with no occasion for alarm regarding the satisfactory service of the welded seams.

Proportioning Concrete for Durability

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Paper presented before the Lethbridge Branch of the Engineering Institute of Canada, January 18th, 1932.

SUMMARY.—The marked improvement which has taken place in recent years in the technique of proportioning and mixing concrete has drawn attention to the importance of durability, water tightness, and strength. The author discusses data now available in the light of recent investigations regarding the effect of the characteristics of the cement in determining the compressive strength of concrete, the effect of water-cement ratio and curing and the results obtained with regard to water tightness.

The potential quality of concrete is shown to depend upon three factors, the quality of the aggregate, the water cement ratio, and the completeness of curing.

Examples are given of structures showing both satisfactory and unsatisfactory results as regards durability, the importance of which is emphasized.

Prior to about 1910, most of our exposed concrete structures were built by forcibly compacting, in thin layers, a mixture of cement and aggregates gauged with only sufficient water to produce a sticky crumbly mass. By vigorous tamping, the aggregate particles were brought into close proximity and, for the most part, securely bonded one to another. The tamping process was judged complete when, in the language of that day, "the mortar flushed to the surface." In general, except where excessive thickness of layer or insufficient tamping resulted in honeycombing, this method was highly successful.

About 1910, due in part to the development of the rotary mixer and in part to the increasing use of reinforced concrete, this method was largely abandoned in favour of the use of more fluid mixtures which could be spouted or flowed into place, with little or no manipulation after the concrete entered the forms.

Up to this time most of the published information on concrete had to do with design and testing of reinforced concrete. Between 1912 and 1915, literature dealing with concrete as a material began to make its appearance. Most of this literature dealt with compressive strength, since this was the property most easily measured and the one which was presumed to give concrete its greatest usefulness. By means of the factors thus evaluated, and particularly following publication of the water-cement ratio strength relation in 1918, engineers began to develop a considerable interest in the design of concrete mixtures for definite strengths. At first, this had the beneficial effect of stimulating research in concrete, the material. Later, however, interest centred on decreasing the amount of cement required to produce concrete of a prescribed strength. During this period, cements were undergoing steady improvement. The standard strength requirements of the American Society for Testing Materials were increased in 1916, again in 1926, and still further increased in 1930. In the fifteen-year span the concrete-strength-producing ability of the average Portland cement increased approximately 50 per cent. The result has been a reduction in the cement content of mixtures, designed on the basis of strength alone, to an extent entirely unjustified from the standpoint of durability.

About 1920, some of the structures built during the preceding ten years began to show unsightly, and in some cases, serious disintegration, while most of the earlier structures were still in good condition. By 1925, engineers began to give attention to the necessity for designing concrete mixtures for durability as well as strength. Through laboratory research and field examinations of existing structures, the histories of which were known, they learned that durability, as well as strength, was subject to control in making and placing the concrete. To-day, the more progressive engineers realize that durability deserves as great or greater consideration than strength in exposed concrete structures.

The most generally encountered destructive agent of concrete is alternate freezing and thawing while saturated with water. In some sections of western Canada and in the western states, alkali (sulphate) ground waters present a serious problem. Other factors worth consideration are the solvent action of percolating water, alternate wetting and drying, and variations in temperature. Water absorbed into pores or minute cracks in concrete expands upon freezing, exerting a disruptive force of some magnitude. If the concrete is of inferior quality, existing cracks are widened, and additional cracks are formed. With subsequent cycles of thawing and freezing these cracks are progressively widened and deepened until spalling and disintegration take place. Alkalies in solution react chemically with certain constituents of hardened cement to form compounds of considerably greater volume than the original compounds and of little or no strength. In a porous concrete this action takes place within the mass as well as at the surface, resulting in progressive disintegration. If, however, the concrete is impervious, alkali attack is prevented or greatly retarded. Fresh water seeping through a porous or honeycombed concrete gradually removes the soluble reaction products (principally calcium hydroxide) increasing the opportunity for attack and depositing unsightly calcium carbonate scale on the surface. Alternate wetting and drying, such as takes place at the water line in hydraulic structures, and alternate rise and fall in temperature cause uneven expansion and contraction and resultant internal stresses. If these alternations are frequent and the stresses thus produced are of considerable magnitude, cracking may result.

It is apparent that protection against these agencies involves considerations of both watertightness and strength, watertightness to prevent or minimize the entrance of water, and strength to withstand the internal stresses developed. Both of these properties, and therefore durability, will be shown to be subject to the control of the engineer.

The nature of concrete and the means by which it develops watertightness and strength are best visualized if we think of concrete as a mass of aggregate particles bound together by a hardened cement paste. Just as in a masonry structure inert blocks of stone or other material are held together by seams of mortar, so in concrete are the inert aggregate particles bonded to one another by a medium of hardened cement paste. With this conception in mind it is at once apparent that, if sound, durable aggregates are used, the problem of concrete quality control is one of properly incorporating these aggregates in a cement paste which, given a reasonable opportunity to harden, will be strong and watertight.

The quality of the hardened paste depends upon three primary factors, the characteristics of the cement, the relative quantities of cement and water (the water-cement ratio), and the degree of completion of the chemical reactions of hardening.

For obvious reasons the manufacture of cement cannot be concentrated in a single geographic location where identical raw materials might be available. Because of the variation in manner of occurrence of the necessary chemical constituents, some variation in the composition of finished cements is bound to occur in spite of very careful control during manufacture. This variation, together with differences in physical characteristics of the product, due to method of manufacture and type of equipment, is largely responsible for observed differences in the behaviour of different cements in concrete. These differences are relatively small, particularly for longer periods of curing, and are primarily in the rates of hydration rather than in the potential quality of concrete produced. In general, those cements which develop strength more rapidly than others also develop other useful properties at a more rapid

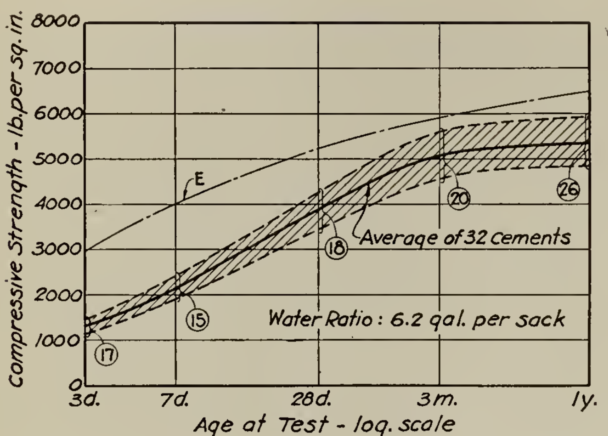

Fig. 1—Age-Strength Relation for Thirty-two Cements.

rate. However, the choice of cements within a given trade area is usually so limited that any advantage obtainable even by a laboratory study of their relative merits is dwarfed by comparison with the pronounced effects of water-cement ratio and curing. Durable, watertight concrete can be made with any Portland cement complying with American Society for Testing Materials standard specifications if the principles set forth herein are adhered to.

A certain quantity of water is required to completely hydrate a given quantity of cement. This quantity, which probably differs slightly for each kind of cement, has not been accurately determined. It is known, however, that the quantity is wholly insufficient to produce workable concrete mixtures when the proportions of aggregates used

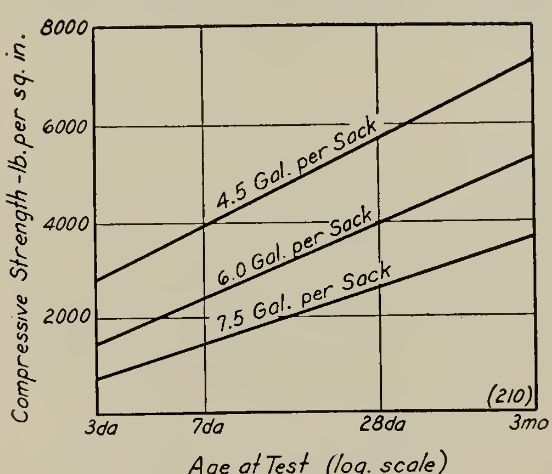

Fig. 2—Effect of Water-Cement Ratio and Curing on Compressive Strength of Concrete.

are within the range of ordinary practice. Furthermore, hydration takes place more readily when a slight excess of water is present. All water, however, in excess of that actually required for complete hydration, dilutes the paste and forces the cement particles farther apart, thus reducing the potential strength and watertightness of the paste.

It has been pointed out that hydration of the cement requires the continued presence of water and favourable temperatures. When concrete becomes completely dry, hydration ceases. When a moist condition is restored the process is resumed, but apparently at a slower rate than before the original mixing water was removed. Within limits the rate of hydration increases with increased temperature. At temperatures below 50 degrees F. the rate is greatly reduced until at or below 32 degrees little or no action is possible. For temperatures above 50 degrees there is a consistent increase in the rate of hydration up to about 120 degrees. Data concerning the effects of higher temperatures are limited, but there is some indication that these are detrimental.

As hydration proceeds, water is combined with the solid cement particles to form additional solid matter about equal in volume to the water combined. Thus, with little or no change in the overall volume, the internal structure of the paste is converted from a granular mass containing 30 to 50 per cent of solids to a solidly bonded mass consisting of 45 to 75 per cent of solid matter. In this manner, *and only to the extent to which this process is allowed to continue*, the recognized properties of the hardened concrete are developed.

The foregoing has had to do with the behaviour of the cement paste which, although it forms only about 25 per cent of the volume of concrete, practically controls the performance of the concrete structure in service. However, since the remaining 75 per cent is made up of the aggregates, it is important that only material composed of sound mineral particles be used. Objectionable types of aggregate are those which disintegrate or undergo large changes in volume due to saturation with water, freezing, or temperature changes above the freezing point. These types include shales, cherts, argillaceous limestones, argillaceous sandstones, clay-ironstone, and ochre. When such materials are present in appreciable quantities in exposed concrete, spalling and cracking of the surface takes place, occasionally progressing to such an extent as to necessitate costly repair. This action is appreciably retarded if the protecting medium of cement paste is of low water-cement ratio and is given ample opportunity to harden.

The data in Figs. 1 to 5, taken from studies made in the research laboratory of the Portland Cement Association, are offered in substantiation of the foregoing discussion.* Fig. 1 brings out the part played by the characteristics of the cement in determining the compressive strength of

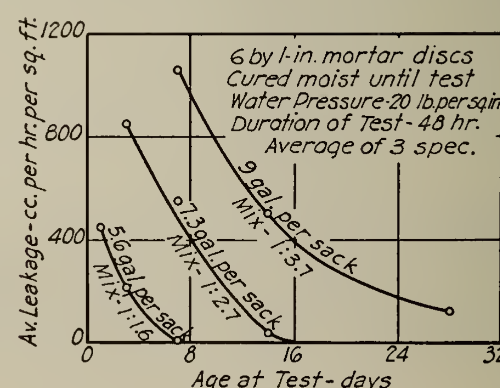

Fig. 3—Effect of Water-Cement Ratio and Curing on Watertightness of Mortar.

concrete at ages up to one year. In these tests, thirty-two brands of cement, selected from all parts of the United States, were made into concretes of identical aggregates, proportions, and water-cement ratio, and were cured under identical conditions. Mix 1-2.4-3.6 by weight, water

*In these data, water-cement ratios are expressed in U.S. gal. per 94-pound sack of cement. To convert these figures to Imperial gallons per Canadian sack, multiply by 0.775.

content 6.2 U.S. gallons per sack; cured in moist room until test. The compressive strengths are plotted against the age at test (duration of curing period), the latter expressed by a logarithmic scale. The heavy line through the middle of the shaded area represents the average strength for the thirty-two cements. The shaded area represents a zone extending 10 per cent above or below the average strength. The number of cements whose strengths fall within this

Fig. 4—Effect of Water-Cement Ratio on Resistance of Concrete to Freezing and Thawing.

range for each age of test is represented by the encircled number. At three and seven days, approximately half of the cements fall within the 10 per cent zone. As the length of curing period is increased, the number increases, indicating greater uniformity in strength until at one year twenty-six cements or 81 per cent of the total are within 10 per cent of the average strength. The effect of duration of moist curing period is also demonstrated in Fig. 1, by the continual upward trend of the curve as the curing period increases from three days to one year.

The effect of both water-cement ratio and curing are illustrated in Fig. 2. Mix 1-4, dry, compact volume; cured in a moist room until test. These tests covered three different water-cement ratios and four periods of moist curing, ranging from three days to three months. As before, the age at test (duration of curing period) is expressed by a logarithmic scale. It will be noted that for any given period of curing, a decrease in the water-cement ratio results in an increase in compressive strength. Again, as in Fig. 1, for a given water-cement ratio, the longer the period of curing the higher the strength.

Similar data with respect to watertightness are presented in Fig. 3. In these tests mortar discs, one inch thick and 6 inches in diameter, were subjected to a water pressure of 20 pounds per square inch after being moist cured for periods ranging from one to twenty-eight days. Each plotted point represents the average hourly leakage for three specimens over a period of two days after beginning of test. No data are shown for the 7.3-gallon concrete at one day, and for the 9.0-gallon concrete at one and three days, since at these early ages the specimens had not developed the necessary flexural strength to withstand the 20-pound pressure. At all ages, where a comparison is possible, it is seen that the leakage decreases rapidly with reduction in the water-cement ratio. For each water-cement ratio, there is a decided reduction in leakage with increased period of curing, the 5.6 and 7.3-gallon concrete becoming watertight at about seven and sixteen days, respectively.

Repeated freezing and thawing of specimens while saturated with water is now quite generally used as a laboratory test for durability of concrete. Fig. 4 affords a comparison of the effects of seventy cycles of freezing and thawing on two groups of 6-inch concrete cubes in which the water-cement ratios were 7½ and 9 gallons per sack. These specimens were cured moist for twenty-eight days prior to beginning of test. Mix 1-2-4, dry compact volume. The 9-gallon concrete is showing serious disintegration, while the 7½-gallon specimens are hardly affected at this stage. It will be noted that most of the spalling in the latter is due to "popouts" caused by occasional unsoundness of aggregate particles (in this case, chert). Attention is directed to the fact that seventy cycles of freezing and thawing are not necessarily representative of the conditions to which concrete is exposed in severe northern climates. Numerous other tests have indicated that concretes of lower water-cement ratios are proportionately more resistant to frost action. A good recommendation for concrete which will be exposed to repeated freezing temperatures in the presence of water is that the water-cement ratio should not exceed about 6 U.S. gallons per sack.

Fig. 5 calls attention to the necessity for using only sound aggregates in concrete exposed to frost action. In this case, a gravel consisting largely of brown chert particles, mix 1-2-3, dry, compact volume, was made into concrete of 6-gallon per sack water-cement ratio. In order to hasten the results the concrete was cured for only three days prior to first freezing. After twenty-seven cycles of freezing and thawing, the specimen shown is almost completely disintegrated due to shattering of the chert pebbles. After thirty-five cycles, the concrete could be easily broken in the hands. In the centre of the cube face can be seen a large pebble illustrating the manner in which disintegration has taken place.

From the foregoing discussion it is seen that the potential quality of concrete depends upon three factors, the quality of the aggregates, the water-cement ratio, and the completeness of curing. Practically, the aggregates and paste must be combined in such a manner as to produce a plastic, workable mixture in which all space not actually occupied by the aggregate particles is completely filled with cement paste.

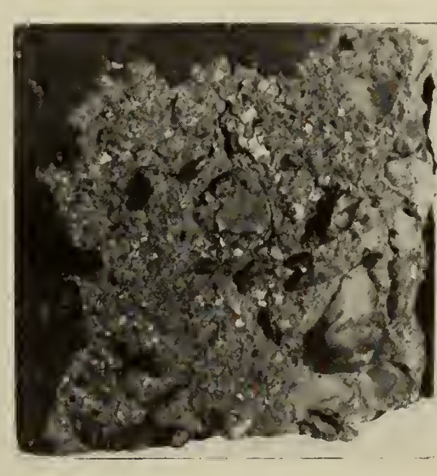

Fig. 5—Effect of Unsound Coarse Aggregate on Resistance of Concrete to Freezing and Thawing.

Having selected the water-cement ratio necessary to produce a paste of the quality required for a specific project, the most satisfactory method of determining the proper combination is to make actual trial mixtures using the aggregates available for the job. When the finely divided cement particles are mixed with water, the result is a viscous paste in which each particle is suspended individually and separated from each of its neighbours by a thin film of water. This is also the condition of the paste in a workable concrete mixture. Such a paste is capable of suspending several times its own volume of aggregate particles, varying in size from the smallest to the largest, provided the quantity and viscosity of the paste are suited to the quantity and gradation of sizes of the stone particles present.

When cement and water, alone, are mixed in the most economical proportions suitable for durable concrete, there

Fig. 6—Lock Wall in Illinois Mississippi Canal, built in 1894.

is an excess of water over that required to make a plastic paste, and the cement particles can be kept in suspension only by agitation. As aggregates are mixed into the paste, however, and the surface of each aggregate particle is wetted, the mixture stiffens, and the cement particles become uniformly distributed. The smaller the aggregate particles, the rougher their surface texture, and the greater the quantity added, that is, the greater the total surface

Fig. 7—Portion of Dam Showing Segregation of Constituents and Consequent Disintegration.

area to be wetted, the greater the stiffening effect. The total quantity of aggregate which can be added to a given quantity of paste depends, therefore, upon the water-cement ratio, the type, size, and grading of the aggregate, and the consistency required for proper placement.

There is a fairly wide range of consistencies within which the mixture can be considered workable, that is, in which the aggregates can be freely suspended in the paste. If, however, the consistency is too wet, the paste is too thin to support the aggregate particles, causing segregation in handling and a decided increase in the water-cement ratio of the concrete at the top of each lift. This results in unsightly patches of honeycomb and the accumulation of laitance at each fill plane with a layer of weak, porous concrete immediately below. On the other hand, if the mixture is too harsh due to insufficient paste, the concrete is difficult to handle and cannot be properly compacted in the forms by the means ordinarily available. Either extreme produces conditions which are directly opposed to watertightness and durability. The most successful concrete structures to-day are those in which a medium or mushy consistency is used.

Because of the relative costs of cement and aggregates, economy requires efficient use of the cement paste. This is accomplished by the use of well graded aggregates, of as large maximum size as placing conditions will permit, and in such quantity that the mixture is plastic but no wetter than necessary to place the concrete with a reasonable handling cost.

The necessity for plastic, workable mixtures, and for the utmost care in handling and placing cannot be overemphasized. In practically every concrete structure that

Fig. 8—Disintegration of Concrete in Buttress of Dam Due to Wet Consistency and Segregation.

is showing signs of deterioration to-day, there are considerable areas of concrete in good condition. This indicates that the general quality of the concrete, as it left the mixer, was at least fair, and that the defective areas are the result of segregation due to lack of workability and to improper methods of handling and placing.

Reliable testimony as to the soundness of the earlier method of concrete construction is to be found in the structure pictured in Fig. 6. This is one end of a lock wall in the Illinois-Mississippi canal, built under the supervision of the United States Engineer Corps in 1894. It is said to be the oldest concrete canal lock in the United States and the second oldest in the world. The mixture used was approximately 1-2-4½ by volume and of stiff consistency. The concrete was placed in 8-inch layers and heavily rammed. The records indicate that moist curing was continued for from two to three weeks. The concrete is in excellent condition to-day. The form markings and the gauge marks (lower centre) are practically as sharp as when the forms were removed. Even at the water line, the point of most severe exposure, no disintegration has taken place.

Fig. 7 presents a glaring example of the piling up of coarse aggregate at the point of deposit due to the use of overwet consistencies. This portion of the structure, a dam in high altitude, was built in 1916. Coarse aggregate of large size was used, together with extremely wet consistencies. In the upper part of the photograph, the coarse aggregate, unsupported by the thin, watery paste, has formed a large pocket of honeycomb. Immediately below the construction joint the concrete shows advanced disintegration due to the accumulation of water and laitance at the top of the preceding layer. At the bottom the disintegrated material is seen piled upon the horizontal surface formed by the step-like design of the face.

Fig. 9—Dam in Northern Minnesota, built in 1905-1907.

Further evidence of the damaging effect of overwet consistencies is seen in Fig. 8. This buttress is a part of a dam in northern Michigan, built about 1907. The sloping face of the buttress was moulded by means of a top form, and the concrete, placed in the body of the dam, was required to flow into the form with little or no puddling because of its inaccessibility, thus permitting the accumulation of thin paste at the more remote points and at the top of each lift.

This has resulted in serious disintegration of the concrete in these locations. Near the top of the photograph it will be seen that the laitance layers and porous concrete immediately below have been eroded to a depth of several inches, while the concrete immediately above the construction joints is hard and sound.

Examples of the durability of structures in which durability has been given primary consideration are infrequent at present since the importance of this property has been recognized only in recent years. There are notable instances, however, in which the proportions and methods used in earlier structures conform to the recognized principles of to-day.

Fig. 9 presents an example of such a structure in the Pine river, located in northern Minnesota. This dam was built by the United States government in 1905 and 1907. Although the specifications called for the usual stiff consistency and the use of 35-pound tampers, the engineer in charge found that slightly more plastic mixtures and lighter tampers permitted better compacting. The mixture was designed on the basis of a constant (1-2) cement-sand ratio, and the proportion of coarse aggregate was regulated to prevent harshness. The mixing water was carefully controlled, and a definite period of moist curing was required.

After twenty-five years of service under as severe conditions of exposure as can be found in the United States, this structure is in almost perfect condition. Throughout the structure the form marks are distinctly visible and the edges are sharp and well defined, with no evidence whatever of raveling or disintegration.

It is significant that in the four structures shown, the two which are eminently successful embody the careful application of the principles set forth herein, even though they were built years before any appreciable progress had been made in the scientific study of concrete. On the other hand, the two structures which show serious disintegration, present unmistakable evidence of violation of some or all of these principles.

In closing, it is desired to emphasize these facts which are clearly substantiated by the data and examples presented:

(1) Durability of concrete must be made a basic consideration, of equal or even greater importance than strength, for successful outdoor structures.

(2) Durability, watertightness, and strength are interrelated and are equally amenable to control in concrete construction.

(3) The factors by which durability is assured are durable aggregates, cement-water paste which when hardened is durable, and proper incorporation of the aggregates in the paste. All these factors are subject to the control of the engineer.

Figs. 1, 3, 7, 8 and 9 are reproduced through the courtesy of the Engineering News-Record, the McGraw-Hill Book Company, Civil Engineering, and the Journal of the American Concrete Institute.

Tests of Generators at Seven Sisters Development

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Paper presented before the Winnipeg Branch of The Engineering Institute of Canada, February 4th, 1932.

SUMMARY.—The large generators in the power station at Seven Sisters, Manitoba, were built up in the field and no complete factory tests were therefore possible. The author describes the arrangements which had to be made to carry out these tests, discusses the methods and equipment employed and gives a number of the results obtained. The tests were made to determine whether the machine complied with the specifications as regards regulation, efficiency and temperature-rise under rated load. They involved the determination of friction and windage by the deceleration method, of which a full description is given; the iron loss, friction and windage, by a second series of tests; and the load loss, friction and windage by a third series.

The generators at the Seven Sisters hydro-electric development are rated, 32,500 kv.-a., 85 per cent power factor, 11,000 volts, 3-phase, 60-cycle, 138½-r.p.m. and are of the direct-coupled vertical type with Kingsbury thrust bearings, upper and lower guide bearings and direct connected exciters.

As the machines were built up in the field no factory tests were possible and accordingly a complete set of tests was carried out in the field to determine the regulation and efficiency of one unit and to prove its ability to carry the rated load without exceeding the specified temperature rise.

Portable instruments of good quality were used throughout this test and considerable care was taken to insure that the results obtained would be at least commercially accurate.

Cold resistances of field and armature were measured by the voltmeter-ammeter method with power derived from the station battery. The armature winding is a two parallel star and the resistance of both halves of each phase was taken. When the field resistance measurement was taken the voltmeter leads were bearing directly on the slip rings. The temperature of the machine and surrounding air was noted on six different thermometers when this test was taken. The average of the six readings, all of which were within 2 degrees C. of one another, was considered to be the temperature of the windings. The resistances obtained are shown in Table I.

Open circuit and short circuit saturation curves were taken in the usual manner, the unit being driven by its own turbine and the speed maintained constant by manual control of the governor. The speed was indicated by an electric tachometer belted to the main shaft and the tachometer was calibrated by counting the revolutions of the generator and timing with a stop watch.

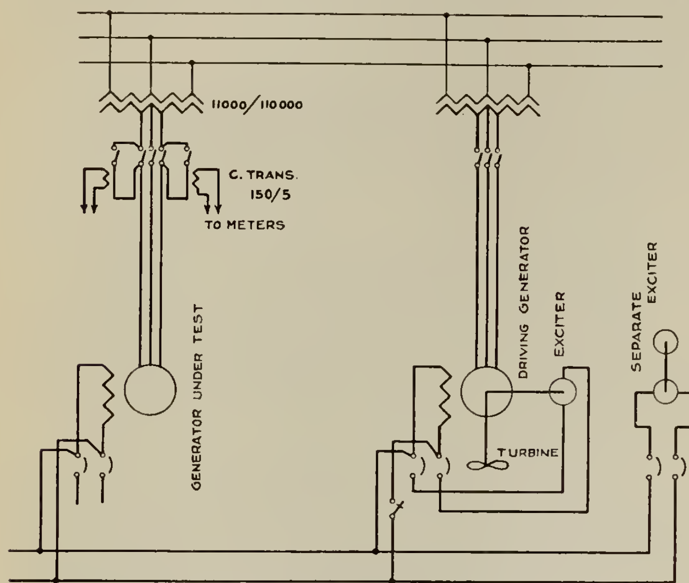

Fig. 1—Diagram of Connections for Deceleration Tests.

Table I
Resistance of Stator

Phase	Amperes: Weston No. 23650 20 C	Amperes: With Shunt 100 R	Volts: Weston No. 39181 1.5 C	Volts: With Mult. No. 1398 150 R	Resistance Ohms: Cal.	Resistance Ohms: Ave.
	÷ 5		÷ 100			
	Read	*Total*	*Read*	*Total*		
A Phase	70.0	14.0	37.9	.379	.0271	
	75.0	15.0	40.7	.407	.0271	.0271
T9-T12	72.5	14.5	39.1	.391	.0269	
	72.0	14.4	39.0	.390	.0271	
T3-T6	75.0	15.0	40.7	.407	.0271	.0272
	77.3	15.4	42.0	.420	.0272	
	77.7	15.54	42.6	.426	.0274	
B Phase	73.9	14.78	40.0	.400	.0271	
	71.9	14.38	38.4	.384	.0267	.0271
T8-T11	74.8	14.96	40.6	.406	.0271	
	78.7	15.74	42.7	.427	.0271	
	72.0	14.40	39.0	.390	.0271	
T2-T5	72.7	14.54	39.2	.392	.0270	.0271
	74.8	14.96	40.5	.405	.0271	
	77.0	15.40	41.8	.418	.0271	
C Phase	71.9	14.38	39.0	.390	.0271	
	72.7	14.54	39.4	.394	.0271	
T7-T10	74.6	14.92	40.5	.405	.0271	.0271
	76.9	15.38	41.9	.419	.0273	
	71.3	14.26	38.8	.388	.0272	
T1-T4	72.3	14.46	39.0	.390	.0270	.0271
	74.5	14.90	40.3	.403	.0271	
	76.8	15.36	41.6	.416	.0271	
	Stator temperature 20 degrees C. Av.					

Note:—T9-T12 etc. one-half of one-phase winding from line terminal to neutral.
Temperature of windings 20 degrees C.

For the short circuit curve the armature winding was short circuited by bolting heavy copper straps directly across the machine terminals.

A check saturation curve was taken with the short circuit applied at the low tension disconnecting switches in order to ascertain the field current required to circulate full load current through the machine windings and the low tension cables. This information was required when the short circuit loss was being measured. The cold resistance of the low tension cables and machine windings in series was also taken.

The coupling between the generator and turbine was opened up and the remainder of the tests were made with the generator running as a synchronous motor, driven by another similar machine.

When starting up as a motor the driving and driven machines were synchronized from rest in the usual manner. Both machines while stationary were excited from an external source, approximately normal no-load field current being circulated in each field. The turbine of the driving machine was then started slowly. The driven machine started immediately the other moved, and the two came up to speed together under control of the driving turbine.

Fig. 1 is a diagram of the connections used. As there is no low tension bus in the station it was much easier to leave the transformer banks in circuit, paralleled on the high tension side, than to make low tension connections. The transformer banks have each 10 per cent reactance but no difficulty whatever was experienced in starting.

Two current transformers 150/5 ampere capacity were connected in circuit (Fig. 1) to measure the no load input. They were short circuited during the starting period by the main disconnecting switches for the first two or three starts, but it was found later that this was an unnecessary precaution. A baby knife-switch was provided to short circuit the instruments, whenever the current would exceed 150 amperes for short intervals, due to incorrect adjustment of field currents, or changes in speed of the driving machine.

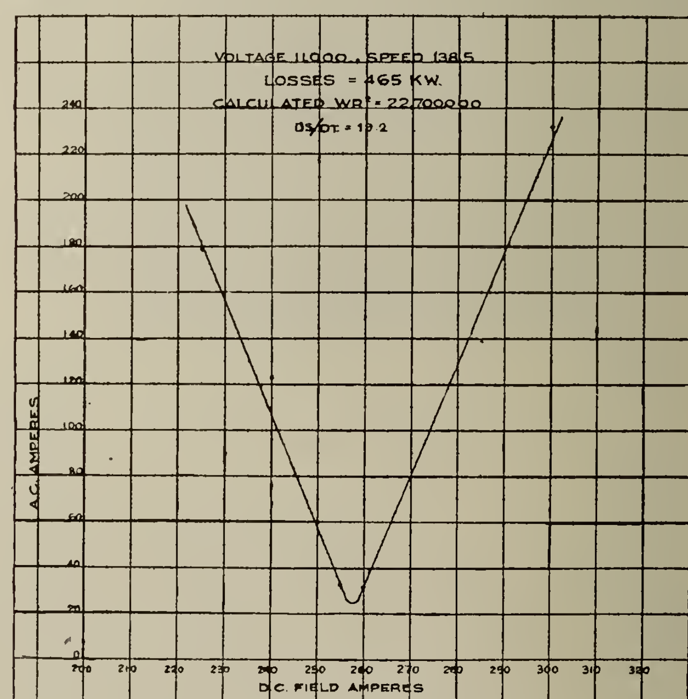

Fig. 2—*V* Curve for Generator No. 2*.

After the machines had been brought up to speed the exciter of the driving machine was paralleled with the separately driven exciter and the knife switch connecting the field of the generator to this source was opened. This

*32,500 kv.-a., 85 per cent p.f., 3-phase, 60 cycles.

permitted independent adjustment of the field currents of the two machines.

With both machines running at normal speed the field currents were adjusted, maintaining normal voltage, to determine the minimum current input. In order that the accuracy of this determination might not depend on a single reading, a "*V*" curve (Fig. 2) was taken and field conditions and the value of armature current at the point of the *V* were noted.

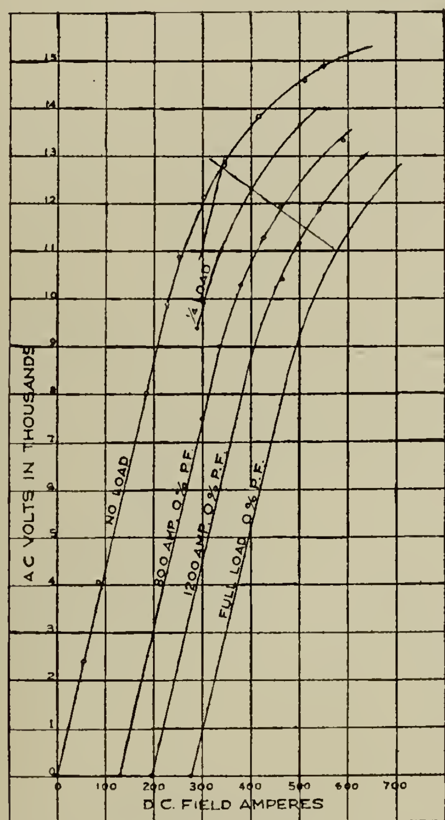

Fig. 3—Excitation Curves from Test Generator No. 2.

The field currents were maintained at the values thus determined, the speed of the driving machine was kept as nearly constant as possible, and an attempt was made to read on a wattmeter the power input to the driven machine. Due to slight changes in speed, and other variables, however, it was found that a satisfactory reading could not be obtained and so a rotating standard watt-hour meter was substituted for the indicating wattmeter. This meter was timed roughly and found to make four revolutions in approximately one minute. Speed and field currents being maintained as before the time required to make exactly four revolutions was accurately measured with a stop watch. Four separate readings were taken and the average of the four (465 kw.) was assumed to be correct.

½ and ¾ load. These were plotted, together with the no-load saturation curve and a full load zero power factor curve was drawn in. (Fig. 3.)

The next test consisted of the determination of friction and windage by the deceleration method.

The theory on which this method is based may be stated as follows:

The kinetic energy of a rotating mass:

$$E = \frac{WR^2\omega^2}{2g}.$$

$$\frac{W}{g} = \text{The mass of the rotating body.}$$

$$R = \text{Radius of gyration.}$$

$$\omega = \text{Angular velocity.}$$

If a rotating body is losing energy the speed must decrease, and the rate of decrease will be a function of the rate at which energy is being dissipated, or in other words a function of the power loss.

The power loss at any particular instant of time will be

$$\frac{de}{dt} = \frac{WR^2}{2g} \cdot 2\omega \frac{dw}{dt}$$

If s = speed in revolution per second:

$$\omega = 2\pi s$$

and the equation becomes

$$\frac{de}{dt} = \frac{WR^2}{2g} \cdot 8\pi^2 \cdot s\frac{ds}{dt}$$

If W is measured in pounds, R in feet and t in minutes the power loss will be in foot pounds per minute.

Changing to s = revs. per min.

we may write:

$$\text{Loss in kw.'s} = \frac{4WR^2\pi^2S}{32.2\,(3600 \times 33000 \times 1.34)}\frac{ds}{dt}$$

$$= .0000000077 \times S \times \frac{ds}{dt} \times WR^2$$

(32.2 is the acceleration of gravity and the expression in the denominator contains the necessary factors to convert from seconds to minutes and from foot pounds per minute to kw.'s).

The manufacturers' calculated value of WR^2 being 22,000,000 the equation for the machine being tested becomes:

$$\text{Loss in kw.'s} = .1694 \times S \times \frac{ds}{dt}.$$

The value of WR^2 was checked as will be explained later and was found to be so close to the manufacturers' estimate that the figure of 22,000,000 was used throughout the calculations.

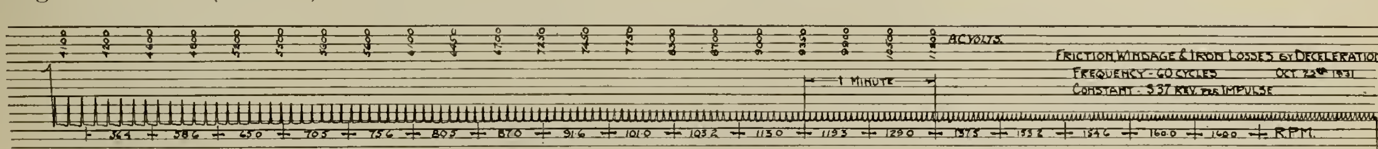

Fig. 4—Test on Generator No. 2—Friction, Windage and Iron Losses by Deceleration.

It will be noted that the point of the "*V*" curve indicates a minimum current input of 24.5 amperes. This multiplied by normal voltage and the square root of 3 gives a no-load input of 466.8 kw.

After the no load input had been measured, load zero power factor curves were taken. As it was not possible to get a full load reading at normal voltage, readings were taken at 800 amperes and 1,200 amperes or approximately

It remains then to determine the values of S and $\frac{ds}{dt}$ or as we are particularly interested only in the loss at normal speed to determine the value of $\frac{ds}{dt}$ at the moment when $S = 138.5$; or, in other words, the rate of deceleration in revolutions per minute, per minute; just as the machine passes through normal speed when slowing down from a higher speed.

To determine the rate of deceleration a graphic instrument was made up which for want of a better name has been called a revolution recorder. (Fig. 8.)

The chart of this instrument is driven at a speed of three inches per minute by a telechron clock motor which of course runs at a synchronous speed. The recording pen

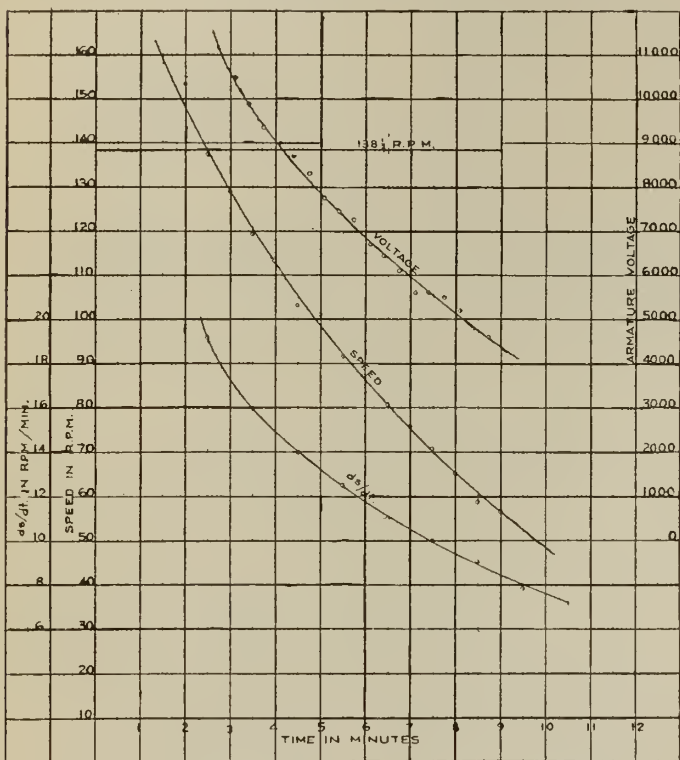

Fig. 5—Friction, Windage and Iron Loss. Speed and Voltage Curves.

is controlled by a single-phase watt element which can be energized from any convenient source. A resistor is connected in series with the voltage coil of this element. With a constant load on the watt element the recording pen draws a straight line down the centre of the chart.

To control the recorder a contact-making device (Fig. 8) was arranged to be driven by a belt from the generator shaft. At the upper end of the exciter shaft of the machine being tested a small extension shaft is provided for the operation of an overspeed device. This proved to be a very convenient point for the mounting of a pulley to drive the contact-making device. Pulley sizes were chosen, and gears arranged to close a pair of contacts once for every five (approximately) revolutions of the generator shaft.

The contacts are arranged to short circuit part of the resistance in the potential circuit of the recorder. This action causes the pen to move across the chart. As soon as the short is removed, the pen returns to its normal position. As the short circuit lasts only a very short time, the record is a sharp point on the chart.

By counting the points on the chart the number of revolutions of the machine for any minute or fraction of a minute can readily be determined. As the maximum speed recorded was 160 r.p.m. the points on the chart are never more numerous than ten per inch and they are therefore quite distinct. As a matter of fact the distance travelled by the chart while the generator was making a single revolution at 160 r.p.m. can easily be measured so that records taken from the chart should be accurate to a single revolution.

When the device was completed and mounted in place it was calibrated and the exact constant was found to be 5.37 revolutions of the generator for each point on the chart. This constant was carefully checked several times both at the beginning and end of the tests and the same figure was arrived at each time. There was evidently no belt slippage, and creepage if any was constant.

The frequency of the circuit to which the chart driving motor was connected was noted on a high grade frequency recording instrument as each test was taken and allowance for any variation from 60-cycle was made when the results were worked out.

With the contact-making device belted to the exciter shaft and the recorder mounted in a convenient location but not running, the machines were synchronized from rest and brought up to approximately 125 per cent of normal speed. The field circuit was then opened and the low tension disconnecting switches opened. The control circuit of the revolutions recorder was closed and a chart obtained as the machine speed decreased.

The iron loss, friction and windage was determined in much the same way as the friction and windage. When the machines had been brought up to speed and the field circuit and disconnecting switches had been opened, the field switch was again closed. The field was built up to normal no-load value and was maintained constant at that point. As soon as the field had reached the proper value the recorder was placed in operation and a chart obtained as before.

The load loss, friction and windage, was determined by a third similar test. When the disconnecting switches had been opened a second set connected to short circuit the machine was closed. The field current was built up to the value required to circulate full load current and was maintained at that value. As soon as the field had been built up the recorder was started and a third chart obtained.

To illustrate the method of obtaining the required information from the charts secured we will consider the

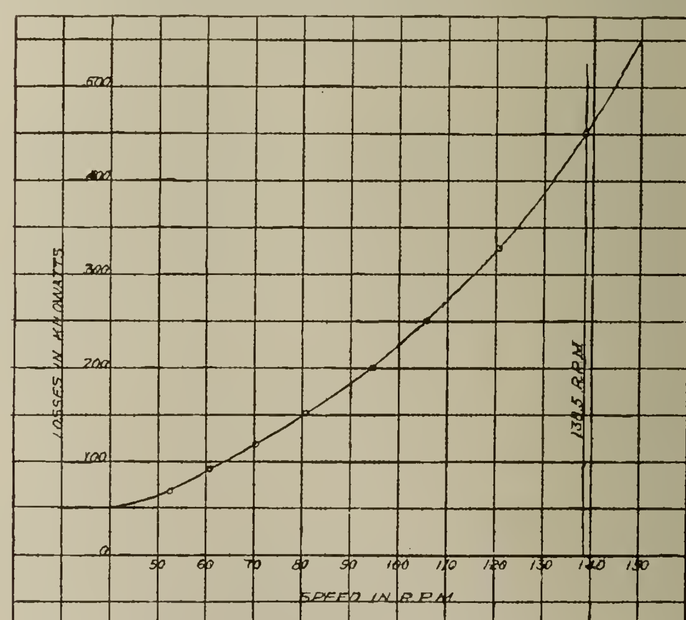

Fig. 6—Friction, Windage and Iron Loss.

one taken during the iron loss, friction and windage test. (Fig. 4.)

The number of revolutions occurring in each minute is measured from the chart. This is considered as the average speed for the minute and a curve plotted of r.p.m. against time. (Fig. 5.)

Table II is compiled from the curve in Fig. 5. In the third column of this table are listed the instantaneous speeds

Table II
Friction, Windage and Iron Losses by Deceleration
(From curve of Speed and Deceleration)

Time in Minutes	A.C. volts	Av. r.p.m.	S r.p.m.	ds/dt r.p.m.p.m.	Kw. Loss $.1694 \times s \times ds/dt$
0		148			
	11,400		138.4	19.2	450
1		128.8			
	9,500		120.8	16.0	328
2		112.8			
	8,150		105.8	14.0	251
3		98.8			
	7,100		94.6	12.5	200
4		86.3			
	6,150		80.8	11.0	151
5		75.3			
	5,300		70.3	10.0	119
6		65.3			
	4,550		60.8	9.0	93
7		56.3			
	3,900		52.4	7.8	69
8		48.5			

at definite times. For convenience the times are taken one minute apart. If the speed for each one minute interval is considered to vary uniformly then the speed at the dividing time between two successive intervals will be the average of the speeds for those two intervals. These speeds are listed in column four. The loss of speed in each interval may be noted from column three and if this is also considered as changing at a constant rate for each interval the figure may be set down in column five directly opposite the corresponding figure in column four as it represents the rate of change of speed at the instant that the speed noted in the latter column exists. Columns four and five then list corresponding values of S and $\frac{ds}{dt}$ and the loss at each

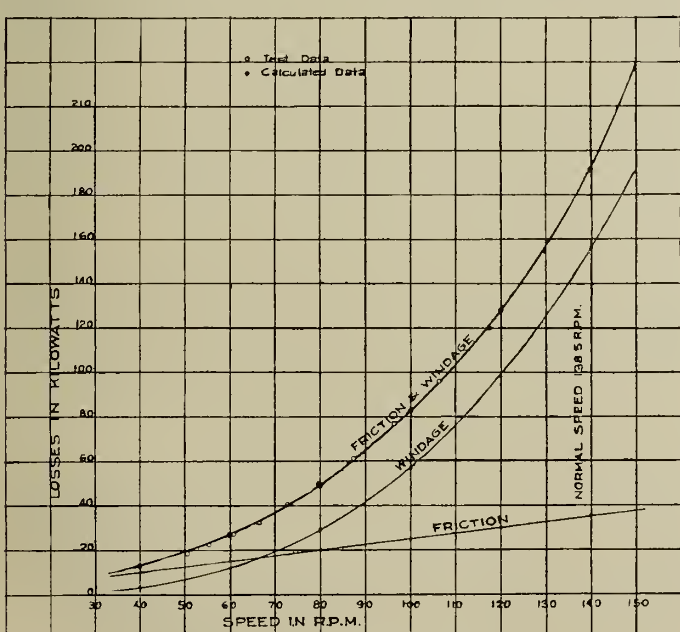

Fig. 7—Friction and Windage.

instant may be calculated and set down in column six.

If kw.'s in column six are plotted against r.p.m. in column three and a smooth curve is drawn through the points obtained the loss at normal speed may be accurately determined. (See Fig. 6.)

If the speed is changing rapidly, intervals of time shorter than one minute may be used to give more accurate results.

It will be noted that the loss derived by this method is 452 kw. as against a no-load input of 465 kw. measured by wattmeter; a difference of only 2.9 per cent.

A curve of friction and windage (Fig. 7) is drawn in the same way from the chart obtained during that test. The difference between the curves (Fig. 5 and Fig. 6) at normal speed is of course the iron loss at normal voltage.

A curve of friction, windage and load loss is also drawn

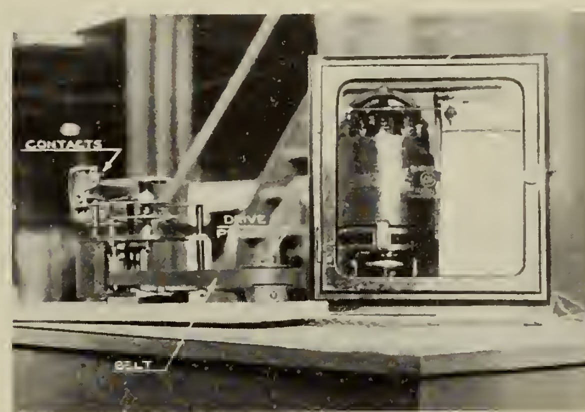

Fig. 8—Revolutions Recorder.

up. From this must be subtracted the friction and windage and the calculated I^2R in the armature. The remainder is the sum of the stray losses.

A curve of iron loss at different voltages was derived from Fig. 5 and Fig. 7 and was used to determine the iron loss at the induced voltage when calculating efficiency. The voltages Fig. 5 were noted as the deceleration chart was being recorded. The chart was marked when the first reading was taken and subsequent readings were taken at 20-second intervals.

The field current at different loads and power factors is obtained graphically from Fig. 3, in the manner set out in American Institute of Electrical Engineers standards.

With this information available we are in a position to calculate the efficiency of the machine. The results obtained are indicated in Table III.

No exciter losses are included in these calculations except windage and brush friction which would be very small. There are no exciter bearings and losses in slip ring brushes are not included. The unit is lubricated by means of an oil pump geared to the main shaft. This pump was in operation during the tests and the slight amount of power required to drive it will be included in the friction loss.

The field current at full load 100 per cent power factor was found to be 410 amperes and at full load and 85 per cent power factor 510 amperes. From Fig. 3 the corresponding open circuit voltages are 13750 and 14650. Regulation therefore at

100 per cent power factor

$$= \frac{13750 - 11000 \times 100}{11000} = 25 \text{ per cent}$$

85 per cent power factor

$$= \frac{14650 - 11000 \times 100}{11000} = 33.2 \text{ per cent}$$

From the no-load input as measured by wattmeter and the formula:—

$$\text{Loss in kw.} = .0000000077\ WR^2 \times S \times \frac{ds}{dt}$$

(S and $\frac{ds}{dt}$ from Fig. 5).

We can calculate $WR^2 = 22{,}700{,}000$ whereas the manufacturer's calculations showed 22,000,000. A very satisfactory check on this design figure.

Table III

Calculation of Efficiency by Losses at 85 Per Cent Power Factor

Note:—Losses do not include exciter losses.

Stator Resistance between Terminals at 75 degrees C. R = .0338 ohms.
Field Resistance at 75 degrees C. r = .404 ohms.

LOAD	¼	½	¾	F. L.
Line amperes per terminal I	426	853	1,278	1,706
Field amperes i	308	370	445	510
Terminal volts E	11,000	11,000	11,000	11,000
Stator winding copper drop e	12.5	25	37	50
Total induced volts (2)	11,012.5	11,025	11,037	11,050
Iron loss kw. (3)	257	258	260	262
Field copper loss (4)	38	55	80	105
Stator copper loss (5)	9	37	83	148
Stray losses (6)	4	14	31	55
Friction and windage (7)	186	186	186	186
Total losses	494	550	640	756
Kv.-a. output	8,130	16,250	24,400	32,500
Real kw. output	6,910	13,820	20,730	27,650
Real kw. input	7,404	14,370	21,370	28,406
Efficiency	93.3%	96.3%	97.3%	97.4%

Calculation of Efficiency by Losses at 100 Per Cent Power Factor

LOAD	¼	½	¾	F. L.
Line amperes per terminal I	426	853	1,278	1,706
Field amperes i	270	285	363	410
Terminal volts E	11,000	11,000	11,000	11,000
Stator winding copper drop e	12.5	25	37	50
Total induced volts (2)	11,012.5	11,025	11,037	11,050
Iron loss kw. (3)	257	258	260	262
Field copper loss (4)	30	33	53	68
Stator copper loss (5)	9	37	83	148
Stray losses (6)	4	14	31	55
Friction and windage (7)	186	186	186	186
Total losses	486	528	613	719
Real kw. output	18,130	16,250	24,400	32,500
Real kw. input	8,616	16,778	25,013	33,219
Efficiency	94.4%	96.8%	97.6%	97.8%

I = Amperes per phase.
I_1 = Eq. Single phase amperes = 1.732 I.
i = Field amperes at load I.
R = Resistance between terminals at 75 degrees C.
r = Field Resistance at 75 degrees C.

Then e = Ohmic drop per phase in stator winding, $e = 1.732 \frac{R}{2} I$.

(2) = Total Induced Volts $E + e$.
(3) = Iron Loss at Induced Voltage (2) from Iron Loss curve.
(4) = Field copper loss i^2r.
(5) = Stator winding copper loss = $I^2R \times 1.5$.
(6) = (Assumed to vary as I^2) = Load loss $- \{(7) + (5)\}$
(7) = Friction and windage.

Total losses = (3) + (4) + (5) + (6) + (7), Output = $E \times I \times$ P.F.,
Input = Output + losses

and Efficiency $= 100 - \frac{(\text{Losses} \times 100)}{\text{Output} + \text{Losses}}$

It is commonly assumed that the loss due to windage in a rotating machine varies as the cube of the speed. If the coefficient of bearing friction remains constant the friction loss will vary as the first power of the speed. A curve of friction plus windage plotted against speed will therefore have the form:—

$$T = Fs + Ws^3.$$

Where T = Total loss.
F = Coefficient of friction.*
W = Coefficient of loss due to windage.
S = Speed.

*Note:—F is not, strictly speaking, a coefficient of friction. The term has been used for convenience. It is a constant which includes all losses except those due to windage.

The information already obtained enables us to solve this equation and so separate the windage loss from the friction loss.

The values of the coefficients may be found by substituting values read from two points on the friction and windage loss curve (Fig. 7) and solving these equations simultaneously.

Taking values at 100 and at 50 r.p.m. we get

$$82.5 = 100\,F + (100^3)\,W = 100\,F + 1{,}000{,}000\,W,$$

$$19 = 50\,F + (50)^3\,W = 50\,F + 125{,}000\,W.$$

Solving for F and W we get

$$F = .232, \qquad W = .000059.$$

Using these coefficients we can calculate a friction and windage curve. When this is done it will probably be found that the observed curve and the calculated curve do not coincide at all points. As a matter of fact the shape of the curve is altered materially by very slight changes in the values of F and W. It may therefore be necessary to solve for these coefficients at several different pairs of points on the curve and to take an average of all values thus obtained. This was done in this particular case and the final figures arrived at were $F = .252$, $W = .000057$.

A curve was calculated using these values and it will be noted that it coincides exactly with the observed curve. It seems reasonable to suppose from this that these calculated values are correct.

Following all tests to determine losses a temperature run was made. In making the temperature test, the machines were run in the same manner as when taking the load zero power factor saturation curves. As we were unable to get full load current at normal voltage the run was made at 32,500 kv.-a., 12,000 volts, zero power factor.

Thermometers were placed at various points on the armature copper and the stator iron, in addition to the six exploring coils which are embedded in the windings. Readings of voltage drop on the slip rings were taken as a check on the field temperature at intervals throughout the run.

The run was continued for twelve hours and at shut down additional thermometers were placed at two points on the field copper and on the slip rings. All readings indicated clearly that machine temperatures throughout were well below the specified limits of 50 degrees C. rise on the armature and 60 degrees on the field.

The regular test floor procedure would have been to give over-potential tests of both armature and field immediately following the temperature run. These were as a matter of fact given at the end of the dry-out run before the machine was placed in service. With the machine windings at approximately full load temperature the armature was given a test of 23,000 volts for one minute and the field 2,500 volts for one minute.

The chief interest in these tests of course attaches to the determination of losses by the deceleration method. The absence of low tension breakers made the taking of these tests somewhat inconvenient in this particular case. The removal of the field, manipulation of single pole disconnecting switches, and re-establishment of the field, took considerable time, and prevented the starting of the recording chart as far above normal speed as would have been desirable. Except for this handicap the making of the tests was very simple and it is felt that the results obtained are quite accurate. At Seven Sisters as in many other locations no other practicable method of determining losses was available. The revolutions recorder which was specially made up for the tests was a comparatively simple device, consisting mainly of standard meter parts, and worked very satisfactorily indeed.

Non-Technical Aspects of Telephone Engineering

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Paper presented before the Toronto Branch of The Engineering Institute of Canada, December 3rd, 1931.

SUMMARY.—The author draws attention to the very special economic conditions under which the telephone industry is carried on. The paper refers to the studies which are necessary in planning for future development in a telephone system; treats of the important question of personnel, and shows that in telephone engineering the treatment of human relations both as regards the employees and customers is a most important feature of the industry.

Those who know something of the modern telephone system appreciate the part played by electrical and mechanical engineering in bringing the service to its present stage of development. This paper will not touch on this side of telephone engineering, however, but will approach the subject in a broader way. It will indeed not be confined entirely to telephone engineering, but will bring out some of the problems in management which confront many telephone engineers. After all, an engineer is interested in production, and when the article in question is a service, many non-technical factors enter into the process.

In his address before the Toronto Branch of The Institute in November, 1931, Dr. Britton referred to the large number of engineers who were engaged in the public service. He was apparently thinking about the many municipal, provincial and federal departments and government commissions. In addition to this group, there are a number of so-called private companies, who are subject to regulation by commissions and boards. The telephone company is an example. The two groups have much in common as both are serving the public. In and around Toronto a dozen or more bodies can be found in the first group and perhaps half that number in the second. Then there is a third group of large corporations such as the electric companies and oil companies, who furnish service of one kind or another. The tendency is therefore for a greater proportion of engineers to find themselves engaged by commissions and corporations, hence observations on the structure of one of these companies may be of interest to engineers generally.

While one may be inconvenienced by the telephone on occasions, it is difficult to conceive how modern industrial and commercial life could continue without this instrument. In turn, the telephone organization has had to make great efforts to respond to the demands made upon it by the acceleration and growing complexity of modern business. As a result of this almost phenomenal growth it is found that the Bell Telephone system as it has developed on this continent is actually the largest business institution in the world. As a background for further remarks, the following statistics, which have been taken from a speech by the President of the Bell Telephone system in November, 1930, may be noted:—

Statistics—Bell System

Plant and other assets	$5,000,000,000
Annual construction programme	500,000,000
Customers	20,000,000
Employees	400,000
Daily calls	80,000,000
Stockholders	550,000

But not only is the telephone "big business" but it is an extraordinarily complicated business, due primarily to the fact that the number of possible connections increases very much more rapidly than the number of telephones. For example, with six subscribers you have fifteen possible combinations, but with 6,000 there are not merely 15,000 but 17,997,000.

The telephone company has been likened to a railway that is compelled to run a special train for every passenger. Not only that, but it is also compelled to keep the local lines over which this special train is moving free from other traffic while the passenger is being transported. Moreover, the telephone may be likened to a railway whose tracks extend to the premises of every prospective passenger with a private station at the end of each line for that customer's personal use.

In considering the colossal figures just quoted, it may well be asked—How was this huge structure built up? An attempt will be made to answer this question, from an engineering standpoint, under three heads—(1) a vision; (2) a programme, and (3) a policy.

The man who had the vision was undoubtedly Dr. Alexander Graham Bell, who, conceived the idea of the telephone in Brantford, Ont., though, in his own words, it was born in Boston. In a letter he wrote in 1878 when most people considered the telephone only a toy, he said:—

> "It is conceivable that cables of telephone wires could be laid underground or suspended overhead, communicating by branch wires with private dwellings, custom houses, shops, manufacturies, etc., uniting them through the main cable with a central office where the wire can be connected as desired, establishing direct communication between any two places in the city. Such a plan as this, although impracticable at the present moment, will, I firmly believe, be the outcome of the introduction of the telephone to the public. Not only so, but I believe in the future, wires will unite the head offices of the telephone company in different cities and a man in one part of the country may communicate by word of mouth with another in a different place. I am aware that such ideas may appear to you Utopian and out of place, for we are met together for the purpose of discussing not the future of the telephone but its present. Believing, though, as I do that such a scheme will be the ultimate result of the introduction of the telephone to the public, I will impress upon you all the advisability of keeping this end in view, that all present arrangements of the telephone may eventually be realized in this grand system."

It must have been invaluable to have had this vision of the ultimate development, but of course it was necessary to have a year by year programme to achieve this objective. The essential feature in this programme since the organization has existed in its present form, has been a determination, on reasonable assumptions of future service requirements, of the most economical arrangement of plant at some future—ultimate—date and the most economical programme for arriving at this ultimate arrangement from the plant as it exists at the time of preparing the study. The necessity for such a study usually arises out of some major plant extension programme such as conversion from manual to dial or the introduction of a new operating centre.

In order to illustrate the procedure the case of Toronto at the time of introduction of the dial system will be referred to.

Fig. 1 shows the city as it had developed under the manual system. It will be noted that there are eleven offices shown which of course were inter-connected by a net work of trunks, so that one subscriber in one centre could reach any other subscriber in the city.

The introduction of the machine evidently brought in a new set of conditions. Former cost studies were not applicable so a new fundamental plan study was made considering existing and future conditions and involving such factors as:

1. Location and size of land and buildings.
2. Arrangement of conduit, feeder cables and inter-office trunks.

3. Type of central office equipment.
4. Type of subscribers line equipment for different zones.

The various steps in the preparation of such a plan can best be considered under the following five headings:—

1. Market and development survey.
2. Fundamental districting plan.
3. Plant extension programme.

Fig. 1—Manual Offices City of Toronto.

4. Loop and trunk study.
5. General conduit plan.

Market and Development Survey

The market and development survey, as the name implies, is made to determine the number and general location of telephones and lines about twenty years in the future.

The preliminary steps in preparing such a survey involve the setting down of the best views as to future policies in respect to the types of service to be offered, the rate structure, sales activities and any broad factors that may influence telephone development.

The next step in the survey is to determine, from office records, the present telephone services by convenient sized sections for the area to be surveyed, to serve as a basis for estimating the distribution of the future telephone development. The size of these sections usually is from five to fifteen city blocks. This record is set up by street address and shows the name, amount and kind of service.

Following the recording of the present telephone services, a count is made in the field, by sections, of the present residence market and present business market.

With the foregoing survey and analyses of it available, a forecast is made of the future market considering first, the growth of the community for the past twenty or twenty-five years and the conditions and forces that influenced that growth; second, to what extent those conditions and forces will be continued in the future; third, what new conditions and forces, if any, will come into operation; and fourth, the effect of these conditions and forces upon the future community.

The distribution of this estimated future market is made first by major areas which show distinctive growth tendencies or characteristics, and then split down into the same sections for which the survey was made. The survey of the existing market is, of course, of primary importance in making this distribution.

The final steps of the estimate are to develop the number of stations and lines for the different small areas and to subdivide them by business and residence classes and by types of service.

With the estimates as to future development available, the next step is to proceed with the fundamental districting plan.

Fundamental Districting Plan

The purpose of the fundamental districting plan is to determine the most economical arrangement of central office locations and area boundaries to serve the lines and stations estimated for the ultimate period. For this purpose a number of different plans of arranging the central office areas and wire centres are set up to be compared. Figure 2 shows one of these possible plans for treating the Toronto area. All of the plans selected are then carefully compared with each other in order to eliminate any unnecessary duplications. If the plans are considered as super-imposed on each other it will usually be found that with certain minor adjustments, central office boundaries can be made common to several plans.

The superimposed plans with their boundaries correlated, if drawn out on a single map (the way it is actually done) will appear to divide the exchange area into a number of areas like an irregular grid. Such a map is prepared and is known as the "combination grid map." The line and station development for the ultimate period can be determined for each "grid area" and then by fitting together grid areas to form the different plans, the work is very much simplified. This method also insures comparable data being used in all plans, which is an important factor in all cost comparison work.

The amount and distribution of the calls originating in the exchange area and their holding time, have, of course, an important bearing on the cost and arrangement of plant. It is therefore necessary to prepare an estimate of the calls that will originate in each grid area, and the way these calls will distribute to each other grid area. An estimate

Fig. 2—Proposed Eight-Office Plan, City of Toronto.

of out and in long distance or toll calls is also prepared. The "holding times," i.e. the average period during which the equipment is tied up due to a single call, for the various groups of calls are also estimated. These estimates are based on existing conditions for the same or comparable areas and all information that can be developed as to future trends based on past trends.

Having the foregoing estimates of lines, stations and traffic available, the next step is to develop for each of the plans selected for comparison the amount of plant necessary under each plan. This includes such items as land, building, central office equipment, trunk and feeder cable. The portions of plant which are common to all plans are excluded from the comparison to simplify the work. This includes such items as subscribers equipment.

The cost and annual charges of the portion of plant being compared under the different plans can now be developed. An example of the summary of this portion of the study is shown in Table 1.

Table No. 1

Ultimate Districting Comparison—Fundamental Plan

Step-by-Step Equipment							Form 19
Plan Number	1	2	3	4	5	6	7
No. of Office Centres	1	2	2	3	3	4	4
No. of Units (C.O.E.)	6	6	6	6	6	7	7
A.C. Sub. Lines	$170.059	$123,044	$125,650	$102,102	$99,829	$73,810	$102,319
A.C. Trunks	0	3,314	3,112	5,323	4,708	6,965	6,006
A.C. C.O. Equipment	221,952	220,488	222,696	228,405	228,517	234,645	234,647
A.C. D.S. "A" & S.O. Bds	9,315	9,826	9,769	9,995	10,081	10,621	10,761
A.C. Maintenance	116,475	118,778	120,508	121,842	121,357	122,332	124,374
A.C. Operation	62,800	66,000	64,700	68,500	68,900	71,400	70,900
A.C. Land	1,598	3,271	2,568	4,213	3,510	3,025	4,751
A.C. Buildings	42,300	47,100	48,500	54,000	54,100	59,400	58,400
Total Ann. Cost	624,499	591,821	597,503	594,380	591,002	582,198	612,158
Difference from Lowest	42,301	9,623	15,305	12,182	8,804	0	29,960

Plant Extension Programme

The plant extension programme develops the various steps in building up the present plant to the ultimate arrangement selected from the fundamental districting plan. In the example chosen, it was not clear which of two plans should be selected for the ultimate period, so a programme was developed for each of the two most promising plans and the costs and annual charges worked out. In order that the annual charges will be on a comparable basis for expenditures that are incurred at different periods in the programme, they are all reduced to a "present worth" basis and then compared. A summary of the present worths of annual charges is shown in Table No. 2, which indicates that plan No. 5 is the most economical to follow over a period of years despite the indicated economies of plan No. 6 in the cross-section taken at the ultimate period in the districting plan study.

Table No. 2

Programme Study—Fundamental Plan

Summary of Present Worth of Annual Charges from 1929 to 1947

Plan Number	5	6
Number of Centres	3	4
Offices	C-G-H	C-K-H-J
Number of Units (C.O.E.)	6	7
Outside Plant	186,829	136,652
C. O. Equipment	1,303,636	1,362,746
Operation	200,957	212,510
Building	178,770	192,177
Land	13,103	8,899
Total Present Worth	1,883,295	1,912,984
Excess over Plan 5		29,689

Note—Items common to both plans have been omitted from the study.

Loop and Trunk Study

In some cities, it is found that the loop and trunk study develops useful information in rounding out the fundamental plan. The object of the study is to determine the most economical apportionment of the transmission losses to the subscribers' loops and inter-office trunks, for the plan selected. The study is usually made for a period of five or six years in the future. Cost comparisons are made with different office and trunk losses in such a way as to develop the division of loss that will result in the most economical loop and trunk plant. This study also develops as a useful by-product the data for preparing a map of subscribers' set zones.

General Conduit Plan

Another plan of considerable value that can be developed is the general conduit plan. This plan usually consists of a map of the exchange on which is marked the existing underground conduit runs and numbers of ducts in the runs and the future requirements for ducts on these runs and any extensions of them required to provide for the lines estimated for the ultimate period. The plan can be prepared from the information on lines already developed for the districting plan, which are then converted into cables and ducts making due allowance for working fills on the cables on the different routes.

In addition to the mathematics involved in fundamental plan studies, good judgment plays an important part both in setting up the original plan and in interpreting and revising the plan in the light of new developments.

The same general procedure is used in the provision of long distance or toll line facilities. Substitute North America for Toronto and the problem becomes one of determining the best method of laying out a network of large trunk routes between a few centres of population, with subsidiary networks to reach the tributary area. Such a study has resulted in the tentative selection of some ten regional centres shown in Fig. 3. By concentrating long haul traffic on major routes greater operating efficiency is obtained and less switching is necessary resulting in greater speed and better control. More and more of the major open wire routes are being replaced by cable, reducing the possibility of interruption due to storms, etc.

Trans-Canada telephone circuits have just been placed in operation with the co-operation of the seven large telephone companies in Canada. This is a remarkable feat when the difficulties of construction and operation of such circuits are considered.

The next step of course is to consider the world as a unit and by means of cable and wireless telephone connections to bring the dream of universal service nearer fulfillment. Already there is ship to shore communication on some half dozen, and some aeroplane routes are being equipped in a similar manner.

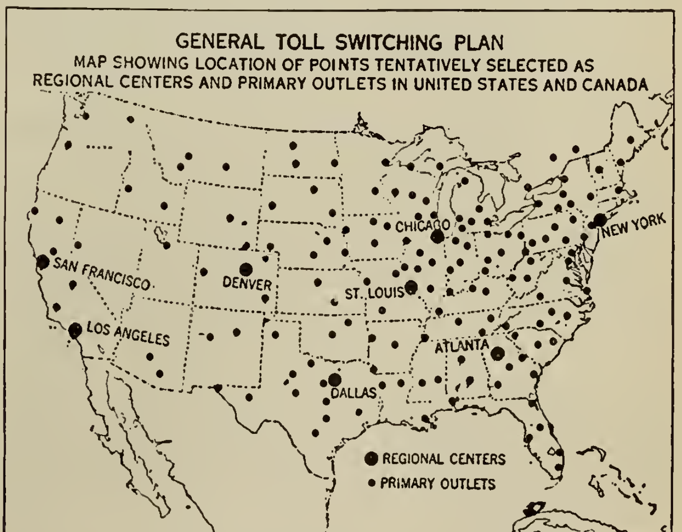


Fig. 3—General Toll Switching Plan.

The third factor which has assisted in bringing the huge structure known as the Bell system into its present position, is its policy, which found expression in the phrase used by Mr. Gifford a few years ago—

"The best possible telephone service at the least cost consistent with financial safety."

Engineers will appreciate the reasonableness of the statement. On the one hand is a perfection of equipment, a refinement of adjustment and a correspondingly enormous, if not incalculable expenditure. On the other, there is the necessity for keeping the cost down so that the rates may be such as to attract and hold business. The compromise is a constantly improving quality as further research and better manufacturing enables the system to give more to the subscriber at the same or reduced cost. In some cases refinements are available at luxury prices.

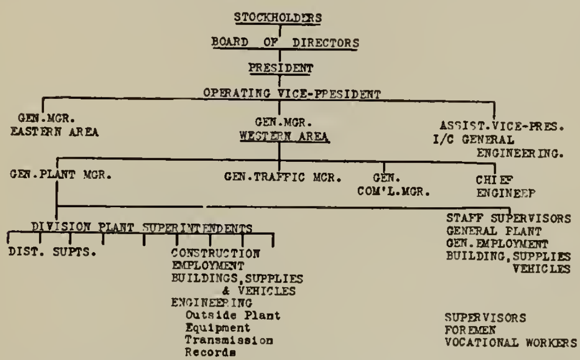


Fig. 4—Organization of Bell Telephone Company of Canada, Ltd.

Having endeavoured to answer the question "How was this huge structure built up?", the next query that presents itself is "How is it kept going?"

In the first place, there is naturally an organization, of necessity an intricate organization. The general plan involves a central co-ordinating company controlling a manufacturing company and a most efficient research laboratory, with some twenty regional operating companies. Fig. 4 shows the organization of the Bell Telephone Company of Canada. There are three major operating departments in the company; the commercial, the traffic and the plant. For illustration purposes, the plant department only has been shown in any detail. It should also be noted that there are some eight hundred and forty connecting systems in Ontario and Quebec serving about 140,000 telephones.

A second factor in keeping the whole in successful operation is the application of modern scientific research and development.

As you may know the Bell Laboratories in New York employ some five thousand scientists and assistants. The whole aim of these scientists is to make the telephone service better, extend its possible range and make it cheaper, or in other words to effect improvements.

Engineering developments have, for example, made possible the use of small wires for communication over distances which would otherwise have required extremely large wires, the use of one circuit to do the work of several, the use of less expensive metals and alloys in telephone equipment, and innumerable other economies. It is conservatively estimated that only eight engineering developments of this kind have saved $465,000,000 in initial investment and $70,000,000 in annual expenses, if it were possible to conceive of the present telephone service being given without them.

Full advantage is taken of the widespread regional operating areas to gather data on methods and results and by comparison and analysis endeavor to find the one best way. As a result, specialization, standardization and mechanization are introduced for trial and test in one or more limited areas, followed by general adoption if proved desirable.

One illustration of specialization is the information board for the city which is centrally located at Kingsdale just off Yonge, north of Bloor. There each of the operators has at her hand information as to changes and new connections. Incidentally it may be observed that 50 per cent of the calls are for numbers in the current directory.

The principle of standardization has been applied in the usual way. For example, the number of wire pliers in common use has been reduced from seventy to seven.

The principle of mechanization is illustrated in the conversion from manual to dial operation and in the use of machines for cable placing.

Given a well conceived plan of organization, efficient methods and proper tools and equipment with constant improvement as the result of research, it is still necessary to consider a very important factor, the human element, the personnel of the company.

In the study of the relation between management and workers the telephone industry can fairly claim a leading place.

It is significant that the senior vice-president of the Bell Telephone Co. of Canada, Mr. J. E. Macpherson, should have charge of personnel matters for the company. In an address in January, 1930 before the Border Cities Chamber of Commerce he said "The personnel policy of the Bell system seeks to bring out and develop the best qualities in each individual and to find ways and means to weld the individual performance of each into the competent team-playing co-operation upon which any successful group accomplishment depends"—. "The relationship that he must feel is that he is a part of it—not a servant of it nor simply an independent contractor with it."

The subject is an extensive one. It is presumed all are more or less familiar with such phases as first aid courses, accident prevention, sickness and death benefits, pension schemes, employees' stock plans, correspondence courses in arithmetic and electricity, and life insurance for employees. In passing it should be noted that with regard to the latter, arrangements were made with two of our large Canadian Life Insurance companies to make salary deductions on a monthly basis for the payment of premiums. Standard policies are issued which are essentially the personal property of the employee.

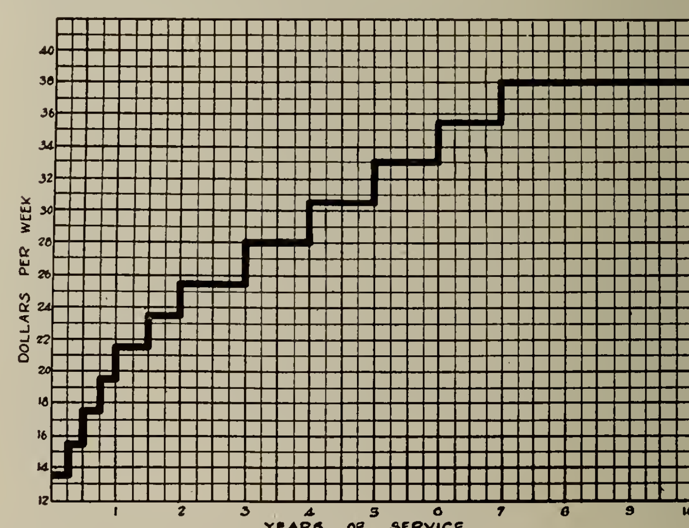
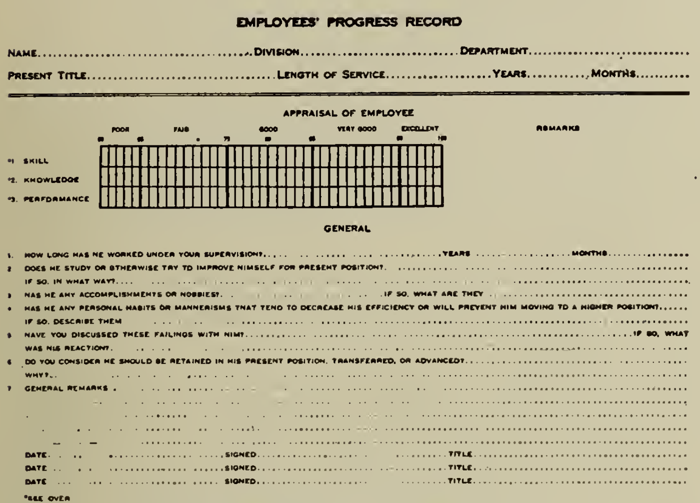


Fig. 5—Typical Wage Schedule.

However, to consider in more detail certain personnel features which are less routine in character and which have perhaps a closer relation to production, i.e., employee and foreman training, student engineer training, supervisory appraisals and employee representation.

The policy of the company is to recruit a fair proportion of young men with high school or technical school education. An effort is made to determine their mechanical aptitude by a practical test but naturally they have to be instructed in the special features of telephone work. As an indication of the complexity of their vocational knowledge it may be noted that one branch of the work, cable splicing, has been analyzed and broken down into some two hundred and forty job assignments. A sample of a job assignment is the operation of "boiling out a cable" after the wires are spliced and before the joint between the two ends of lead covered cable are connected by a lead sleeve and two



EMPLOYEES' PROGRESS RECORD

NAME........ DIVISION........ DEPARTMENT........

PRESENT TITLE........ LENGTH OF SERVICE........ YEARS........, MONTHS........

APPRAISAL OF EMPLOYEE

POOR — FAIR — GOOD — VERY GOOD — EXCELLENT — REMARKS

*1 SKILL

*2. KNOWLEDGE

*3. PERFORMANCE

GENERAL

1. HOW LONG HAS HE WORKED UNDER YOUR SUPERVISION?........ YEARS........ MONTHS........
2. DOES HE STUDY OR OTHERWISE TRY TO IMPROVE HIMSELF FOR PRESENT POSITION?........ IF SO, IN WHAT WAY?........
3. HAS HE ANY ACCOMPLISHMENTS OR HOBBIES?........ IF SO, WHAT ARE THEY........
4. HAS HE ANY PERSONAL HABITS OR MANNERISMS THAT TEND TO DECREASE HIS EFFICIENCY OR WILL PREVENT HIM MOVING TO A HIGHER POSITION?........ IF SO, DESCRIBE THEM........
5. HAVE YOU DISCUSSED THESE FAILINGS WITH HIM?........ IF SO, WHAT WAS HIS REACTION?........
6. DO YOU CONSIDER HE SHOULD BE RETAINED IN HIS PRESENT POSITION, TRANSFERRED, OR ADVANCED?........ WHY?........
7. GENERAL REMARKS........

DATE........ SIGNED........ TITLE........

DATE........ SIGNED........ TITLE........

DATE........ SIGNED........ TITLE........

*SEE OVER

Fig. 6—Employees' Progress Report.

plumber's joints. This operation is necessary to drive all moisture out of the paper-covering on the wires and consists of pouring hot melted paraffin wax over the spliced wires.

This job assignment is outlined for instruction purposes under the headings:

Purpose of boiling.
Preparing wires.
Handling and locating pot.
Pouring paraffin.
Draining paraffin.

The development of a completely trained splicer takes several years and in this period he normally progresses from wage group to wage group, promotion serving to encourage him and mark his advance in his craft. A typical wage schedule is shown in Fig. 5. It will be noted that the schedule covers seven years. This is two years longer than the course for most handicrafts such as plumbers and electricians, but it is felt that while a man may learn the actual technique and develop his skill in five years, two more years can well be considered as completing his training as an all round workman. In this period he should develop the opportunities that his job offers for maintaining good public relations; he should take his place as one qualified to teach junior employees and to explain and sell the service to the public—not only as a general proposition but as an actual salesman under the everybody selling plan, which provides for the participation of employees in sales activities.

As a check on his advance, progress reports are made at various intervals by the new employee's foreman. (Fig. 6.) If it is evident that he is not going to make a good telephone man, he is dropped for the good of all concerned early in his employment.

Training is carried out both in classroom and on the job. The former is specially useful in times of abnormal expansion or the introduction of new methods or new equipment. The latter demands more from the foreman but is considered more economical and effective.

The emphasis placed on the value of the foreman makes him a key man. In an effort to make him realize the responsibilities of his position, a series of training classes each lasting two weeks were held in which twelve men, under a leader, discussed their jobs and analyzed them in detail from a production and human relations standpoint. Every supervisor from the division superintendent down took this course. A similar method was followed in a six weeks training course for a selected group treating the method of instructing others on the job more intensively than was possible in the first course. In both these courses supervisors and foremen acquired a new appreciation of the policies of the company and a greater realization of the importance of management and training in their jobs.

In these and similar classes the directed discussion method is used in which each member is encouraged to contribute to the discussion. The leader is responsible for guiding the group so that definite conclusions may be reached.

In spite of efforts to develop supervisors from within the organization, most companies nowadays have found it advisable to recruit a certain number of university graduates year by year. There are, of course, many positions of a highly technical nature for which a thorough training in engineering is essential. That many advance past these positions may be gathered from the fact that in the company in Canada, the president, the general manager in the western area and the general plant manager in the eastern area are graduates in engineering.

It is important that these young graduates should receive a good introduction to their work as soon as possible as in many companies student engineers are given a course lasting some four to six months. As an illustration of the system used locally in training men for the plant department, the following shows a typical week's work.

Student Engineer Training

Subject—Underground conduit design and construction.

Lecture—Conduit Design and Construction.
Text—"Handbook on Conduit Design."
"Conduit specifications."
Assignment of Problem. *1 day*

Job —With Conduit Construction gang as worker and observer. *4 days*

Problem—Solution to problem including students plans and estimates of labour and material criticized and discussed. *½ day*

By following theory with practical work on the job and an application of knowledge gained to the solution of a problem, the course is made more interesting and valuable. Not all phases lend themselves to this treatment, of course, as the man is given training in commercial, traffic and other work.

In any company of such a size it is important to have some system for noting the progress of supervisory and supervisory material. For this purpose appraisals are made at intervals by immediate supervisors and checked by those next up the chain of organization. Such appraisals demand great care. The form used in making a follow-up appraisal is illustrated in Figs. 7 and 8.

Four questions which might assist to a proper appraisal of ourselves or another are:—

(*a*) Effectiveness in getting results.
(*b*) Ability and willingness to delegate authority and responsibility properly.
(*c*) Ability to develop men to the limit of their capacities.
(*d*) Capacity for growth.

The latter, indeed, is one of the most important features and in an ideal system such an appraisal would be followed by an individual training programme extending over some years to permit the man to advance to the limit of his capacity.

When properly prepared, filed and used, such appraisals ensure that a man's progress more nearly corresponds to his deserts and qualifications than would be the case if sole reliance were placed on a last minute search for a man to fill a job. They should also encourage the training of substitutes and the transfer of men to jobs for which they are better fitted.

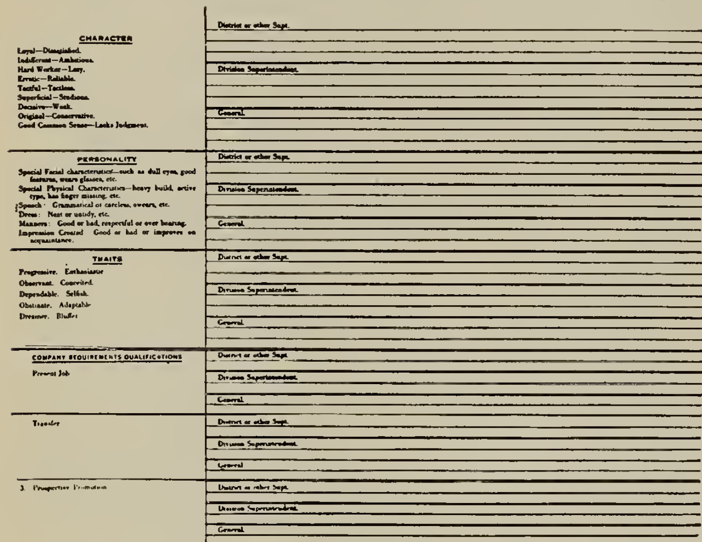


Fig. 7.

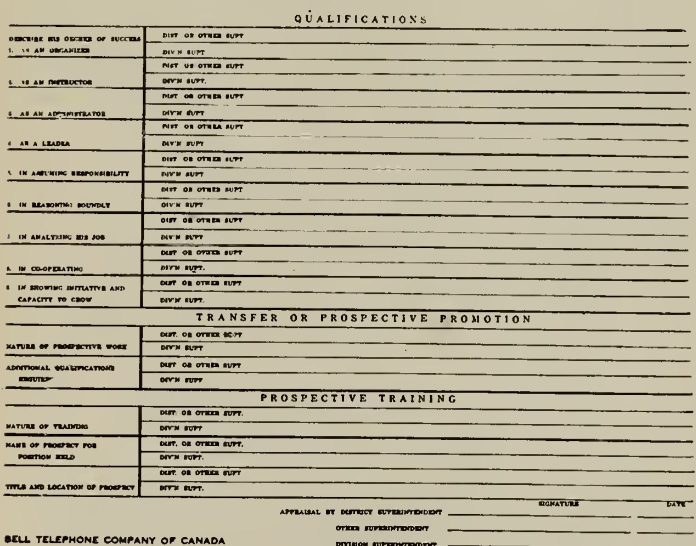


Fig. 8

It will be conceded by those who have noted the various plans and policies that have been mentioned that the company has given much thought to the welfare of the employees. It is natural however, that the employees should have their own point of view on many matters, including plans and policies such as outlined, and it is desirable that there should be some recognized means of two-way communication between the employee body and the management. In highly unionized industries such a need has been met in a way by walking delegates of one kind or another. Modern industry has found the conference method a useful one for arriving at conclusions and planning actions involving many departments. This method has been adopted by the company as an essential feature in a plan for employee representation.

Under this plan groups of employees doing similar work or in a certain district elect representatives by secret ballot once a year who meet in the company's time to discuss their common problems and then meet representatives of the management in a joint conference.

The purpose of employee representation as carried out in this manner is to assure regular and frequent contacts and conferences between management and elected employees representing the general forces in order—

> To develop the facts and conditions of employment from the point of view of both the employees and the management, and by discussion undertake to arrive at a common viewpoint and understanding of these facts, thereby establishing conditions that are mutually satisfactory;
>
> To provide an additional opportunity for regular discussion of matters pertaining to the business and its operations and—
>
> To determine the interests and desires of the employees in plans or projects designed to promote their personal well being,

all to the end that the best interests of the employees, the owners and the public shall be considered and conserved.

In the early stages the conference was really a "grievance" committee, but now discussions cover a wide range of wages, working conditions, company policies, methods, materials and broader company problems.

Times like the present are a test for any such plan. It has proved invaluable in acquainting the employees with the economic and financial aspects of the situation, and in some cases the employee representatives have obtained a new conception of management problems with a stabilizing effect on the general force.

Such are some of the operating features involving human relations that are indeed very non-technical aspects of telephone engineering. It is doubtful, however, whether any engineer can go very far other than in a restricted and narrow technical field, without encountering these and many other problems. Whether it is possible to prepare a man to deal with them in the course of his university training is a debatable point. It is understood that a one year course in business administration is being planned by Western University. At any rate, something might be done and no doubt is being done in our engineering schools to give a man a sympathetic attitude to such matters and make him realize mere technical performance will not carry him very far in many fields. Some of us would like to think that while a good technical school trains a man to exercise skill, a university should train a man for leadership.

In conclusion, there is a quotation from "Constructive Citizenship," by Dr. L. P. Jacks, an international authority on social and industrial conditions.

He specifies the three main elements in the staying power of human society which he relies upon to improve conditions in the modern industrial and economic structure.

> "We find the first in the immense capacity for skillful work which civilized man has acquired and passed on down the course of the ages. We may call it the capacity of his intelligence. The second, in the possession, by large numbers of men and women, of certain high qualities, in virtue of which they act faithfully as trustees for the general interest and in the accumulating traditions that gather round their service. We may call this the moral capacity of the citizen. The third, in the creation and continuous improvement of certain scientific methods for harmonizing conflicting claims and for turning human relations, which would otherwise be mutually destructive, into relations of mutual helpfulness. We may call it man's organizing power."

It seems that the engineer, to a peculiar degree by training and by experience, combines these elements.

If Dr. Jacks is right in his contention that the best way towards permanent improvement in modern industrial and economic structure lies in developing to the utmost the strong points of the existing order and if these are as he says, skill, trusteeship and the application of scientific methods, then we may well take an added pride in our vocation as engineers.

Discussion on "The Train Ferry *Charlottetown*"

Paper by Walter Lambert, M.I.N.A., M.E.I.C.[1]

Frederick Bridges, m.e.i.c.[2]

Mr. Bridges stated that with regard to the rolling of the *Northern Light*, it had always been found on the St. Lawrence that when the ice was beginning to take in the early winter a tug which was a little tender and rolled easily was much better at keeping the channel open than a steadier vessel.

The design of the *Prince Edward Island* raised a question which had been much debated, namely, the desirability of bow propellers. Most of the Russian ice breakers had three, and years ago at a discussion on this point Russian naval architects claimed that the function of the bow propeller was to draw water from under the ice in front of the vessel, leaving the ice unsupported and consequently easier to break. As Russian icebreakers in the Baltic had been successful in winter navigation for years, he thought a good deal could be said in favour of the three screws.

There had been some criticism of this system in Canada principally on the point of efficiency of propulsion which after all was more a question of summer than winter work for which an icebreaker should be primarily designed.

If speed was the primary consideration, the arguments of the opponents of the bow propeller would be found to be well supported in the author's paper.

On studying the graph on page 83 of The Journal which showed the mean i.h.p. and mean speed, at the point *E* it would be observed that the speed was nearly 14½ knots with only two after engines running, and that for the same horse power but with three engines running the speed was 14 knots.

This could also be observed by referring to the table on page 84, runs 7, 8 and 9, where for a decrease of 780 i.h.p. or about 11.6 per cent a decrease of only .02 knots in the speed, or about .14 per cent, was indicated.

It was to be regretted that a progressive set of runs with the two propellers had not been made. The cause of the retarding action of the bow propeller would appear to result from the impinging of the column of water set up by this propeller on the sides of the vessel in contrast to a clear flow as was the case with those aft.

He would be glad to hear the author's comments on the subject of the three propellers and the retarding effect of the one in the bow.

It was also most interesting to learn that so great a part of the material entering into the construction of the vessel was manufactured in Canada.

C. H. Nicholson[3]

Captain Nicholson stated that he had read with interest the author's paper which dealt with the history of the various means of communication adopted between the mainland and Prince Edward Island in the past, resulting finally in the placing in service during 1931 of the up-to-date carferry *Charlottetown*, built, he understood, from plans of the author's firm and under their supervision.

The following comments were not intended to be too critical but rather to indicate the practical viewpoint of an operator.

The dimensions of the *Charlottetown* in length, depth and design were about those of the average lake type of carferry, judging from Fig. 5 and Fig. 9, and had doubtless been calculated for the trade in which the vessel was engaged, having in mind the limited depth of water at the terminals, and the heavy ice conditions encountered during the winter.

The cut-away fore-foot and the forward propeller were first adopted by the late Mr. Frank Kirby of Detroit, for carferries engaged in operations in the Straits of Mackinaw where exceptionally heavy ice conditions were encountered, and this plan had been accepted by designers ever since for vessels engaged in heavy ice work, both in the United States and Europe; also by the Russian government.

The ship seemed to be possessed of ample power, and he had no doubt that the author's decision to install the same size and horse power engine for the forward screw as was used for each of the stern screws of the ship was a wise one.

In connection with the power plant he wondered if it would not have been advisable to have installed six boilers of a larger size instead of eight. These could have delivered the same volume of steam with less initial and maintenance cost, and would have resulted in reduced wages due to the smaller stokehold complement required. With six boilers fitted athwartship having fore and aft stokeholds and using oil as fuel, two firemen and one watertender on a watch would have been sufficient.

He was of the opinion that the selection of oil for fuel was a happy one because of the conditions stated, but in addition, the steady temperatures which resulted from the use of fuel oil, and the absence of contraction and expansion due to the necessary introduction of cold air when feeding and cleaning coal fires, would materially prolong the life of the boilers, and it would be found that boiler maintenance costs were reduced possibly as much as 75 per cent as compared with coal fired boilers.

Further, he had noted that consideration had been given to the use of straight Diesel or Diesel-electric drives. The decision in favour of steam might have been wise under the circumstances due to the isolated location of the operation, and the further advantage of the ability to change crews with the other and older vessel as occasion might arise.

He had a favourable opinion of Diesel-electric installations, for, while first costs were higher, the total weights including boilers were not generally any greater, especially if two-cycle engines were used, also the operating costs were considerably less.

Outside of the cost of fuel itself there was an enormous saving in using oil as compared with coal, in other directions than those which had already been pointed out. He had in mind two ships which he had been instrumental in converting from coal to oil fuel, when the adoption of oil as fuel was more nearly in its infancy than it was to-day, which resulted in an economy in one case of $44,143 per year and in the other of $66,279 as compared with similar expense when using the best coals obtainable.

The average well-kept triple expansion engine, including the usual auxiliaries, would show a consumption of about 1.5 pounds of fuel per i.h.p. hour but with a properly constructed Diesel engine this would be .4 pounds of fuel per s.h.p. hour. In considering the loss involved in the generation of electric current and transmission it would be found to be very little in excess of the difference between s.h.p. as compared with i.h.p.

With regard to the features above the main deck. There seemed to be a large amount of waste space, also that

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(1) This paper was presented at the Annual General Meeting of The Institute, Toronto, Ont., February 4th and 5th, 1932, and published in the February, 1932, issue of The Engineering Journal.

(2) Superintendent, Government Shipyards, Sorel, Que.

(3) Manager, Steamships and Car Ferries Department, Canadian National Railways, Toronto.

it would have been better to have built up the funnels, boiler and engine room fiddleys amidship in a fore and aft arrangement, rather than athwartship as at present, and the deck fitted with four tracks instead of three. The ship had been given 7 feet additional beam as compared with vessels of similar dimensions on the lakes having four tracks.

The Ontario Carferry Company's steamers, *Ontario No. 1* and *Ontario No. 2*, had a length of 107 feet with 20 feet 6 inches depth and 54-foot beam. They carried thirty loaded gondola type coal cars of fifty tons capacity each, or from 26 to 28 coal and box cars, and the maximum cargo would be about 3,000 tons including the weight of the cars, besides bunkers and stores, on a draught of approximately 17 feet 6 inches in fresh water.

According to the table of statistics on page 75 of the author's paper, the maximum movement occurred in 1930 when 22,921 cars of all kinds were taken to the island, and 22,222 cars from the island to the mainland. This was done in 2,085 round trips of the steamer *Prince Edward*, an average of eleven cars each way. The *Charlottetown* would handle this number of cars in approximately 1,389 trips. With a capacity of 26 cars she could handle the same number in 882 round trips, which gave a saving of approximately 36 per cent of steaming time—an economy not to be despised.

In addition there would be extra space for any increase in traffic which might be secured with the return of normal conditions. Further, he thought that this could be done without diminishing the passenger accommodation. Passengers could be handled on and off the present automobile deck with gangways arranged opposite suitable entrances to the cabins without causing any serious delay in the handling of the automobile traffic. The steamers of the Ontario Car Ferry Company frequently handled one thousand passengers per trip and a full cargo of loaded cars. These steamers had a run across Lake Ontario of approximately 60 miles and had made as high as 743 round trips in a year, handling 38,507 cars (loads and empties), no passenger cars included. It must be remembered that from May 30th until Labour Day, one steamer was held to a schedule of only one round trip per day, with the other steamer handling excursions and freight as traffic conditions warranted. In a good season the two vessels combined would handle approximately seventy-five thousand passengers during the year.

He was interested in the arrangement for partly closing the after opening of the car deck and wished that the author had gone into that feature in greater detail and included sketches. In his experience he had not found that there was any great danger in shipping water from a following sea, as generally a ship would run away before it could break over the stern. More water was taken aboard from a sea forward of the beam. The best arrangement he had seen was a rolling gate, something like the roll top desk, which when closed covered the after part in semi-circular runways. These were handled by a winch. This type of gate, while not wholly watertight, was storm-proof and in addition, it kept out much of the cold during the winter and thus effected a substantial steam saving by preventing condensation in the lines to deck auxiliaries and heaters.

The figures given were in most instances approximate, but they were submitted in the hope that they might add somewhat to the discussion.

P. L. Pratley, m.e.i.c.[4]

Mr. Pratley questioned the advisability of such a large expenditure on luxurious fittings in a ship that was to travel only seven or eight miles.

[4] Monsarrat and Pratley, Montreal.

W. U. Appleton[5]

Mr. Appleton considered that the paper was very complete. There was one feature that might be mentioned, however, and that was that the construction of this boat had been carried out in a Canadian ship yard and he understood it was the largest undertaking of the kind completed to date, and the enterprise of those concerned was to be commended.

James French[6]

Mr. French mentioned that he had been associated with the author in the construction of the *Charlottetown* which was now classed by Lloyd's Register of Shipping to the highest rating for the service intended.

The comparison of the *Charlottetown* with the *Prince Edward Island* was particularly interesting, inasmuch as the designer had provided a vessel of about 25 per cent more displacement, on a draught of nine inches less. This had been obtained by an increased beam, fuller block coefficient, and the adoption of oil fuel instead of coal. The resulting economy was evident when it was noted that the new vessel carried about the same capacity of freight cars, and in addition forty automobiles which were not carried on the older vessel.

The structure of the *Charlottetown* had not suffered in any way on account of the extra load and the strengthening for ice was equal to any emergency that might arise. He thought both the designers and builders were to be congratulated on the very fine example of Canadian workmanship.

Walter Lambert, m.e.i.c.[7]

The author observed that Mr. Bridges' remarks were of interest as giving emphasis to a feature of the design to which reference in the paper had been somewhat cursory. That was the three-propeller arrangement and its functions.

The purpose of the bow propeller was:

(*a*) To assist ice-breaking efficiency.
(*b*) To improve manoeuvring ability within the confined harbor limits.

In this respect the design adhered to the S.S. *Prince Edward Island*, but he understood one of the former vessels had been equipped with a bow rudder instead of a bow propeller, and this was afterwards removed as being unsatisfactory.

Captain Read, who had had much experience in this service, was in favour of two bow propellers, that was, four in all, but it was thought that any advantage in such an arrangement might be negatived by increased susceptibility to damage.

Mr. Bridges was entirely correct in drawing attention to the slightly decreased propelling efficiency involved with the bow propeller, but of course the whole matter of power and propeller arrangement was governed by the critical winter operating conditions, and it was fairly obvious that if summer operation only was in question, no one would seriously consider installing 8,000 h.p. in a hull of that size and on such a short route.

The author observed that Captain Nicholson spoke from a wealth of experience both on the Pacific coast and on the Great Lakes, and he must confess to a considerable responsive sympathy with some of his criticisms.

There were many things which he suggested in the trend of modern development which the designers would like to have felt free to do, but were restrained within the limits of somewhat severe conservatism by such considerations as

[5] General Manager, Atlantic Region, Canadian National Railways, Moncton, N.B.

[6] Chief Surveyor, Lloyds Register of Shipping, New York, N.Y.

[7] Lambert and German, Naval Architects, Montreal.

the fact that the service was to all intents and purposes an orphan one; that the well-being of the island province would have been prejudiced by service interruptions which were avoidable; that the crew and local repair facilities were attuned to the ordinary type of steam machinery; and that no commercial competitive conditions applied to the service.

Generally speaking, he concurred in Captain Nicholson's pre-disposition in favour of the Diesel-electric drive in the absence of such considerations as just referred to, and undoubtedly modern tendencies in design were entirely in favour of it, given suitable conditions. In the present instance, however, the economy usually obtainable was largely offset by the low price paid for boiler fuel, due to the provision of ample storage facilities at Borden and the ability to take the complete cargo of a large tanker.

Captain Nicholson mentioned a consumption of 1.5 pounds per i.h.p. hour for a triple expansion job, as against .4 pounds per s.h.p. for a Diesel, and offsetting the loss in transmission by the difference between i.h.p. and s.h.p.

As a matter of fact the guaranteed consumption in the case of the *Charlottetown* was 1.1 pounds per i.h.p. hour, which figure had been consistently bettered. The boiler fuel cost about three cents per gallon, whereas Diesel fuel would be at least double this price, so that the fuel economy of the Diesel-electric installation was not sufficient to be a governing factor, as against other factors of importance.

A six boiler arrangement had been suggested in preference to eight boilers and the fore and aft arrangement proposed was interesting and somewhat novel outside of the Great Lakes. It was a proposal, however, which he thought would require considerable study to arrive at a definite appraisal of its value. It would seem to interfere with the excellent watertight sub-division of the arrangement adopted, which also permitted of one complete boiler room being virtually closed down in the summer. To obtain any advantage from this would mean modifying the fuel tank arrangement which, as explained in the paper, had definite value both from a structural and steam economy point of view.

Captain Nicholson's reference to the waste of space above the main deck was not entirely understood and he thought that had it been feasible to reproduce the general arrangement plans, this opinion would not have been formed. It was hardly appropriate to compare the *Charlottetown* with a lake ferry and the width of houses on the sides, to which apparently objection was made, was really necessary to provide a runway for the automobiles. The designers would have been very reluctant to add another deck as suggested, having regard to the nature of the service; as a matter of fact, there were three tracks as against two on the *Prince Edward Island*, and in the early stages of the design the practicability of the three track arrangement was very seriously questioned by a government official who was well qualified to form a sound opinion.

The consequent economy stated would apparently not be achieved in any case as actually the automobile traffic appeared to have more effect on the number of trips than the capacity for railroad cars.

Captain Nicholson's contribution to the discussion was greatly appreciated and the information given concerning the operation of the Ontario ferries was of interest. It was his experience, however, that all these problems were individual and the factors governing one operation were hardly ever sufficiently similar to allow of the conditions in another location being met with similar equipment.

Mr. Pratley's query as to the advisability of large expenditure on luxurious fittings for a voyage of seven or eight miles was worthy of reply, having regard to the present hard times.

While the vessel was a costly one, it was so by reason of the severity of winter operation, which required an exceptionally strong hull and extremely powerful machinery. These were essentials it was impossible to get away from if the service was to be satisfactory, and if a normal life of ship, with freedom from excessive maintenance costs were important factors.

The additional cost involved in attractive passenger accommodation, instead of comfortless spaces, was trivial compared with the complete cost of the vessel, while, although the distance between terminals was only nine miles, ice conditions in the past had sometimes extended the time of transit to days instead of hours.

It might also be stated that the ultimate cost of the job was slightly within the designers' original estimates and the idea that money had been spent unwisely was to be deprecated.

Mr. Appleton's remarks were apparently limited by the realization that the operation of the vessel came under his direction, and perhaps by a desire to retain an open mind. It would be very interesting to have his opinion in about five years' time, when no doubt many of the features of the vessel would have definitely proved themselves.

Mr. French's constructive remarks were appreciated. As chief surveyor on this continent for Lloyd's Register of Shipping, he shared the responsibilities of the designers and his experienced advice was most valuable.

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The Welland Ship Canal and the St. Lawrence Deep Waterway

The dignified and impressive ceremonial on the sixth of August, at which His Excellency the Governor General declared the Welland Ship canal "open to the commerce of the world," formed a fitting termination to the nineteen years of effort which have now enabled the largest lake steamers to pass the Niagara escarpment between Lake Ontario and Lake Erie. In fact, at this official opening, in the presence of a great gathering, representative of the whole Empire, a Canadian-built vessel over six hundred feet long, drawing twenty feet of water, and carrying some sixteen thousand tons of grain, passed down the flight of twin locks at Thorold on its way to the present terminus of deep water lake navigation at the foot of Lake Ontario.

In his introductory address, the Minister of Railways and Canals sketched the history of the undertaking, from the eight-foot canal of 1829 with its forty locks, to the twenty-five-foot canal of 1932 with eight locks. He paid a well-deserved tribute to the successive administrators and engineers, whose skill and determination had carried the present project to completion. Dr. Manion's appreciative references to the part which engineers have taken in the design and construction of the canal sounded a note which is too seldom heard on such occasions, and is particularly welcome when expressed in such kindly terms at a public ceremony by a Minister of the Crown.

The Prime Minister, who followed, was brief and to the point, and left his audience in no doubt as to his views regarding the desirability of further development. He reminded his listeners that the canal's real significance was as a link in the St. Lawrence waterway between the ocean and the Great Lakes, and that it would be of comparatively little value otherwise.

The presence of many of the delegates to the Imperial Conference gave a special distinction to the occasion. Their speeches, commencing with that of Mr. Baldwin, expressed congratulation and goodwill from Britain, Australia, New Zealand, South Africa, the Irish Free State and India.

Among the thousands of spectators who took part in this historic celebration there must have been many whose thoughts turned to the ultimate completion of the St. Lawrence deep waterway, and the effect of the provisions of the treaty which has recently been negotiated and now awaits ratification by the legislative bodies of Canada and the United States.

The advocates of the treaty claim that its provisions with respect to the waterway constitute an equitable arrangement under which Canadian sovereign rights are adequately protected. All existing rights of navigation are maintained, and are available to all British shipping. The flow of water out of Lake Ontario will be so controlled as to give full protection to navigation in the harbour of Montreal and in the navigable channel below that point. The works in the International section of the river will be constructed by an International Commission, the cost being charged to the United States, and it is provided that the part of those works on the Canadian side of the boundary shall be constructed by Canadian engineers, Canadian labour, and with Canadian materials. Further, Canada will construct the works in the province of Quebec entirely independently of the United States. It is claimed also that a solution of the Chicago diversion controversy has been secured, with safeguards as to the future. There is to be no abstraction from the Great Lakes system to another watershed except by authorization of the International Joint Commission. In the event of diversions being made into the Great Lakes system from watersheds lying wholly within the borders of either country, the exclusive rights to the use of the quantity of water so diverted will be vested in the country diverting such waters. Thus, for example, should Canada effect the proposed diversion of a considerable flow in the Ogoki river from the Hudson Bay watershed to Lake Nipigon, and thence to Lake Superior, Canadian ownership of this additional supply is recognized throughout the Great Lakes and the St. Lawrence. Canada retains complete proprietary rights and control over all works located on the Canadian side of the International boundary, and at any time may construct and operate all-Canadian canal and channel facilities on Canadian territory in the International section of the St. Lawrence, and in the waters connecting the Great Lakes.

The St. Lawrence Deep Waterway is no new conception, and now that the Welland canal is open, the problem of providing a twenty-seven foot channel from the Great Lakes to the sea is reduced substantially to that of dealing with the Montreal-Lake Ontario section of the river. The fact that the projected navigation works on this section are combined with the works required for the development of an immense amount of power (to the advantage of both navigation and power) has tended to create the impression that the completion of the waterway itself will involve Canada in a disproportionate expenditure. In order to get a clear idea of the situation it is necessary to distinguish between the expenditures necessary to construct a twenty-seven foot waterway from Lake Ontario to the sea, the dams, etc., being so designed as to provide for the ultimate development of power, and the additional sums required for buildings, machinery, electrical equipment and transmission lines, which are in no way chargeable to navigation.

A deep waterway is now virtually available from the head of Lake Superior to the first rapids on the St. Lawrence below Lake Ontario, and in this long stretch of nearly fifteen hundred miles very little further work is needed to provide twenty-seven foot navigation. It is in the rapids section of the St. Lawrence, between Prescott and Montreal, a distance of only about one hundred and twenty miles, that important construction works are needed, partly in the International section and partly in the province of Quebec.

The best figures available as to the capital cost of the waterway are based upon the estimates of the Joint Board of Engineers made as of the year 1926, which, however, make no provision for interest during construction.

The treaty provides that each country shall pay for certain navigation works and for land damages within its own territory, and provides also that all works in the International section of the river which are common to navigation and power shall be paid for by the United States.

Under this arrangement, and taking the 1926 estimates, it appears that Canada will be called upon to disburse twenty-two million dollars for work in the International rapids section, plus eighty-three millions for the locks and canals in the wholly Canadian section below Cornwall; a total of one hundred and five millions, the expenditure of which will be distributed over a period of from five to seven years.

Not all of this will be a charge upon the Dominion government, however, for some sixty-seven millions chargeable to power will be paid by the province of Ontario to the Dominion as the province's share of the cost of works common to navigation and power which will have been constructed at the expense of the United States. Accordingly, under the treaty, the net new capital cost to the Dominion of the completion of the twenty-seven-foot waterway will be some thirty-eight million dollars, a sum only about one-third of the amount already expended by Canada upon the Welland canal, with which Canada is to be credited under the treaty.

The cost to the United States is larger, and includes some sixty-five millions for work necessary in United States waterways in the Upper Lakes section, plus one hundred and seventy-eight millions in the International section. These figures, however, include the cost of power development as well as navigation. As regards the sufficiency of these estimates, it is stated that the United States government has recently let contracts for portions of the work in the Upper Lakes at figures very substantially less than those estimated for these particular jobs by the Joint Board in 1926, thus indicating that present-day actual construction costs would be lower than those taken by the Board.

Having regard to the fact that the estimated figures quoted above do not provide for interest during construction, and remembering that a considerable sum will have to be expended for harbour improvements which will be needed to accommodate larger lake vessels at terminals or points along the route, opponents of the treaty believe that the total expenditure on the completion of the navigation works from Lake Ontario to the sea will considerably exceed the above amounts. In any case, the result will be an increase of the burden upon the Canadian taxpayer, while any saving effected in the cost of moving freight through the waterway will only benefit him indirectly. They consider, therefore, that the completion of the waterways under the treaty will add materially to our national debt and question whether we can afford this prospective expenditure without any direct revenue in compensation.

It is admittedly doubtful whether the expense to Canada of deepening the St. Lawrence waterway can be justified by the expected saving on purely Canadian traffic, but in the United States it is claimed that the completion of the waterway to the sea will bring into being an immense volume of new traffic originating in United States ports. This being so, a careful study should be made of the proposal put forward by Mr. Ker in an address recently delivered before the Hamilton Branch of The Institute, to the effect that, as in the case of other great ship canals, tolls should be imposed for the use of the waterway, applying equally to the shipping of all nations. The apportionment of the resulting revenue as between Canada and the United States should not present any difficulty greater than those which have already been surmounted during the negotiation of the treaty in adjusting the incidence of the capital expenditure, and the adoption of such a system of tolls would at once remove some of the principal objections now put forward by the opponents of the lake-to-ocean waterway.

OBITUARIES

Frederick Baylis Brown, M.E.I.C.

The deplorable accident on August 6th, 1932, which resulted in the death of Frederick Baylis Brown, M.E.I.C., will be widely regretted. He was struck down by the propeller of a seaplane which had just arrived at his summer cottage on Lake Ouareau to take up some of his guests, and death was instantaneous.

Mr. Brown was born in Montreal on December 27th, 1881, and received his early training at the Montreal Collegiate Institute and the Montreal High School. Entering McGill University, he received the degree of B.Sc., with honours in mechanical engineering, in 1903, taking honours in electrical engineering the following year, and proceeding to the degree of M.Sc. in 1905.

Following his university course, he became a member of the staff of Ross and Holgate, consulting engineers, and in 1910 took up private practice as a partner in the firm of Walter J. Francis and Company. On the death of Mr. Francis in 1924, his place was taken by Mr. Brown, who later has been practising under his own name.

Mr. Brown was associated with many important engineering undertakings such as the Westmount refuse destructor and electrical plant, the water supply of the city of Moose Jaw, Sask., and the scheme for the Carillon power development, and he served as consulting engineer with the Royal Commission of Inquiry on the Hydro-Electric Power

FREDERICK B. BROWN, M.E.I.C.

Commission of Ontario, and the Dominion Iron and Steel Company's plate mill investigation for the Dominion government.

As a consulting engineer he was called in to assist many municipalities and corporations in connection with engineering problems. At the time of his death he was a member of the board of consulting engineers on the Beauharnois power development, and also had just inspected the new street lighting system for the town of Mount Royal, which had been installed under his supervision.

He joined the Canadian Society of Civil Engineers as a Student in 1903, becoming an Associate Member in 1909 and a Member in 1914. He took an active interest in the affairs of The Institute, serving on Council from 1920 to 1925 inclusive and was prominent in the movement for the registration and licensing of professional engineers. From 1920 until 1930 he served as Honorary Secretary-Treasurer of the Corporation of Professional Engineers of Quebec, and was a Member of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers.

His loss will be deeply felt by a large circle of friends, by the engineering profession of which he was such a prominent member, and by the many social and Masonic organizations in which he participated so actively.

Sidney Henry David Fowler, S.E.I.C.

It is with deep regret that the untimely death of Sidney Henry David Fowler, S.E.I.C., is recorded. Mr. Fowler was drowned on May 29th, 1932, when the boat in which he was sailing on Lac St. Anne, near Edmonton, Alta., capsized.

He was born at Trehorris, South Wales, on February 19th, 1907, and attended the technical school, Edmonton, during the years 1920-1924. In 1928 he entered the University of Alberta and had completed three years in civil engineering, being a brilliant and progressive student.

During the years 1929, 1930 and 1931, Mr. Fowler was on the staff of the city engineer's department, Edmonton.

Mr. Fowler joined The Institute as a Student on January 19th, 1932.

PERSONALS

R. R. Duffy, A.M.E.I.C., has rejoined the staff of Price Brothers and Company Ltd., as assistant to the sales manager, lumber sales, and is now located at Etchemin Bridge, Que.

G. A. Dirom, S.E.I.C., a member of the staff of the Consolidated Mining and Smelting Company of Canada, Ltd., has been transferred by the company from Vancouver to the Echo Bay Area, Great Bear Lake, four hundred miles from Fort Resolution, N.W.T.

Engr. Lieut.-Commander C. Stephen, R.N. (Ret.), A.M.E.I.C., has been appointed technical adviser to the Royal Canadian Mounted Police, Ottawa, Ont. Commander Stephen was for a number of years superintendent engineer at Macdonald College, Ste. Anne de Bellevue, Que., and in 1930 became chief engineer and technical adviser with the Department of Inland Revenue, Ottawa.

A. S. Mansbridge, A.M.E.I.C., has joined the engineering department of Pacific Mills Limited at Ocean Falls, B.C. In 1931 Mr. Mansbridge was for a time structural engineer with the Powell River Company at Stillwater and Powell River, B.C., and later was attached to the engineering department of the West Kootenay Light and Power Company at South Slocan, B.C.

W. Lloyd Bunting, S.E.I.C., is on the staff of the North British Mining and Milling Company at Herb Lake, Man. Mr. Bunting, who graduated from the University of Manitoba in 1928 with the degree of B.Sc., was for a time with the Good Roads Board at Winnipeg, Man. In 1930 he was on the staff of the Winnipeg Hydro-Electric System at Slave Falls, Man., and in 1931 he was connected with the Department of Public Works, Manitoba, at Winnipeg.

The Engineers of the Welland Ship Canal

The formal opening of the Welland Ship Canal which took place on August 6th brings to mind the engineers who for years have been engaged on its design and construction.

At the inception of the scheme in 1912, the chief engineer of the Department of Railways and Canals was William A. Bowden, M.E.I.C., who was appointed to that office in 1910, and had charge of the initial stages of the work. On his death in February, 1924, he was succeeded by Colonel A. E. Dubuc, M.E.I.C., under whose general direction the canal has been completed and put into service.

The first engineer in charge of the canal works was John Laing Weller, M.E.I.C. For some years Mr. Weller had been superintending engineer of the older canal, and after his appointment as engineer in charge in 1912, was largely responsible for the location and general layout of the new work. Construction work was interrupted from 1917 to 1919 and on its resumption he became consulting engineer. Had he lived three months longer, he would have seen the opening of the canal for which he had done so much. His successor as engineer in charge was Alexander Joseph Grant, M.E.I.C., who has been responsible for the later stages and completion of the work, and has had to grapple with the many problems which always arise in an undertaking of such unprecedented character and magnitude.

No small portion of the success which has been achieved is due to the engineers of the Department at Ottawa, and to the field engineering staff, specialists in their own subjects, whom Messrs. Weller and Grant gathered around them in the Niagara Peninsula.

Much advisory and investigational work fell to the lot of Luman Sherwood, M.E.I.C., assistant chief engineer, Department of Railways and Canals, who, together with Duncan W. McLachlan, M.E.I.C., followed the work throughout at Ottawa, advising Mr. Bowden and Colonel Dubuc in regard to the design and specifications as well as constructional matters.

In the field, the principal assistant engineer was at first William Henry Sullivan, M.E.I.C., who was succeeded in 1924 by Evan Guthrie Cameron, A.M.E.I.C.; the field staff who worked with them and gave so freely of their skill and effort included such well-known engineers as F. E. Sterns, M.E.I.C. (Designing), M. B. Atkinson, M.E.I.C. (Bridges), and A. L. Mudge, M.E.I.C. (Electrical Work).

The services of the engineering staff both at Ottawa and in the field received well-merited recognition from the Minister of Railways and Canals in his address at the formal opening of the canal.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Institution of Mechanical Engineers: Proceedings, vol. 121, July-December, 1931.

The Institution of Civil Engineers of Ireland: Transactions, vol. 57, 1930-1931; List of Members, June, 1932.

American Railway Bridge and Building Association: Proceedings, Thirty-eighth Annual Convention, 1928.

American Institute of Electrical Engineers: Quarterly Transactions, vol. 51, no. 2, June, 1932.

Reports, etc.

Department of Labour, Canada:
Eleventh Report on Organization in Industry, Commerce and the Professions in Canada, 1932.

[*Department of Railways and Canals, Canada*]:
The Opening of the Welland Ship Canal, Aug. 6, 1932.

Department of The Interior, Topographical Survey, Canada:
[Map of] Hunter Bay—Coppermine River, 1932.

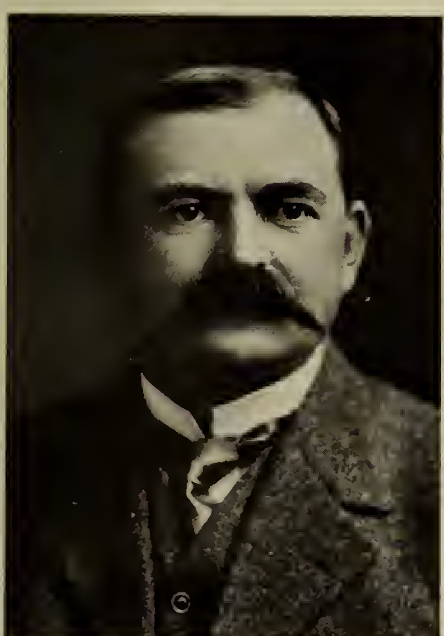
Air Ministry, Aeronautical Research Committee, Great Britain:
Reports and Memoranda:
No. 1377: Application of Goldstein's Airscrew Theory to Design.
No. 1440: Stresses in a Wire Wheel With Non-Radial Spokes Under Rim Loads.
No. 1444: Torsion and Flexure of Cylinders and Tubes.
No. 1445: Interference between Bodies and Airscrews.

Colonel A. E. Dubuc, M.E.I.C.

A. J. Grant, M.E.I.C.

D. W. McLachlan, M.E.I.C.

WELLAND SHIP CANAL 1912-1932



The late J. L. Weller, M.E.I.C.

The late W. A. Bowden, M.E.I.C.

E. G. Cameron, A.M.E.I.C.

No. 1447: Thrust Integrating Tubes. Wind Tunnel Experiments.
No. 1455: Sideslip and Performance of Multi-Engined Aircraft.
No. 1457: Two Reports on Tail Buffeting.
No. 1458: Measurements of Take-Off and Landing Runs.

Technical Books, etc.

Presented by McGraw-Hill Book Co.:
Manual of Electric Arc Welding, by E. H. Hubert. 1932.
Presented by Ernest Benn, Limited:
Dielectric Phenomena. Vol. 3: Breakdown of Solid Dielectrics, by S. H. Whitehead. 1932.
Artificial Earthing for Electrical Installations (Automatic Safety Switching), by T. C. Gilbert. 1932.
Presented by Canadian Engineering Standards Association:
Dimensional Standard B37-1932: Standard Blade Punching for Road Grading Machinery.
Purchased:
Standards of the American Institute of Electrical Engineers.
Titles and Forms of Address: A Guide to Their Correct Use. Published by A. and C. Black. 1929. 2nd edition.

BOOK REVIEWS

Secondary Aluminum

By Robert J. Anderson. Sherwood Press, Inc., Cleveland, Ohio, 1931, cloth, 6 x 9 in., 563 pp., illus., tables, $10.00 postpaid.

This book is intended as a work of reference for works managers or engineers concerned with Aluminum, and treats of the somewhat thorny question of utilization of aluminum scrap, the proper methods of melting and refining it, and the quality of the resulting product.

The author believes (p. 449) that "secondary aluminum is and can be satisfactorily used for any purpose where primary metal is regularly employed," but points out that this statement applies only where properly controlled sorting and metallurgical methods are employed, and claims that under these conditions the material obtained by remelting scrap is the "metallurgical equivalent of primary aluminum in every respect." Even with the above limitation the statement seems somewhat sweeping, in view of the acknowledged difficulties inherent in effecting complete control in sorting. In the case of metal required for certain special purposes, which are, however, limited in number, it would surely be necessary to identify correctly every pound of metal used. Mr. Anderson's treatment of the subject of sorting is, however, one of the most valuable features of the book, as he deals with it in detail and must have gathered his information from sources where the methods described were actually giving results. Many of his suggestions as to sorting are eminently practical.

In other chapters he discusses at some length the effect of metallic impurities and gases upon the product, considers refining methods and melting practice, and deals with the difficulties arising from the use of scrap consisting of aluminum alloys. Each chapter is accompanied by a selected bibliography and the book contains much information of value to those interested in the utilization of scrap metal. It is excellently indexed, both as to author and subject headings.

Electrical Insulating Materials

By H. Warren. Ernest Benn, Ltd., London, 1931, cloth, 7½ x 10 in., 516 pp., photos, diagrs., tables, 42/- net.

Reviewed by D. W. Callander, A.M.E.I.C.*

In this book the author has compiled a very large amount of data with reference to insulating materials of practically all kinds, which data should be of great value to designers and manufacturers of electrical equipment and also to manufacturers of insulating materials. Information is given regarding the sources of supply of the various raw materials; their application; the processes involved in converting them into usable insulating materials including many illustrations of the machinery involved in these processes; physical, electrical and chemical properties; etc.

The contents of the book as briefly outlined below, are concisely arranged and indexed so that ready access may be had to information regarding any particular material of interest.

Outline of Contents

Part I—Natural Mineral Insulations.
In this section there are five chapters covering such materials as mica, asbestos, slate, marble, etc.

Part II—Vitrified Insulations.
The six chapters in this section are devoted to such materials as porcelain, stoneware, glass, vitreous enamels, etc.

Part III—Moulded Composite Insulations.
In the eleven chapters in this section data is compiled on binders, fillers, moulded compounds, moulding processes, moulding equipment, etc.

Part IV—Sheet, Rod and Tube Insulations.
The six chapters in this section contain information on such materials as wood, paper, pressboard, fibre, etc.

Part V—Varnishes, Paints, Cements, Mineral Oils, etc.
In this section there are six chapters dealing with insulating varnishes, protective enamels, lacquers, impregnating and filling compounds, mineral oils, etc.

Part VI—Treated Sheet Insulations, Sleevings, etc.
There are two chapters in this section covering varnished cotton cloth and silk, varnished sleevings, varnished paper, varnished pressboard, etc.

Part VII—Wire Coverings.
The two chapters in this section are devoted to cotton, silk and asbestos wire insulations, enamelled wire, etc.

From the above it will be readily seen that the author has covered a very wide field. Both European and American practices have been considered in most instances.

While this book as a whole is not suitable for a text for engineering students it contains much information which should be of great value and interest to them. It is therefore an excellent reference for engineers and students in practically all phases of the electrical industry.

*Transformer Engineer, Canadian Westinghouse Co. Ltd., Hamilton, Ont.

Graphs for Engineers and Architects

By Donovan H. Lee. E. & F. N. Spon, London, 1932, cloth, 8¾ x 11 in., 88 pp., graphs, tables, 7/6 net.

Reviewed by Major J. M. Oxley, M.E.I.C.*

This handbook contains a series of graphs giving sizes, carrying capacity, and relative costs of many of the principal elements involved in building design. The information is based on the most recent British Codes of Practice, and includes references to American units making many of the graphs applicable for use on this continent.

Extracts are given of the principal requirements of the London County Council Regulations for Reinforced Concrete, and graphs showing safe spans, loads and shears for several series of standardized beams based on these regulations.

Of particular interest are some graphs giving economic relations of building elements, such as the economic depth of excavation for foundations for various column loads with safe soil pressure increasing with depth, and the economic size of windows for various wall thicknesses and storey heights. These are prepared for working loads and unit prices as existing in London, but the ideas are clearly expressed and similar graphs could easily be made by an engineer or architect to picture the local conditions for his own locality and should prove valuable for reference.

Safe loads for steel beams of English and American sections are given in convenient charts suitable for quick reference.

In several cases the charts are not on the page facing the text explaining them. While this is a fault fairly common in reference works it is one which this reviewer thinks should be seriously considered by authors and publishers, and rectified even at the cost of leaving blank pages where it may be necessary to attain the desired result.

The charts for reinforced concrete design are, of course, based on British units and conventions, and would require some study and revision to be convenient for use on this side of the water.

The ideas and methods used throughout the preparation of the book appear to be sound, and it should prove of value, particularly in preparing quick estimates of the comparative cost of the main elements of the structural design of a building, which would prove useful in making decisions as to type of construction before a more detailed design was undertaken for the type of structure chosen.

*Chapman & Oxley, Architects, Toronto, 2, Ont.

Canada Year Book for 1932

The 1932 edition of the Canada Year Book, which deals with natural resources, history, institutions, social and economic conditions in the Dominion, chiefly from a statistical viewpoint, has just been issued by the General Statistics Branch of the Dominion Bureau of Statistics. The book extends to eleven hundred pages, and is preceded by an introduction. There are thirty chapters in the main part of the volume, which is illustrated by many maps and diagrams. Copies may be obtained from the King's Printer, Ottawa, at a nominal charge.

National Sewer Pipe Company, Ltd., announce the publication of a new booklet describing and illustrating a new product "Nasepico Aerating Underdrain" used in the construction of sewage disposal plants. Copies of the booklet may be obtained free from the company's head office at Aldershot, Ont., or at the sales offices, in the Metropolitan building, Toronto 2, Ont.

THE ENGINEERING INSTITUTE OF CANADA

HONOUR ROLL

1914 - 1918

The work of checking the names of members of The Institute who served overseas during the Great War and are eligible for inclusion in The Institute's Honour Roll has now been completed, as far as possible, and the resulting list is published below for the information of all concerned. This list has been made up in accordance with the instructions of Council to include the names of all those who belonged to The Institute in any class of membership and during that membership served with the allied land, air or naval forces outside of Canada and the United States between August 1914 and November 1918.

While every effort has been made to insure correctness, it will be appreciated if members will point out any corrections or additions which should be made.

C. A. Ablett, O.B.E.
J. Adam
W. A. Adam, M.C.
F. P. Adams
W. D. Adams, M.C.
E. K. Adamson
L. S. Adlard
A. W. Agnew
A. B. Aitken, M.C.
A. M. Alberga
G. F. Alberga
F. G. Aldous,
K. Alexander, O.B.E.
E. B. Allan, M.C.
H. D. Allan
L. E. Allen
F. Alport, M.C.
F. X. Amoss, M.C.
A. A. Anderson, D.S.O.
A. C. Anderson
A. G. Anderson, M.M.
G. F. Anderson, M.C.
T. V. Anderson, D.S.O., (F)
D. G. Anglin
L. Annereau
C. J. Armstrong, C.B., C.M.G., (F)
R. F. Armstrong, M.C.
W. Armstrong
A. P. Augustine
F. D. Austin
C. R. Avery

T. H. Bacon
H. C. Baker, Jr., M.C.
J. C. Ball, O.B.E., D.S.O., (F)
S. Ball
T. B. Ballantyne
R. G. Bangs
N. M. Barclay, M.C.
H. F. Barnes
L. F. Barnes
W. C. Bate, M.C. & Bar
H. E. Bates
C. Batho
M. E. Bauset
C. M. Bayne
F. K. Beach
H. P. Beaudoin
J. M. Begg
G. E. Bell
D. P. Bell-Irving
G. A. Bennet
C. S. Bennett
H. F. Bennett
B. C. Berry
M. C. J. Beullac
D. W. Bews
R. Bickerdike, Jr., D.S.O. & Bar
L. M. Bidwell
J. R. Biggs
P. V. Binns, M.C.
E. R. Birchard
J. M. Bishop
T. A. G. Bishop
A. P. Black
J. W. B. Blackman
W. E. Blue, D.S.O.,
H. L. Bodwell, C.M.G., D.S.O., (F)
J. L. H. Bogart, D.S.O.
E. J. Bolger
F. L. C. Bond, D.S.O.
C. D. G. Booth
P. D. Booth, D.S.O., M.C.
M. L. Boswell
W. Bowden
J. Bowie
E. P. Bowman
F. Bowman
J. H. Brace
J. H. Bradley
W. Brass
J. F. Brett
F. E. A. Bremner
F. M. Brickenden
E. D. G. Brouse
C. K. Brown, M.C.
C. W. Brown, M.C.
D. M. Brown
H. L. Brown
J. C. Brown, O.B.E.
L. B. Brown
W. G. Brown
E. F. Browne
G. A. Browne
G. H. Brunner
W. F. M. Bryce
C. A. Buck
R. S. Buck, D.S.O.
S. W. Bulman
H. L. Bunting, M.C.
F. R. Burfield
G. K. Burnett
B. H. A. Burrows
G. A. Butler
T. H. Byrne

W. P. Caddell
J. F. F. Cahan
R. M. Calvin
C. S. Cameron
J. A. Cameron
O. L. Cameron
A. Campbell
J. J. Campbell. M.C.
T. C. Campbell
W. I. H. Campbell
F. L. Cann
C. M. Canniff
C. L. Cantley
E. G. M. Cape, D.S.O.
C. N. T. Carnsew, M.C.
J. Carroll
H. R. Carscallen, M.C.
C. L. Cate
J. E. Caughey
A. L. Cavanagh, M.C.
F. G. Chadwick, M.C.
H. D. Chambers
F. Chappell,
H. H. Charles
P. Charton, (F)
M. P. Chevalier
C. G. Childe
K. G. Chisholm
C. W. U. Chivers, D.S.O., M.C.
H. R. M. Christie
A. W. G. Clark
C. R. Clark
F. Clarke
F. F. Clarke, D.S.O. & Bar
T. W. Clarke, M.B.E.
J. Clendinning
H. G. Cochrane
J. R. Cockburn, M.C.
R. N. Coke
G. E. Cole
E. V. Collier, D.S.O.
C. Collingwood, M.M.
W. S. Collins, M.C.
W. J. Coltman
H. S. Cooper
J. H. Cornish
J. R. Cosgrove, D.S.O., M.C.
G. W. Coward
R. P. Cowen
A. T. N. Cowley
F. P. V. Cowley
F. A. Creighton, (F)
H. C. Craig
J. C. Craig, D.S.O.
E. A. Crawley
J. A. Creaser, M.C.
H. T. Crosbie
F. G. Cross
W. B. Crossing
H. Crutchfield
C. R. Crysdale, M.C.
J. G. Culshaw
A. L. Cumming
A. I. Cunningham
J. H. Curzon

C. A. d'Arrast D'Abbadie
W. R. C. DaCosta
F. A. Dallyn
G. F. Dalton, M.C.
W. T. Daniel
E. F. M. Dann
G. H. Davis
W. E. Davis, D.S.O.
W. M. Davis
H. Daw
A. S. Dawes, M.C.
F. J. Dawson,
I. H. Dawson, M.C.
J. K. Dawson
G. deCardaillac, (F)
L. De Cew
C. S. deGruchy, M.C.
C. T. deKam
J. A. DeLancey, M.C.
F. J. Delaute, O.B.E.
H. G. S. Delepine
P. L. G. de Lestang
A. C. J. de Lotbiniere, C.B., (F)
M. J. dePaul
S. N. deQuetteville
L. H. Derrer
R. A. deValter
E. V. Deverall, M.C. & Bar
W. J. Dickson, M.M.
W. N. Dietrich
J. V. Dillabough
H. G. Dimsdale, M.C.
W. W. Dines
G. B. Dixon
F. W. W. Doane
W. L. Dobbin
G. J. Dodd
C. A. Doherty
J. M. Donaldson
P. E. Doncaster
C. B. C. Donnelly, (F)
C. O. Donnelly
H. H. Donnelly
J. W. Dorsey
F. W. Douglas
E. E. Down
R. W. Downie
W. H. Draper
F. S. Drummond
L. Drummond
A. E. Dubuc, D.S.O. & Bar, (F)
C. G. DuCane, O.B.E.
P. B. Duff
J. C. Dufresne
H. S. Duggan
K. L. Duggan
A. F. Duguid, D.S.O.
P. E. Dulieux
E. Duncan
W. E. P. Duncan
H. J. Dunlap, M.C.
G. Dupont
H. A. Dupre, M.C.
F. S. Dyke

R. S. Eadie
E. A. Earl
F. G. Earle
H. Earle
L. I. Easton, M.C.
H. T. Eaton
A. C. Eddy
J. H. Edgar
C. W. Edmonds
A. J. Edward
H. A. Elgee
G. R. Elliott
D. S. Ellis, D.S.O.
J. Ellis
J. G. St.J. Ellis
S. C. Ells
F. E. Emery
F. H. Emra, O.B.E.
D. J. Emrey, M.M., M.C.
A. E. Evans
G. W. F. R. Evans, M.C.
W. M. Everall
C. Ewart, D.S.O.
D. M. Ewart, M.C.
W. A. Ewing, M.M.

R. M. Fair
J. Farrow
A. W. Ferguson
G. Harry Ferguson
G. Hendry Ferguson, M.C.
J. Ferguson
L. L. Ferguson
T. Ferrier
C. B. Ferris, D.C.M. (F)
C. V. Fessenden
E. P. Fetherstonhaugh, M.C.
W. S. Fetherstonhaugh, C.B.E.
P. A. Fetterley
E. G. Fiegehen
W. M. Fife
A. D. Fisken, M.C.
G. O. Fleming
F. P. Flett
C. Flint, D.S.O., (F)
W. J. Forbes-Mitchell, D.S.O.
W. S. Ford
J. L. Foreman
T. A. J. Forrester
E. S. Fowlds
F. S. Fowler, M.C.
C. J. Fox, M.C.
W. L. Frame
E. W. Francis
C. E. Fraser
J. A. Fraser
W. G. French, M.M.
C. H. R. Fuller
F. Fyshe

C. E. Gage
O. J. Gagnier
J. S. Galbraith, M.C.
R. D. Galbraith, M.C.
O. G. Gallaher
A. Galloway
J. C. Galway
C. W. Gamble
W. M. Gardner
A. C. Garner, D.S.O.
A. B. Garrow
F. M. Gaudet, C.M.G., (F)
A. J. Gayfer,
G. Gear
C. N. Geale
C. F. Gervan
H. M. Gibb
J. M. Gibson, D.S.O.
J. M. Gilchrist
L. W. Gill
J. R. Gilley
A. Gillies
W. C. Gillis
E. P. Girdwood
R. deB. Girouard
J. C. Glanville
F. W. Glover
T. S. Glover, M.C.
F. T. Gnaedinger, M.M.
B. Godwin
E. C. Goldie, D.S.O.
G. A. Gooderham
M. L. Gordon
D. F. Gorrie
D. A. Graham
D. S. Graham
E. R. Grange, D.S.O., (F)
J. R. Grant, M.C.
LeR. F. Grant
R. P. Graves
A. W. Gray
L. K. Greene
P. W. Greene
E. O. Greening
A. H. Greenlees
H. S. Greenwood
A. W. Gregory, M.C.
F. F. Griffin
W. A. E .Grim
E. Grummitt
R. W. Guy, M.M.
H. N. Gzowski

H. Hadley
H. J. A. Haffner
J. S. Hall
N. M. Hall, O.B.E.
T. E. A. Hall
G. M. Hamilton, M.C.
H. E. R. Hamilton
J. Hammer-Schou
J. Hammersley-Heenan
H. S. Hancock

(F) Foreign Orders.

J. Handley
C. F. Hanington
J. J. Hanna
J. T. Hanning
R. H. Harcourt
W. G. Hardy
R. B. Harkness, D.S.O., (F)
J. F. Harkom, M.C.
J. W. Harkom
A. D. Harris
R. W. Harris
E. H. Harrison, M.C.
J. P. Harvey, M.C.
F. G. Haven
E. E. Hawkins
S. H. Hawkins, M.C.
A. K. Hay
N. K. Hay, (F)
W. W. Hay
L. T. Hayman
J. G. Hayward
T. J. C. Heeney
J. G. Helliwell
R. A. Henderson
T. D. Henderson
C. S. L. Hertzberg, M.C., (F)
H. F. H. Hertzberg, C.M.G., D.S.O., M.C.
C. L. Hervey, D.S.O.
J. A. Hesketh, C.M.G., D.S.O.
E. P. Heywood
H. P. Heywood
J. H. Hewson
H. C. Hick
E. M. M. Hill
D. Hillman, D.S.O.
W. E. Hobbs
H. W. Hodge
A. E. Hodgins
F. O. Hodgins, D.S.O.
H. M. T. Hodgson
B. B. Hogarth
C. E. Hogarth
A. Holland
R. H. Hooper
G. C. Hoshal
J. W. Houghton
J. Houliston, D.S.O.
J. A. Houston
B. H. Hughes
C. A. Hughes, M.M.
G. B. Hughes, C.B., C.M.G., D.S.O.
H. T. Hughes, C.M.G., D.S.O.
E. E. H. Hugli
G. B. Hull
A. E. Humphrey, D.S.O.
W. H. Hunt, M.C.
W. H. Hunter
W. B. Hutcheson

C. J. Ingles, D.S.O.
C. W. Innes
J. H. Irvine
J. C. Irving
T. C. Irving, D.S.O.

A. M. Jackson
R. Jacquemart
J. H. E. Jaffary
E. A. Jamieson
G. A. F. R. Janin
P. J. Jennings, O.B.E.
T. Jepson
E. N. Johnson
G. A. Johnson, M.C.
B. A. Johnston
G. W. F. Johnston
H. W. Johnston
J. H. Jones
W. G. Jones
W. H. Jones
R. L. Junkin, M.C.

J. A. Keefer, M.C.
T. C. Keefer, Jr.
A. J. Kelly, M.C. & Bar
J. C. Kemp, D.S.O., M.C.
H. C. Kennedy
H. E. M. Kensit
E. S. Kent
V. J. Kent
A. R. Ketterson, D.S.O.
W. W. King
L. B. Kingston, M.C.
L. W. Klingner, M.C.
F. W. Knewstubb
A. G. Knight, D.S.O., M.C.
F. C. Knight
J. A. Knight, M.C.
G. H. Kohl
F. H. Kortright

L. H. Laffoley
P. A. Laing, M.C.
H. J. Lamb, D.S.O.
S. R. Lamb
Y. Lamontagne
G. E. LaMothe, M.C.
C. S. Landon
P. A. Landry, O.B.E.
A. J. Latornell
F. M. Lawledge
A. J. Lawrence
W. S. Lawrence
G. F. Layne, M.C.
S. T. Layton, M.C.
F. E. Leach
R. G. E. Leckie, C.M.G.

W. J. LeClair
P. L. P. Le Cointe, (F)
H. Lefebvre, M.C.
A. G. T. LeFevre, D.S.O., (F)
A. Leger
A. H. Legge
V. J. Lennox
I. Leonard, D.S.O.
C. C. Lindsay, M.C., (F)
G. A. Lindsay
R. E. Lindsay
A. P. Linton, O.B.E.
E. C. Little, (F)
D. A. Livingston
F. F. Longley, C.B.E., D.S.M.
W. E. Longworthy, M.C.
H. R. Lordly
H. C. Lott, M.C.
T. R. Loudon,
N. Lowden, M.C.
E. J. Lowe
F. T. Lucas
H. A. Lumsden
R. G. Lye
D. Lyell, C.M.G., C.B.E., D.S.O., (F)
C. D. Lyon, M.C.
E. N. Lyon
E. L. Lyons

C. A. Macaulay
F. Macarthur
A. C. MacDonald, D.S.O., (F)
A. T. Macdonald
C. A. Macdonald
C. B. R. Macdonald
J. C. MacDonald, M.C.
L. S. MacDonald
W. M. B. Macdonald
A. E. MacGregor
J. G. MacGregor, M.S.M.
B. H. T. Mackenzie
C. J. Mackenzie, M.C.
H. J. MacKenzie, M.C.
J. A. MacKenzie, D.S.O.
J. F. MacKenzie
W. L. Mackenzie
K. R. MacKinnon, M.C. & Bar
M. A. MacKinnon
O. T. Macklem
J. B. MacLachlan, M.C.
R. C. MacLachlan
G. P. MacLaren
D. G. MacLean
N. J. Maclean
T. A. MacLean
A. L. MacLennan
G. G. MacLennan, (F)
G. MacLeod
G. W. MacLeod, D.S.O. & Bar
A. Macphail, C.M.G., D.S.O., (F)
D. MacPherson
O. C. Macpherson, O.B.E.
J. P. Macheras
C. M. Macreath
C. B. Magrath
W. H. Magwood
H. L. Mahaffy
H. W. Mahon
T. C. Main, (F)
W. L. Malcolm
C. S. Manchester
H. S. Manisty, M.C.
A. B. Manson
O. J. Marchbank
J. Marshall
J. A. P. Marshall
B. E. Martin
J. Mason, D.S.O., M.C.
W. Matheson
C. H. Mathewson, M.C.
D. M. Mathieson, M.C.
J. E. Mathews, M.C. & Bar
G. S. Maunsell
W. G. Mawhinney
J. D. McBeath
W. R. McCaffrey
N. F. McCaghey, D.S.O., M.C.
J. W. McCammon
G. A. McClintock
S. E. McColl
T. C. McConkey
H. E. McCrudden
G.E.McCuaig,C.M.G.,D.S.O. &Bar
M. W. McCutcheon
S. S. McDiarmid
H.F.McDonald,C.M.G.,D.S.O.,(F)
J. N. McDonald
A. McDougall, C.B., (F)
A. L. McDougall
A. B. McEwen, D.S.O.
M. L. D. McFarlane
W. T. McFarlane
F. A. McGiverin, M.C.
J. McGregor, D.S.O.
W. A. McInnes
E. D. McIntosh
W. L. McIntosh
J. K. McKay
R. McKillop
A. W. McKnight
R. C. McKnight
D. B. McLay
E. B. McLean
J. Reg. McLean
J. Rose McLean
N. B. McLean
R. A. McLellan
A. G. McLerie

W. S. McMaster
H. C. McMordie, M.C.
A.G.L.McNaughton,C.M.G.,D.S.O.
O. M. McNeil
J. A. McNicol
J. McNiven
D. S. McPhail
M. N. McPhee, M.C.
A. J. McPherson
H. R. McQueen
J. P. McRae
H. B. McVean
A. de C. Meade, M.C.
J C. Meade
F. C. Mechin
V. M. Meek
A. U. Meikle, M.C.
J. M. Menzies
L. F. Merrylees
W. C. Merston, D.C.M., M.C. & Bar
H. F. V. Meurling, D.S.O., M.C., (F)
V. Michie
J. R. Middleton
A. L. Miéville, D.S.O., M.C.
L. Mignault
A. P. Miller, D.S.O., M.C. & Bar
A. S. Miller
H. B. Miller, M.C.
W. C. Miller
W. M. Miller, M.C.
C. A. Millican
F. S. Milligan, M.C.
F. O. Mills
L. G. Mills
A. H. Milne
J. E. Milne
J. A. Milot
C. H. Mitchell, C.B., C.M.G., D.S.O., (F)
C. N. Mitchell, V.C., M.C.
G. Mitchell, M.C.
J. C. Mitchell
R. W. Mitchell, M.C.
J. Monckton-Case
W. Monds
G. H. N. Monkman
T. M. Montague, (F)
S. C. Montgomery, M.C.
G. C. P. Montizambert
H. St.J. Montizambert
W. H. Moodie, D.S.O.
F. H. Moody
F. M. Mooney
W. N. Moorhouse, D.S.O., (F)
P. J. Moran
B. M. Morris
H. I. Morris
H. F. Morrisey
T. S. Morrisey, D.S.O., (F)
H. K. Morrison
J. H. T. Morrison
J. R. Morrison
T. E. Morrison
H. M. Morrow, M.C.
G. P. Morse
F. R. Mortimer
H. A. Morton
K. W. Morton
G. B. Moxon
H. B. Muckleston
R. Mudge
T. Muirhead
J. M. L. G. Mullon
R. H. Mulock, C.B.E., D.S.O. & Bar
A. H. Munro
J. H. Munro
W. H. Munro
E. P. Muntz
P. F. Murphy
H. A. Murray
J. Murray, M.M.
N. Murray
R. H. Murray
V. F. Murray
W. P. Murray, M.C.
J. C. Murton

T. E. Naish
C. R. Needs
S. A. Neilson
D. H. Nelles
A. Nowlan

S. M. Oborn
A. A. Oldfield
F. J. O'Leary, D.S.O., M.C. & 2 Bars
H. G. O'Leary
J. E. Openshaw
R. H. O'Reilly
C. D. Otty
G. N. D. Otty
R. B. Owens, D S.O.
A. C. Oxley, D.C.M., M.C.
J. M. Oxley

J. A. Page
H. M. Pardee
J. Paris
C. S. Parke
S. D. Parker
J. H. Parks, O.B.E., D.S.O., (F)
C. B. Parr
C. St.C. Parsons
R. H. Parsons
P. deL. D. Passy
K. S. Patrick
A. L. Patterson

R. G. Patterson, M.M.
L. F. Pearce, D S.O., M.C.
W. G. Pearse
H. M. Peck
E. Peden
H. B. Pelletier
E. H. Pense
H. W. Perkins
G. W. H. Perley
B. R. Perry
C. V. Perry, M.C.
K. M. Perry, D.S.O. & Bar
S. M. Peterkin
H. Peters
F. A. Pickering
E. R. B. Pike
H. H. Pinch
R. C. L. Pinget, (F)
W. A. Plant, M.M.
A. S. Poe
R. A. Pook
W. B. Porte
A. T. Powell, D.S.O.
R. W. Powell, M.C. & Bar
T. E. Powers, D.S.O.
A. L. Powter
T. E. Price
J. E. Pringle
E. Probst, (F)
E. F. Pullen, D.S.O.
J. H. Puntin
J. M. Purcell
J. S. Pym, D.C.M.

W. E. Raley
J. H. Ramsay, M.C. & Bar
C. W. P. Ramsey, C.M.G., D.S.O.
T. G. Randolph, M.C.
P. H. Raney
F. S. Rankin
G. Rankin
J. E. Ratz
W. B. Redman
E. W. Reed-Lewis
W. J. D. Reed-Lewis, O.B.E.
A. C. Reid
J. G. Reid, D.S.O.
R. H. Reid
G. E. Revell
G. Reynolds
C. C. Richards
A. A. Richardson, O.B.E.
C. E. Richardson, M.C.
C. W. B. Richardson
F. A. Richardson
S. S. Richardson
W. A. Richardson, M.C.
W. F. Richardson, M.C.
W. H. Richardson, M.C. & Bar
A. G. Riddell, M.C.
L. M. H. Rime
B. Ripley, C.B.E., D.S.O.
A. B. Ritchie, M.C., (F)
W. W. Ritchie
J. R. Roberts
A. K. Robertson
A. M. Robertson, M.C.
T. E. Robinson
L. B. Rochester
C. H. Rogers, M.C.
C. S. G. Rogers
R. P. Rogers, D.S.O.
O. Rolfson
J. M. Rolston, D.S.O., (F)
G. Romanes
H. M. Roscoe
J. T. Rose
P. E. M. Rosenorn
J. H. Rosher
C. F. D. Ross
G. W. Ross
F. G. Rounthwaite
J. C. Rowan
H. G. Rowley
A. V. Roy
T. D. Ruggles
F. C. Rust
F. S. Rutherford
C. C. Ryan, M.C.

R. T. H. Sailman
B. J. Saunders
R. G. Saunders, M.C.
W. L. Saunders
J. K. Scammell
E. L. Schellens
A. N. Scott, M.C.
E. H. Scott
G. D. Scott
G. M. Scott
H. M. Scott
M. A. Scott, D.S.O., (F)
N. M. Scott
W. D. Scott
F. K. Searancke
H. V. Serson
E. R. W. Seymour
S. W. Shackell, M.M.
G. L. Shanks
C. N. Shanly
R. E. Shannon
G. W. Shearer, D.S.O. & Bar
O. H. Shenstone
H. W. R. Shepherd
N. C. Sherman
H. L. Sherwood
W. H. Shillinglaw

(F) Foreign Orders.

H. Sidenius
L. E. Silcox, D.S.O.
A. J. Sill
A. W. Sime
R. Simpson
H. B. Sims
A. F. Smith
A. P. Smith
D. A. Smith
D. R. Smith
R. S. Smith, O.B.E., (F)
W. R. Smith
W. W. Smith
E. S. Smyth
R. G. Sneath
T. D. Sneath, M.C.
R. Snodgrass
F. A. Snyder, (F)
R. Sohier, (F)
D. C. Spears
R. A. Spencer, M.C. & Bar
P. O. Spicer
A. R. Sprenger
H. Sprenger
G. Sproule
A. D. Stalker
E. A. Stanger
H. P. Stanley, D.S.O.
G. J. Staples
W. H. Stark
H. G. Starr
W. D. Staveley, M.C.
W. D. Stavert
C. M. Steeves
C. Stephen
G. E. Stephenson
E. W. Stern
W. F. Stevenson
A. Stewart
A. E. Stewart
A. G. Stewart
A. M. Stewart
H. W. Stewart
J. C. Stewart, D.S.O.
J. B. Stirling
R. A. Stirling
A. A. St. Laurent
G. P. Stirrett
D. H. Storms, M C.
R. S. Stronach
J. C. K. Stuart
W J. Stuart
D. M. Sutherland
J. R. S. Sutherland
H. L. Swan
W. G. Swan, D.S.O., (F)
C. J. Swift
J. A. Symes
C. F. Szammers, (F)

S. G Tackaberry
V. H. Tait
J. F. Tanton
H. W. Tate
A. J. S. Taunton, D.S.O.
F. W. Taylor-Bailey, M.C.
G. R. Taylor
A. Theriault
J. H. Thompson
G. O. Thorn
S. M. Thorne, M.C., (F)
L. B. Tillson, M.C.
J. A. Tilston
A. Timbrell
F. H. Tingley, M.C.
M. Tison
J. A. Tom
G. L. Tooker, M.C.
N. L. Tooker
T. L. Tremblay, C.M.G., D.S.O., (F)
J. H. Trimingham
H. L. Trotter, D.S.O.
G. R. Turner, D.C.M., M.C. & Bar
J. A. Tuzo
A. G. Tweedie
J. O. Twinberrow
H. W. Tye, M.C.
W. G. Tyrrell, D.S.O.

W. P. Unwin
H. R. Urie, M.C.

C. P. Van Norman
F. W. Van Wart
G. E. Vansittart
E. Vinet
H. H. Vroom

H. W. Wagner
W. D. Walcott
S. M. Waldron
G. A. Walkem
T. M. Walker, O.B.E.
G. A. Wallace
H. D. M. Wallace
C. S. Walley, M.C.
N. J. Wallis
J. E. A. Warner, M.C.
P. R. Warren, O.B.E.
G. L. Watson, (F)
J. P. Watson
M. B. Watson
A. D. Watts
K. Weatherbe, M.C.
P. Weatherbe
O. Weeks
S. F. Weeks
W. R. Weidman
F. E. Weir
A. E. Welby
H. R. Welch
H. G. Welsford, M.B.E.
C. W. West
F. L. West
F. W. C. Wetmore
D. A. White, D.S.O.
J. A. G. White, D.S.O., M.C.
J. L. Whitside
D. Whittaker
A. A. Wickenden
A. W. R. Wilby, C.B.E.
S C. Wilcox
W. P. Wilgar, D.S.O.
F. A. Wilkin, M.C.
J. B. Wilkinson
J. N. Williams
G. M. Williscroft
F. J. Willson
A. L. Wilson
C. P. Wilson
J. A. Wilson
J. C. Wilson
L. Z. Wilson, M.C.
N. Wilson
W. J. Wilson
W. T. Wilson, D.S.O., M.C.
A. Wimbles
H. S. Windeler, M.C.
R. H. Winslow
H. A. Wood, M.C.
D. H. Woollatt
A. N. Worthington
A. C. Wright
P. A. Wright
J. K. Wyman
L. W. Wynne-Roberts

A. A. Young
W. Youngman, M.C.
R. Yuill

(F) Foreign Orders.

World Power Conference, Scandinavian Meeting

A sectional meeting of the World Power Conference will be held in Scandinavia, from June 26 to July 10, 1933. The organization of the meeting is in the hands of the Swedish National Committee, acting in conjunction with the National Committees of Denmark, Norway, and Finland. The Conference will be devoted to a study of the power questions connected with large-scale industrial installations and with transport. We understand that attention will primarily be given to fundamental engineering and economic problems rather than to questions of technical detail. It is emphasized, moreover, that an endeavour will be made to limit the general discussions on problems of industrial energy to those branches of industry which are large power consumers. The technical sessions will take place in the Parliament House, Stockholm, according to the preliminary programme, from Wednesday, June 28, to Tuesday, July 4. Official receptions will also be held in Copenhagen and in Oslo, and lectures, inspection tours and visits embracing works and places of interest in Denmark, Norway and Sweden are being arranged, while excursions to Finland by boat or aeroplane will be organized. Contributions for presentation at the Conference should be forwarded through the appropriate National Committee. Information concerning the meeting is given in bulletins, printed in English, French, and German, and issued at intervals. Copies of these may be obtained from the various National Committees or direct from the General Secretary, W.P.C. Sectional Meeting 1933, Stockholm 19, Sweden.

—*Engineering.*

Civil Aviation in Canada

In times of general economic depression, and consequent falling returns in revenue from almost every form of commerce, industry and transport, it is difficult to assess, from statistical statements, the real progress that is being made in certain types of activity. Civil aviation may be cited as an example. The figures relating to the number of aeroplanes in service, the mileage covered, the number of passengers carried, and the weight of goods transported, interesting as they undoubtedly are, may not afford any true index to the advances that are being made. The real state of affairs is more clearly indicated by the facts that new airway routes are being established, and that new records are being created every year, in long-distance flights and in the attainment of high speed. Even these do not exhaust the evidence of progress. There are many others, such as the extension of the application of the methods of aerial surveying, the provision of additional landing resources, by national, municipal, and private enterprise, as well as the institution of greater training facilities, the formation of light-aeroplane clubs, as well as the improvement of the design and the reduction of the production costs of thoroughly reliable standard machines. Canada affords an example, where, from statistics, it might, perhaps, be thought that there was no expansion of air activities in 1931. The development of airways in the great Dominion is not in so advanced a stage as is the case in Europe and the United States of America. Yet, nineteen regular air mail services were in operation last year, under Post Office contracts. Owing to drastic reduction of the air service estimates in 1931, certain routes were modified to permit of others being eliminated, with the result that there was a diminution in the total weight of mail carried. Yet much is being done in Canada, in the development of aviation, that augurs well for its future, and for the earlier utilization of the great natural resources of the Dominion, than could otherwise have been the case.

A very valuable contribution to this is due to the use of the aeroplane for photographic survey, and for the transport of engineers, prospectors, equipment, and supplies to places selected for investigation from the air. Extensive experiments, made from 1922 to 1925, by the Topographic Surveys Section of the Department of the Interior, in co-operation with the Air Service of the Department of National Defence, in various parts of Canada, resulted in the rapid development of methods for the practical application of air photography to the mapping out of forest-covered, or mineral-bearing, areas. The work also made possible both the revision of old maps and the supply of photographs for forestry, geological, water power and other investigations connected with natural resources. Since then, all such matters have been concentrated under a single control, and the extent of the operations is well shown by statistics and maps, in a recent publication of the Department of National Defence, entitled "Report on Civil Aviation and Civil Government Air Operations for the Year 1931." This shows that eleven photographic detachments are now on service, each of which is equipped with two machines. The flying time in the year 1931 was 4,820 hours. Both vertical and oblique photographic methods are used. The latter, for the present state of which much credit must be given to the officers of the Canadian Directorate of Civil Government Air Operations, is very extensively used. It affords the means of covering large areas in a short time. In unexplored country it has the advantage over vertical photography, that the area each exposure covers is so large that irregularities in the flying do not result in gaps, necessitating re-flights. Particularly is it useful in forest lands and lake country, where there are no pronounced differences of level and the maze of waterways, lakes, and rivers is so intricate, and so involved, as, practically speaking, to preclude mapping by ground methods of anything but the main routes.—*Engineering.*

De Laval Steam Turbine Company, Trenton, N.J., announces the publication of Catalogue B-5 entitled "De Laval Single Suction Multistage Pumps." This catalogue, which contains 24 pages, describes and illustrates multistage centrifugal pumps with single suction impellers. Copies of the booklet may be secured from the company's offices at Trenton, N.J.

Preliminary Notice

of Applications for Admission and for Transfer

August 20th, 1932

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, 1932.

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

CLARIDGE—RICHARD EARL, of 2 Cameron St., Toronto, Ont., Born at Stayner, Ont., Nov. 6th, 1898; Educ., 1921-24 (completed 2 years App Sci., obtaining pass in 1st year), Univ. of Toronto. Studied radio engrg., Cass Technica School, Detroit, 1929, Central Technical School, Toronto, 1932; 1918-19, operation of high and low tension power stns., H.E.P.C. of Ont., Toronto; 1920-21, compiling records and general office work, and summer 1922, operation of electric rly. power stns., Toronto Transportation Commn.; 1923 (summer), inspn. and testing of automatic electric power stns., Toronto Hydro-Electric System; 1925-27, operation and mtce. of electric rly. power stns., Chicago Surface Lines; 1927 (summer) design of steam power electric generating stns., Sargent & Lundy, engrs., Chicago; 1924-25, installing central office telephone and telegraph equipment, and from Dec. 1927 to Jan. 1932, installing and testing radio broadcast, telephone and telegraph repeaters, carrier equipment, transmission test equipment, etc., Northern Electric Co. Ltd., Toronto, Ont. (A.M., A.I.E.E.)

References: E. A. Allcut, E. T. J. Brandon, F. A. Gaby, D. W. Harvey, T. R. Loudon, R. E. Smythe.

DAVISON—CHARLES FRASER, of 32 Indian Road, Sandwich, Ont., Born at Halfway River, N.S., July 9th, 1893; Educ., B.Sc. (Mech.), Queen's Univ., 1926; 1921-22 and 1923-24, dfting., Hollinger Gold Mines, Timmins, Ont.; 1925-26, dfting. and gen. asst., Canadian Salt Co., Windsor, Ont.; 1926-27, supt., liquid chlorine dept. of same company, at Sandwich plant; 1927-31, supt., liquid chlorine and synthetic H.C.L., and caustic soda finishing, and 1931 to date, supt., salt plant, Canadian Industries Limited, Sandwich, Ont.

References: L. T. Rutledge, L. M. Arkley, W. J. Fletcher, J. E. Porter, C. G. R. Armstrong, R. C. Leslie, W. A. Dawson, J. A. Denovan.

PANNETON—FRANK, of 44 du Chateau St., Three Rivers, Que., Born at Three Rivers, Que., Dec. 10th, 1892; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1915; 1912 (3 mos.), topographic survey, Dom. Govt.; 1914 (3 mos.), and 1915-16, highway works, chief of surveying party, under A. Lariviere, M.E.I.C.; 1916-24, in private practice; 1924 to date, first asst. engr., and chief designer, City of Three Rivers, Que.

References: A. Lariviere, B. Grandmont, N. Vermette, J. C. H. Jette, J. E. Fleury.

RAY—WALTER REGINALD GUBBINS, of 62 Stratford Road, Montreal, Que., Born at Quebec, Que., June 16th, 1900; Educ., B.Sc. (Mech.), McGill Univ., 1925; 1921-22-23 (summers), surveying; 1925-29, with Price Bros. & Co. Ltd., as follows: 1925, millwright on installn. of paper machines; winter 1926, in charge of records dept. for 200 ton paper mill operation; 1926-27, in charge of field engrg. etc., for constrn. of and improving small town; 1927-29, in charge of all field engrg. pertaining to the constrn. of 200 ton paper mill extension; 1930 to date, sales engr., in charge of pump and elect'l. depts., also valve and steam goods depts., Canadian Fairbanks Morse Co. Ltd., Montreal, Que.

References: C. N. Shanly, D. J. Emrey, A. A. MacDiarmid, G. F. Layne, H. A. Wilson, W. G. Mitchell.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BRUMBY—WALTER WILLIAM, of 33 Hewitt Ave., Toronto 3, Ont., Born at Te Aroha, New Zealand, March 16th, 1899; Educ., 1920 and 1925, Auckland University. 1923-26, elect'l. engrg., Sturrock's School of Engrg., N.Z.; Final Elec'l. Engrg. Cert., City and Guilds of London Institute, 1928; 1917-18, N.Z.E.F., Signal Corps., Egypt and Palestine; 1918-22, four years ap'ticeship, National Electrical and Engineering Co., N.Z.; 1922-24, power station and sub-station constrn., Auckland Electric Power Board, N.Z.; 1924-28, shift engr. in main generating station and sub-stations for same Board; 1928 (July-Sept.), constrn. engr., Canadian Westinghouse Co., Vancouver, B.C.; 1928-29, generating and substation constrn., B.C. Electric Rly. Co., Victoria, B.C.; 1929 (Apr.-Aug.), sub-station constrn. and cold storage plant installn., Hawkins & Hayward, Victoria, B.C.; 1929 to date, with Canadian General Electric Co. Ltd., as follows: 1929-30, test dept., 1930-31, asst. foreman, test dept., 1931, D.C. design, engrg. dept., Sept. 1931 to date, transformer design, engrg. dept. (*Jr. 1930.*)

References: L. DeW. Magie, C. E. Sisson, B. Ottewell, W. E. Ross, A. B. Gates, B. L. Barns, W. M. Cruthers.

CAREY—JOSEPH CAREY, of 142 Military Road, St. John's, Nfld., Born at Halifax, N.S., Oct. 22nd, 1905; Educ., 1925-30, night and part day classes, Memorial University College, St. John's, Nfld. Passed Sections A (1929) and B (1930) of the Inst. Civil Engrs. (London, England) Associate Membership Examinations; 1925 to date, with Nfld. Highroads Commission, in the office of the Government Engineer, as follows: 1925-26-27, indentured pupil to T. A. Hall, M.Inst.C.E., on design and constrn. of engrg. works; 1928-31, in charge of works as chief asst. to W. J. Robinson, M.Inst.C.E., surveying, location, designing, drawing and specifications, setting-out, constrn. and inspection of works undertaken during that time; During 1930-31, in sole charge of all surveys for new work; August 1931 to date, private practice, St. John's, Nfld., engaged in general structural and survey work. (*Jr. 1931.*)

References: J. W. Morris, A. Vatcher, J. B. Baird, T. H. Winter, E. W. Neelands.

COSSITT—LAWRENCE SULIS, of 1176 Sherbrooke St. West, Montreal, Que., Born at Smith's Cove, N.S., May 3rd, 1899; Educ., B.Sc. (Mech.), McGill Univ., 1924; 1920-21, machine shop work, Clarke Bros. Ltd., Bear River, N.S.; 1922-23, dftsman., Atlantic Sugar Refineries; 1924-26, production clerk, Northern Electric Co. Ltd.; 1926-29, mechl. dftsman., and 1929-30, estimator, Robert Mitchell Co. Ltd.; 1930-31, master mechanic's dept., Can. Car & Foundry Co. Ltd. (*S. 1921, Jr. 1926.*)

References: J. W. Fagan, G. A. Johnson, L. McCoy, F. S. Howes, J. W. March, P. B. Motley, G. E. Shaw, H. W. B. Swabey.

EVANS—MAURICE JOHN, of Belvedere, Alta., Born at Clacton-on-Sea, England, May 3rd, 1900; Educ., Grad. R.M.C., 1920. 1917-18, (summers), rodman, etc., B.C. Land Surveys; 1920-21, instr'man., Dom. Govt., Irrigation Surveys, Alta.; During winter 1920-21, employed in office of Irrigation Branch, Reclamation Service, on design and layout of irrigation works, canals and all structures; 1921-22, instr'man. in charge of party investigating and mapping dam sites, reservoirs, pumping schemes, etc., in Southern Alta.; in July 1922, with H. J. Whittaker, A.M.E.I.C., formed engrg. and contracting firm, with headquarters at Belvedere, Alta. Since that date has specialized in drainage, roads, piers, and similar work, including preliminary investigations, surveys, designs, submittance for approval and constrn. Employed for the time being by the Dept. of Public Works, Prov. of Alberta, in location design, constrn. and gravelling of main highways within the province. (*S. 1921, Jr. 1922.*)

References: J. S. Tempest, M. H. Marshall, D. Whittaker, S. H. Hawkins, G. F. Hilliard, B. Russell, A. M. Kirkpatrick, G. H. Whyte.

HUNTER—LIONEL McLAREN, of 7 Willard Ave., Ottawa, Ont., Born at Stirling, Scotland, June 30th, 1889; Educ., 1905-10, Stirling Tech. Coll. and Glasgow Tech. Coll.; 1904-08, ap'tice, municipal engrg., Stirling; 1908-10, asst. engr., munic. engrg., Stirling; 1911-12, asst. engr., 1912-31, roadway engr., and 1931 to date, principal asst. engr., engrg. dept., City of Ottawa, Ont. (*Jr. 1913.*)

References: A. F. Macallum, F. C. Askwith, J. Murphy, J. E. N. Cauchon N. B. MacRostie.

JENKINS—THOMAS HARDING, of 610 Mill St., Sandwich, Ont., Born at Toronto, Ont., May 1st, 1902; Educ., B.A.Sc., Univ. of Toronto, 1925; Summers: 1923, timekpr., C.N.R.; 1924, struct'l. steel tracer and detailer, Hamilton Bridge Works; May 1925 to Nov. 1926, struct'l. steel detailer, Canadian Bridge Works, Walkerville, Ont.; 1926-28, struct'l. dftsman., and April 1928 to date, designer and estimator, bridges and bldgs., Grand Trunk Western Railroad Co., Detroit, Mich. (*S. 1922, Jr. 1927.*)

References: J. A. Heaman, A. E. West, P. E. Adams, J. C. Keith, C. G. R. Armstrong, R. A. Spencer, D. T. Alexander, A. J. M. Bowman.

FOR TRANSFER FROM THE CLASS OF STUDENT

MONTGOMERY—HUGH RICHARDSON, of Saint John, N.B., Born at St. Johns, Que., March 25th, 1905; Educ., B.Sc. (Civil), McGill Univ., 1929; Summers, 1925-26, dftsman., Wallace Sandstone Quarries Ltd., 1927, rodman, Fraser Brace Engrg. Co. Ltd., 1928, quantity surveying, Bremner Norris & Co. Ltd.; 1929-30, field and office engr., Atlas Constrn. Co. Ltd; July 1930 to date, res. engr. on Saint John Harbour Improvements for the Atlas Constrn. Co. Ltd. and the Standard Dredging Co. Ltd. (*S. 1928.*)

References: E. Brown, R. DeL. French, G. B. Mitchell, A. S. Dawes, G. G. Hare, D. Bremner, C. H. Gordon, A. Gray.

ROPER—CHARLES PARSONS, of 362 Morris St., Halifax, N.S., Born at Halifax, May 9th, 1904; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1928; 1927, instr'man., C. A. Fowler Co.; 1928-30, instr'man. on constrn., N.S. Power Commn.; 1930 to date, res. engr., Dept. of Highways, Halifax, N.S. (*S. 1928.*)

References: C. A. Fowler, S. L. Fultz, F. R. Faulkner, J. E. Belliveau, R. R. Murray, J. L. Allan, J. D. Fraser.

WEATHERBIE—WESTON EWART, of Tatamagouche, N.S., Born at Tatamagouche, April 19th, 1905; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1931; 1929 (summer), prospecting and surveying; 1930 (May-Dec.), res. engr. in charge of constrn. of Halifax Municipal Airport; 1931 (May-Nov.), inspr., asphalt paving, Halifax, N.S.; 1931 (Nov.-Dec.), and May to July 1932, inspr., for J. T. Donald & Co. Ltd., on Sackville concrete paving. (*S. 1931.*)

References: H. W. B. Swabey, F. L. West, F. R. Faulkner, S. Ball, W. J. DeWolfe.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Vacant

IRON AND STEEL METALLURGIST, with some foundry experience and who thoroughly understands the manufacture of iron and steel in the electric furnace: must also be familiar with moulding, casting technique, annealing and heat treating. Give full particulars in first application. Apply to Box No. 868-V.

SALES ENGINEER, with car and good connection, by one of Canada's oldest established domestic oil burner companies, located in Montreal. Commission basis. Apply to Box No. 869-V.

Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

ELECTRICAL ENGINEER, B.Sc. '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with Canadian General Electric Co.; telephone engineering and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Sales or industrial engineering desirable. Apply to Box 266-W.

CIVIL ENGINEER, A.M.E.I.C., married, thirty years experience in municipal engineering, highway and pavement work, also qualified sanitary engineer. For the past twenty years engaged as construction engineer on large works, including buildings, sewerage and water systems. Experienced executive and up-to-date methods used. Permanent position desired as engineer or superintendent. Location immaterial. Available at once. Apply to Box No. 336-W.

STRUCTURAL ENGINEER, A.M.E.I.C., graduate. Twelve years experience in structural steel design, estimates, details, shop inspection, and erection on bridges, buildings and movable structures. General experience in the building trades. Apply to box No. 399-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, A.M.E.I.C., University graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W

CHEMICAL ENGINEER, graduate of McGill University, B.Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in design, manufacture, sales and installation of pulp and paper, also mining machinery, seeks association with firm as sales engineer. Apply to Box No. 633-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C.; R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, B.Sc., '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

MECHANICAL ENGINEER, Jr.E.I.C., G.I. MECH.E. Ten years practical experience—design and construction—elevating, conveying and transporting machinery—contractor's stone and woodworking machinery. Recently mechanical engineer with pulp and paper company. Will develop and design machinery to suit individual requirements pending full time employment. Available immediately. Apply to Box No. 704-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

Situations Wanted

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

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MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

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ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

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CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

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Situations Wanted

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

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CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monumental and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

SALES REPRESENTATIVE. Electrical engineer with ten years experience in power field interested in representing established firm for electrical or mechanical product in Montreal territory. Excellent connections. Apply to Box No. 795-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C., with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments, in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

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Situations Wanted

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SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

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CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

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— THE —

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Modern Developments in Heating Practice

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 7th, 1932.

SUMMARY.—This paper reviews recent progress in heating, ventilation, and air conditioning for buildings, pointing out the effect of building construction on the installation and operating expenses of the heating system. A brief historical survey of steam heating is given with a discussion of modern methods for the control of steam heating, particularly when supplied at pressures below atmospheric. The author deals with the differences between overall and individual radiator control and treats of the advantages of zoning in large buildings. He refers to the system of panel heating which has been successfully introduced in England, the use of unit heaters in industrial buildings, and concludes with a discussion of the standard degree-day method of computing heating costs.

Introduction

Although artificial heating has been used the world over since prehistoric times, and heating systems have been utilized for generations, the greatest developments in the science have been made since the turn of the present century. Interesting also as a sidelight on the accelerating rate at which our civilization is becoming mechanized is the fact that of these modern contributions, the most significant have been made during the last ten years. At the present time new types of equipment, new methods of heat distribution and an amazing variety of control devices are coming into the market yearly and more are in various stages of research and of testing. It is the purpose of this paper to describe some of the more outstanding of these recent developments.

The Scope of Modern Developments

Among current developments are: (1) unit heaters which are rapidly supplanting cast iron and pipe coil radiators in industrial buildings, (2) concealed radiators which bid fair to oust the exposed radiator from a wide area of the construction field, (3) the circulation of steam for heating at pressures approaching a perfect vacuum which has added new flexibility to an old heat transfer medium, (4) the use of orificing or metering devices to control steam distribution, (5) the development of temperature regulation devices for individual radiators, groups of radiators and entire heating installations, (6) the use of insulating materials, (7) the development of oil fuel combustion and the entry of gas fuel in competition with oil and coal, and (8) the sharp trend toward the electrification of control equipment.

Air Conditioning

Added to these developments is a widespread and growing interest in the subject and practice of air conditioning. A few years ago, heating and refrigeration were considered to be far apart. To-day they are drawing together and within a generation they will be one and the same industry. Engineers now regard cooling as a problem of heat transfer just as they regard heating. Only the directions of flow are opposite.

Air conditioning embraces not only artificial heating and cooling, but also the removal of dust and foreign particles from the air, and its delivery at a humidity related to its temperature so as to produce an optimum comfort environment for building occupants. In addition, research now in progress indicates that the electrical properties of air in occupied rooms, ventilated either by natural or by mechanical means, may influence our comfort and vitality. If and when definite relationships of this nature are demonstrated, an apparatus may be looked for which is designed to maintain the ionic content of the air at a level calculated to give the air that invigorating quality so noticeable in the open country on a bright, clear day in the summer.

The research laboratory of the American Society of Heating and Ventilating Engineers has for years been carrying on extensive research work to determine the physiological effects of temperature, humidity, air motion and air pollution on the human body. One of the results of this research is the psychrometric chart which tabulates the interrelated effects of temperature and humidity. From the psychrometric chart it is found that the most desirable comfort temperature to be maintained in a building in winter is 70 degrees F. (dry bulb) and 50 per cent relative humidity.

Another fact which has been determined is that although the body is capable of adapting itself to rather wide variations in air conditions other than temperature, its ability to maintain heat equilibrium is limited. It follows that the temperature of a building should be maintained nearly constant. In other words, the comfort range in temperatures is comparatively narrow and the conditioning factors of humidity and air movement should be related to temperatures only within this range. Humidifiers will be referred to later in the paper, otherwise the subject of air conditioning must be left with these few notes.

Heat Requirements

Because of the many variables entering into the problem, it is impossible to estimate with extreme precision the heat requirements at any and all times. However, by taking the sum of all the heat losses from the building during the coldest weather, it is possible to determine fairly accurately the maximum heat requirements for a building in any particular locality. The heating system can then be designed with capacity sufficient to heat the building under conditions of maximum heat demand so determined.

A brief consideration of the factors which determine heat demand might be in order at this point. These include weather and construction conditions.

Weather conditions embrace not only temperatures but also the wind velocity and directions, humidity and hours of sunshine and cloudiness.

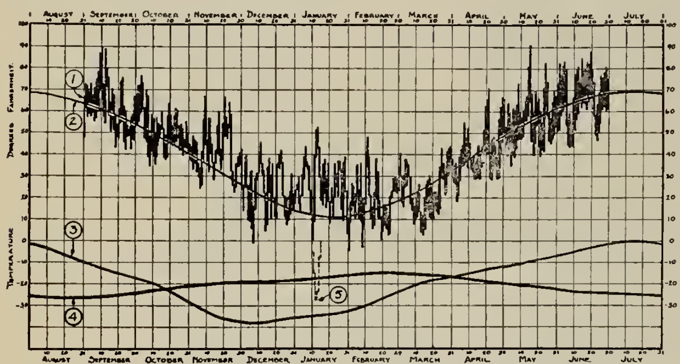


Fig. 1—Chart of Climatic Conditions of Montreal.

Some of the weather conditions recorded at the McGill observatory are shown in Fig. 1. Curve 1 shows the daily temperature variations for the heating season 1931-1932. Curve 2 shows the normal daily mean temperature. Curve 3 indicates the normal monthly sunshine. Curve 4 indicates the normal mean wind velocity. Curve 5 shows the minimum temperature recorded for a portion of the month of January 1914, which includes the temperature of −27.1 degrees F., the lowest temperature ever recorded at McGill University.

The graph shows the general temperature trend, the sudden changes of 30 degrees to 32 degrees in a single day, the protracted periods of cold weather and the periods when only the smallest amount of artificial heat is required. It is evident that outside temperatures impose a requirement of wide and ready flexibility upon a heating system if building temperatures are to be maintained constant.

Wind, its direction and velocity, also affects heat requirements. Buildings are large radiators and just as the fan draught increases the amount of heat wiped off unit heater radiators, so wind increases the heat loss from their surfaces. Wind also increases the infiltration of cold air and exfiltration of heated air. By reason of direction as well as velocity, it may additionally cause variations in the rate of heat loss from different sections of a building. In buildings of flimsy wall and window construction, this sectional difference in the rate of heat loss may be marked. In buildings of substantial construction, with a centrally controlled supply of heat, it has been observed to cause an average variation in inside temperature from the exposed to the protected sides up to a maximum of about 4 degrees. With present knowledge, it is impossible to calculate or determine by experiment the exact heat loss caused by wind movement, although there is at least one method of estimating steam consumption which makes some attempt to evaluate it.

Sun upon one or more surfaces has an opposite effect to wind and also tends to create a variation in heat requirements between sections of a building.

The absorption of heat from the sun by the outside walls of a building has a bearing on the heat requirements, but this effect varies so in intensity, and is so small in comparison to the temperature and wind effect, that it is seldom considered in heat calculations except in large installations divided into a number of heating zones.

Outside humidity has some effect on the heat transmission from the walls of a building but this is negligible and is never taken into account.

Effects of Building Construction

Building design, construction and insulation also affect heat requirements. Usually, the engineer designing the heating system has very little influence upon the building design. The heating system must be designed to suit the building design within the limitations imposed by that particular design. With the advent of exceptionally high buildings, however, engineering design has assumed greater importance than purely architectural design and in such structures the plan and construction may be considered from their effect on the heating design, costs and fuel consumption.

In this connection it may be interesting to note that in the United States, there have been erected recently a number of loft and office buildings in which the boiler rooms are located in the pent-houses instead of the basements. In Los Angeles, for instance, there are buildings which are limited by city ordinances to a height of 150 feet. The pent-houses, however, are allowed to project above this height, and are made large enough and high enough to accommodate the boiler rooms. These buildings, of course, use either fuel oil or gas in their boilers.

At first sight the location of the boiler room in the pent-house might appear to be rather ridiculous, but on closer examination, advantages in and economic justification of the practice can be seen. One has but to consider the high cost of excavating boiler rooms, the fact that today basements of most office buildings can be used to good advantage as garages, and finally the fact that a stack in a tall building not only costs a great deal but also results in a large loss of rentable or usable space. Pent-house heating plants have now been used enough to demonstrate their practicability.

While the heating system is normally designed to suit the building design, the two are interdependent, and to arrive at the lowest heating cost commensurate with the installation and building cost, it is important that certain elements of building design should be considered in relation to their effect on the heating requirements.

The two elements in construction which have the greatest effect on the heating requirements, are first: the exposed wall and roof construction and their insulating, and second: the window construction, weatherstripping and caulking. In the average office or loft building as constructed in Montreal to-day, using no insulation in the walls or roof and using single glass double-hung windows, between 50 and 60 per cent of the heat loss is through the exposed walls and roof, while the remaining 40 to 50 per cent is through the glass and window frames.

Recently, the author reviewed the radiation calculations for a large office building and found some figures which might be of interest. This building had single glass double-hung windows which were weatherstripped; the walls were built of four-inch brick, eight-inch Haydite tile; they were plastered directly on the tile. The window area was about 27½ per cent of the total wall surface. Had double-pane glazing been used, the radiation would have been reduced 25 per cent. Had an insulation material, such as one layer of Celotex 7/16 inch thick been used furred to the Haydite tile and the plaster plastered directly to the Celotex, the radiation would have been reduced 16 per cent. Finally, had both the double-pane glazing and the insulation been used, the radiation could have been reduced 40 per cent. Insulation and double glazing decrease radiation and so the cost of the heating system, decreases the cost of the fuel, and decreases the space required for the boilers and combustion equipment, but they increase the cost of building construction. It is suggested that there is a point at which the combined cost of the heating system and of the building proper is at a minimum. How far one should go in the use of insulation and double glazing is an individual problem for every building project but a problem which deserves consideration both upon the basis of the investment and the operating economies which can be made.

Development of Systems

An ideal heating system would provide enough heat when the coldest temperatures are encountered yet would not overheat in mild weather. It would have sufficient flexibility to respond readily and quickly to the variations in heat demand, be economical in operation, simple mechanically and moderate in initial cost.

Hot Water Heating Systems

In approaching this ideal, hot water heating has had, until quite recently, a distinct theoretical advantage over steam by reason of the range of water temperature and thus the range in heat emission which it could provide. Actually, however, the temperature inertia of the comparatively large volume of water in circulation and the resultant lag of supply variations behind demand curves has constituted a practical disadvantage in control.

Hot water heating has advanced from gravity to forced circulation and from the open to the closed system. It is fairly economical in operation, simple mechanically and moderate in first cost. In the face of these advantages its recession in popularity on this continent, except in residence buildings, must be attributed to its inherent temperature inertia, to the pressure problem incident to the increased height of buildings which its use involves, to the problems it introduces in winter construction and to freezing hazards. Even in the residence field it is probable that, with the introduction of concealed radiators, it will slowly give place to steam in better homes.

Steam Heating Systems

The history of steam heating was discussed comprehensively in a paper entitled "Developments in Steam Heating" by C. A. Thinn, presented at the annual meeting of The Institute in February, 1929.

The one-pipe steam system was introduced back in the time of James Watt, probably about 1770. It was followed by the two-pipe, two-valve type of installation. Then came radiator traps of float and water-seal type and of thermostatic type depending upon the expansion of solids when heated. By 1895, the vacuum return line type of system came into use. It employs two systems of piping, traps and a vacuum pump. It circulates steam at greater than atmospheric pressure while maintaining less than atmospheric pressure in the return lines. In the refinement of this type of system came the change from the float to the fluid-filled thermostatic trap and from the steam to the electrically driven vacuum pump.

A vacuum return line system is shown in Fig. 2. The steam pressure is usually maintained between 0 and 5 pounds depending on the outside temperature, while the pressure in the return mains is usually held between four and eight inches of vacuum by means of a controller set to cut in and out at those respective points, regardless of the steam pressure.

The modern systems to be dealt with in this paper have their origin in the limitations seen by heating engineers in the vacuum return line method of distributing steam for heating. Chief among these limitations was its lack of control. It was able to meet maximum heat demands readily but it did not have the capacity to reduce the supply of heat when the requirements of the building were less than the maximum. Because of this lack of flexibility, it tended to cause overheating during about 95 per cent of the heating season.

Control of space temperatures can be effected in two ways. Either the quantity or the temperature of the heating medium can be varied. Most types of control used with steam heating are designed to govern the quantity of steam admitted to the system as a whole or to individual radiators.

A great variety of thermostatic devices are today available for control of the steam supply to individual radiators. These are of two general types. In one, the motive power to operate the device is supplied from an outside source. In the other, the power to operate the device is supplied by the device itself. Of the first type, the most commonly used is the air-operated type. There are also electrically-operated devices of this type, but these are not used to any extent in Canada as yet. The air-operated systems are so well known as to need no description here. They are sensitive and dependable, but their initial cost is higher than that of almost all other types of control.

The self-contained thermostatic type of control valve was introduced a number of years ago, but its use has only become general within the last two or three years. Its chief advantage is the comparatively low cost and the ease with which it can be added to any type of heating system. Seemingly this type of valve is not as sensitive as the air-operated types, and is inherently complicated in its mechanism.

In view of the vast improvement in system control of the temperatures of entire buildings or sections of buildings, the comparative simplicity and small number of mechanisms required for system control as against individual radiator control, the fact that individual radiator control does not mean control to suit individual tastes when over more than one person uses a room, and the fact that initial costs, fuel costs and maintenance costs favour *system* rather than the individual *radiator* control, it is probable that heating design in the immediate future will see a greater movement toward overall system control than toward individual radiator control.

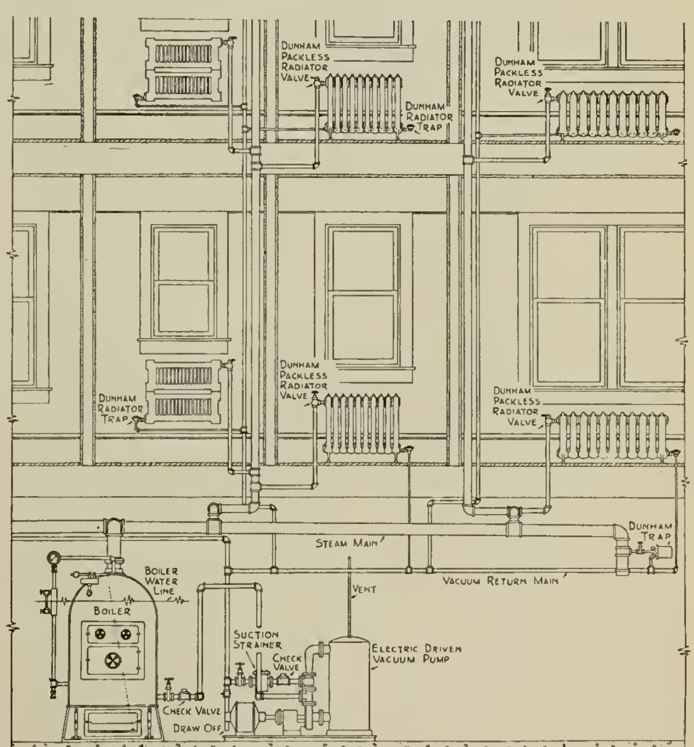


Fig. 2—Typical Vacuum Return Line Heating System.

The Webster Moderator System (see Fig. 3) is an example of overall system control as contrasted with individual radiator control. It is also an example of a type of heating system in which the quantity rather than the temperature of the heating medium—steam—is varied to the heat output. The Moderator System is really an ordinary vacuum return line system with moderator control. In other words, it has the piping, radiators, valves, traps, vacuum pumps, etc., installed in the same way as an ordinary vacuum system but metering orifices are set in the steam mains, steam risers and in the nipples of each radiator valve and a main steam control valve is installed

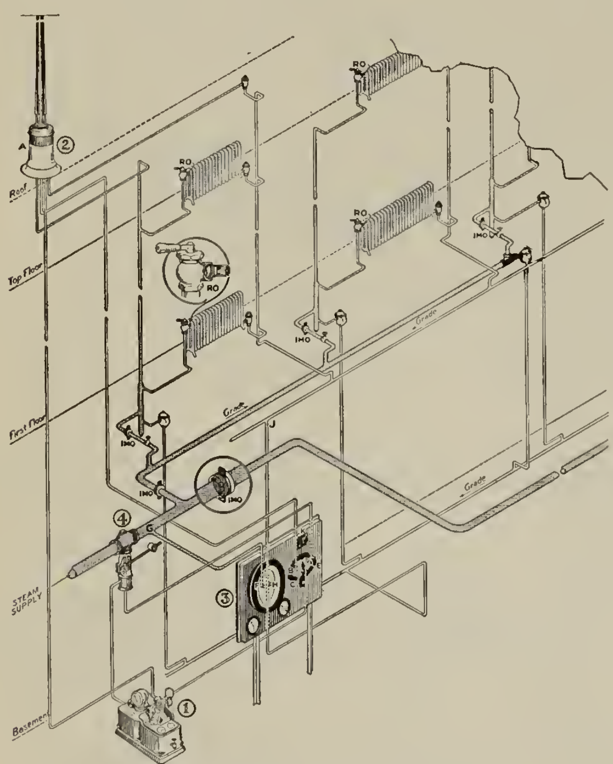


Fig. 3—Moderator Control System.

next to the steam supply. The orifices are sized in relation to the sections of the heating surfaces fed in such fashion that resistance to flow throughout the entire supply piping is closely proportional to the varying heating surface loads upon the various sections of the system. Orifices for these sections would be calibrated so that with the same drop in pressure from the supply to the return end of the system, steam flow to the different sections would be in ratios proportional to the heating load of each section.

After steam circulation is thus balanced, the next step is to provide for a variation in pressure drop or difference through the system. This is done by a combination of automatic and manual control over the main steam valve which admits steam to the system. An outside thermostat usually located on the roof determines the pressure carried in an air line system which in turn determines the pressure carried in an oil line system which increases or decreases the opening of the main steam supply valve. Since the drop in pressure through the system is dependent upon the return main pressure as well, as the rate of steam supply, a second system of pressure control is employed to maintain the relationship between supply and return pressure constantly in accord with the pressure drop called for by the roof thermostat and manual variator. This automatic control can be supplemented by manual control to compensate for wind, sun or climatic conditions other than temperature.

Contrasted in principle of operation with the above type of system is the Dunham Differential System, introduced in 1926, which provides control of the heat output by variations in the temperature as well as the volume of the steam it delivers to the radiation.

The Differential System is an application of the law that the temperature of saturated steam varies with its absolute pressure. Steam is delivered to the radiators at pressures ranging from two pounds above that of the atmosphere down to 25 inches of vacuum and thus at temperatures from approximately 218 degrees down to 133 degrees F. The temperature of the heating surfaces is thus susceptible to a variation of approximately 85 degrees—the variation being automatically or manually controlled in accordance with the heating requirements. This 85-degree range in the temperature of the heating surfaces does not represent the outside limits of the flexibility of the system; in extreme cold weather, possibly intensified by wind, steam pressures above two pounds, even up to five pounds can be used and in very mild weather when a pressure of 25 inches of vacuum is being carried, the supply of steam can be further reduced until each unit of the radiation is only partly filled with low-temperature steam which is equivalent to a reduction in the amount or average temperature of the heating surface. Regulating plates calibrated in relation to the capacity of the radiators at the inlets of all radiators balance the resistance to steam flow so that each radiator receives substantially its proportion of the entire supply.

The equipment for this type of system consists of sub-atmospheric pressure reducing valves which govern the pressure at which steam is admitted to the heating mains, a system of supply piping, sized and graded in accord with vacuum return line practice, packless valves at radiator inlets equipped with regulating plates, concealed or exposed radiation, thermostatic traps capable of operation over the related range of steam pressures and

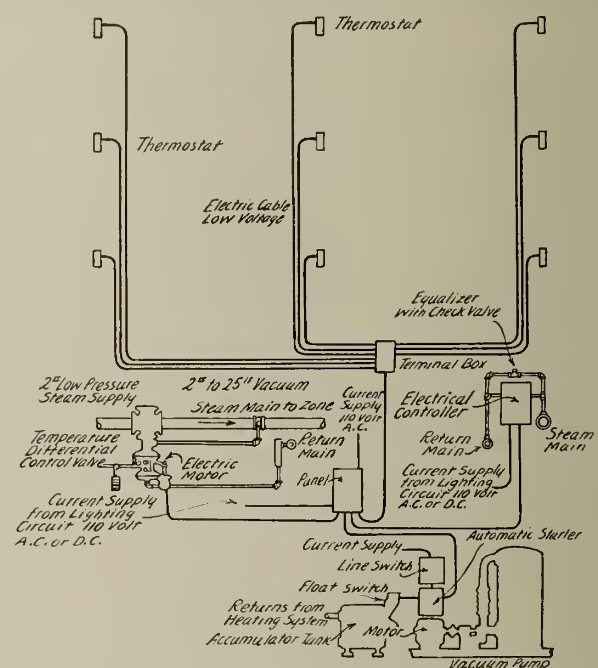
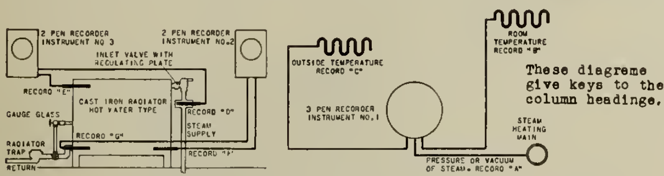


Fig. 4—Differential System with Average Temperature Control.

temperatures used in the system, a system of return piping, a vacuum pump capable of maintaining circulation under minimum pressures of 25 inches of vacuum, and an automatic control over pump operation which will ensure a limited pressure drop from the supply to the return side of the system under all operating conditions.

As the differential type of system was introduced over five years ago and is now in service in a rather extensive group of buildings throughout the Dominion, it is probable that recent refinements in its control will be of greater interest than an amplification of its basic operating principles.

The first Differential installations were manually controlled. Variations in the pressure, temperature and volume of the steam in circulation were under the control of the operator. Subsequent refinements have been in the direction of completely automatic control and have resulted in the introduction this year of Average Temperature



Maximum sustained wind velooity, Feh. 10, was 14 milee per hour, but on Feb. 11 inoreased to 48 miles per hour with a gust velocity whioh reeohed 62 miles per hour. The fallacy of placing thermostate outside e huilding to regulete inside temperatures is illuetrated by the coneiderahle lag of radiator temperature variations hehind outside tempereture ohanges.

Time	February 10, 1932							Time	February 11, 1932						
	A	B	C	D	E	F	G		A	B	C	D	E	F	G
8:30	21"	71°	42°	144°	140°	136°	123°	10:00	22"	72°	60°	137°	107°	91°	84°
8:45	21	71	42	146	141	139	115	10:15	22	72	61	137	107	91	84
9:00	21	71	42	145	138	135	111	10:30	22	72	62	137	105	89	83
9:15	21	71	45	141	135	130	109	10:45	22	72	62	133	103	86	83
9:30	22"	71°	46°	141°	137°	131°	107°	11:00	22"	72°	62°	131°	100°	83°	83°
9:45	22	71	48	140	135	127	106	11:15	22	72	63	130	97	81	82
10:00	22	71	49	138	132	121	102	11:30	22	72	64	130	97	78	83
10:15	22	71	50	136	129	121	101	11:45	22	72	64	129	95	78	83
10:30	22"	71°	50°	138°	123°	114°	98°	12:00	22"	72°	64°	133°	93°	77°	82°
10:45	22	71	51	138	120	109	96	12:15	22	72	62	137	90	77	82
11:00	22	71	51	138	120	107	93	12:30	22	72	63	140	92	77	82
11:15	22	71	52	140	120	110	92	12:45	22	72	64	140	96	80	82
11:30	22"	71°	52°	138°	118°	108°	90°	1:00	22"	72°	64°	140°	98°	80°	82°
11:45	22	71	54	137	116	104	90	1:15	22	72	64	136	98	80	82
12:00	22	71	54	138	115	102	88	1:30	22	72	64	135	98	80	82
12:15	22	71	55	137	109	95	88	1:45	22	72	64	133	97	80	82
12:30	22"	71°	56°	133°	107°	91°	86°	2:00	22"	72°	62°	133°	95°	80°	82°
12:45	22	71	57	136	103	87	85	2:15	22	72	62	133	93	80	82
1:00	22	71	58	137	101	87	84	2:30	22	72	61	135	94	80	82
1:15	22	71	59	130	101	83	83	2:45	22	72	58	139	95	80	82
1:30	22"	71°	59°	127°	99°	80°	83°	3:00	22"	72°	53°	136°	97°	80°	82°
1:45	22	71	59	135	94	78	83	3:15	22	72	50	135	97	80	82
2:00	22	71	60	138	92	77	83	3:30	22	72	49	135	96	80	82
2:15	22	71	60	139	95	79	83	3:45	22	72	48	136	95	80	82
2:30	22"	71°	60°	140°	100°	86°	82°	4:00	22"	72°	46°	136°	94°	80°	82°
2:45	22	71	60	141	105	90	82	4:15	22	72	45	141	95	80	82
3:00	22	71	60	141	110	97	82	4:30	22	72	44	143	99	86	82
3:15	22	71	60	141	112	99	82	4:45	21	72	44	144	107	95	82

Fig. 5—Operating Record of Differential System.

Control which utilizes the average temperature of the space to be heated to govern the rate of heat supply. (Fig. 4.)

In this type of control, a number of potentiometer thermostats are located throughout the building or zone and are hooked together in a series-parallel wiring arrangement so that the current carried down to the control motor on the supply valve is determined by the varying resistance through each thermostat and thus represents the average of the temperatures registered by them all. The nine thermostat arrangement gives a very close approximation of the actual average temperature of the entire space to be heated. It eliminates the undue influence of open windows or turned-off radiators upon any one thermostat and compensates for the effect of wind or sun upon one or more surfaces of the building. The current from the thermostat group actuates a motor which operates the main control valve. The valve opens to greater or less extent depending upon the movement of its motor, clockwise or counterclockwise, as the current increases or decreases in intensity. The motor is continuously in balance with the current from the thermostats and as a result the valve is constantly open to some percentage of its full capacity and steam circulation is uninterrupted.

The tables shown in Fig. 5 indicate the precision of this type of control. The records were taken in a Chicago building using Dunham Differential Heating with Average Temperature Control. The dates were February 10th and 11th. On February 10th at 8.30 a.m. the temperature was 42 degrees outside. By 2 p.m. it had risen to 60 degrees, a most unusual temperature for the time of year. The temperature hovered around 60 degrees from 2 p.m. on the 10th to 10 a.m. on the 11th when it began to rise and reached a maximum of 64 degrees at 1.45 p.m. Then a sudden change occurred and by 4.45 p.m. the temperature had dropped to 44 degrees or approximately 20 degrees in three hours. This sudden temperature drop was accompanied by a very high wind which, according to official reports of the Weather Bureau, at times reached a velocity of 60 miles per hour and although this high velocity was in gusts, the sustained velocity was 48 miles per hour so that conditions were ideal for testing out the control equipment.

During the entire period, the temperature of the building was maintained uniformly between 70 degrees and 72 degrees. During the entire time also the vacuum on the system remained practically constant at 22 inches with only a slight drop on the 11th by 4.45 p.m. Radiator temperature records show that radiators were only partly filled during the period. Temperature conditions were maintained uniform by means of the main valve supplying steam in varying quantities proportional to the average demands of the various thermostats.

Gas Heating

A description of modern heating developments would not be complete without some reference to the use of gas, natural and artificial, for heating. The piping of natural gas from oil fields to population centres, and the crowding out of gas, first from the illumination and recently to quite an extent from the cooking field, have led to the exploration of the heating possibilities of this fuel which offers close to the ultimate in convenience, cleanliness and ease of control.

Gas boilers have been perfected to a point at which boiler efficiencies as high as 80 per cent have been achieved under test. In commercial service, however, efficiencies from 50 per cent to 70 per cent are commonly secured. In view of the cost of gas as compared with oil or coal, some method of reducing cost by increasing heating efficiency is necessary before gas can become a widely used fuel.

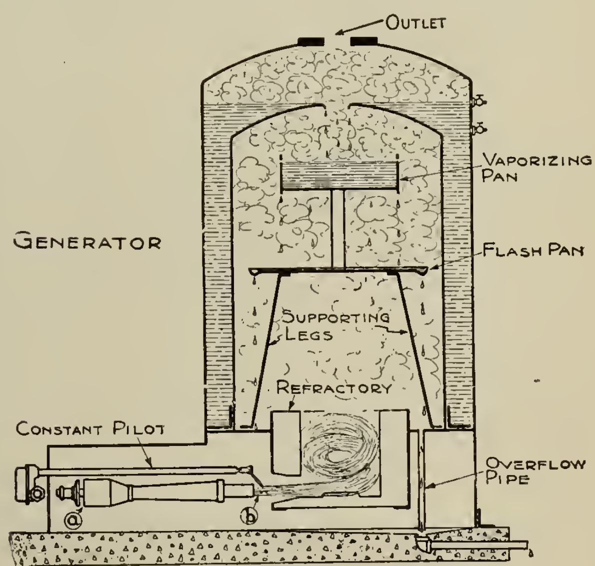


Fig. 6—Section Through Generator.

Just such a method is now in process of field study. In view of its novel departure from all previous heating practice, it warrants comment.

The chief heat waste in a conventional gas boiler is the loss up the chimney which may equal 25 per cent of the total heat available in the fuel. Sav-T-Heat, as the development under consideration is named, eliminates the loss up the chimney by carrying the products of combustion through the radiation. Heating efficiencies of over 90 per cent are claimed for the method.

Natural or artificial gas is burned in a generator in the presence of water and the resultant admixture of the products of combustion and water vapour is circulated under slightly less than atmospheric pressure through the system of radiation which may be cast iron or concealed and out through the return piping from which it is exhausted by a fan. (See Fig. 6.) The system is at present operating commercially under observation by gas companies and further developments will be watched with interest. The equipment is principally designed for residence heating. It is simple, quiet, less costly to install than a steam system and reduces gas consumption sufficiently to make this fuel practicable for residence heating.

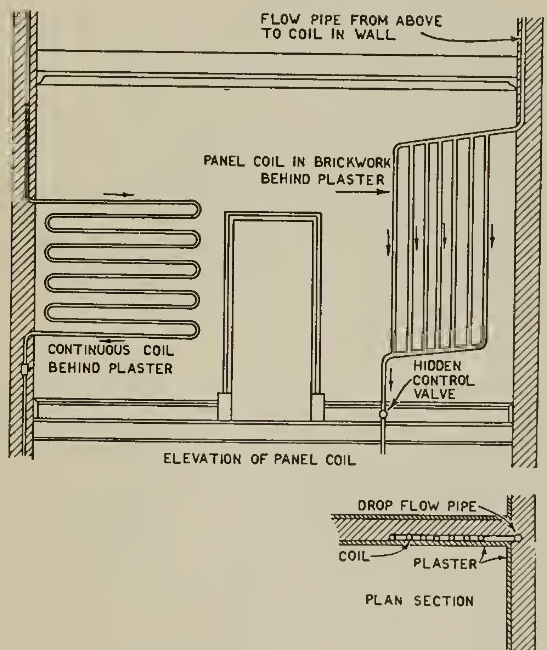


Fig. 7—Panel Heating Installation with Coils in Side Walls.

Panel Heating

Before leaving the subject of modern heating systems, a brief description of a system of heating now extensively used in England may be of interest. The system referred to is known as panel heating or low pressure radiant heating. This system is defined as a method of heating involving the installation of heating units within or at the surface of the walls, floors or ceilings so that the process of heating takes place most by radiation from the wall, floor or ceiling surfaces to persons and objects in the rooms. The heating surfaces or panels are either invisible or inconspicuous. The notable thing about radiant heating is that it raises the air temperature of the room much less than other methods of heating.

Heating systems in Canada are designed primarily to maintain a certain air temperature in the room. As a secondary effect the air temperature slowly raises the temperature of the wall and ceiling surfaces. Consequently, we have a high air temperature and a comparatively cool wall surface temperature. As a result, neglecting evaporation, most of the heat from our bodies is lost by radiation to the wall surfaces and only a small part of it is lost by convection.

With panel heating, on the other hand, the primary objective of the system is to maintain the proper amount of radiant heat and as a secondary effect, the air temperature slowly increases. It follows that with panel heating the air temperature is lower than with other methods of heating and consequently the heat loss from the building should be less with a resulting lower fuel consumption.

The purpose of heating is summed up by Mr. A. H. Barker, an eminent English heating authority, in a recent paper. Mr. Barker states, "The object of heating a building is not to heat the person in the building but to prevent him from losing his own heat too rapidly." In accordance with this theory, the panel and radiant types of heating systems are calculated to control the heat losses so that about the right proportions will be lost by radiation and by convection. These amounts have been calculated by a number of authorities. According to Rubner's figures, a normal human body at ordinary sedentary work, when maintained in a state of comfort, loses 425 B.t.u. per hour. Of this amount, the same authority estimates that 195 B.t.u. are lost by radiation, 138 by convection and about 92 by evaporation.

The method in which the principles of panel heating are carried out offers a wide scope for the ingenuity and judgment of the engineer designing the system. The heating panels are made up in a number of different ways. One method is the use of pipe coils made up of ½-inch or ¾-inch pipe on four- to six-inch centres. In some cases these pipe coils are embedded in the concrete of the ceilings or in the plaster surfaces of the walls. In either case the effect of the coils is to heat the whole of the plaster in contact with the pipe coils so that those surfaces act as radiating surfaces. (Fig. 7.) In the British Embassy at Washington, this method was used. Another method is to place the pipe coils on an insulating material on the rough concrete floor slabs and then to cover them with the finishing floor. The heating panels are also commonly made of cast iron plates which have flat front faces and shallow waterways cast in the back of them in which hot water or sub-atmospheric steam is circulated, or steel plates, with waterways welded to the back of them. In either case these panels are made in sections and are connected together by means of screwed nipples in the same way as ordinary radiation, so that the front is a continuous flat surface.

Wood or composition veneers may be applied over these flat surfaces so as to harmonize with the decoration of the rooms. In other cases the iron plates are cast with a slight grain on them so that when they are painted they resemble oak. Electrically heated panels are also being used extensively in England. Some of them are metal and others are pottery panels about 5/8 inch thick with graphite heating elements built into them.

While the heating panels can be placed in the ceilings, walls and floors, they are generally placed in the ceiling. The obvious disadvantage of placing them in the walls or floors is that their effect may be very seriously reduced by furniture placed against or over them. On the other hand when the panels are placed in the ceiling they do not counteract the down draught for large windows. When placed on the walls they are generally placed between the windows or as a dado around the walls. It is probable in a cold climate such as we have in Montreal, that it would be necessary to use a combination of warming panels placed in the ceiling either with the floor warmed slightly or with warming panels as a dado or between the windows.

The panel systems are controlled either manually or automatically by means of a radiation or comfort thermostat. Obviously an ordinary room thermostat would be of very little value for this purpose because it is affected by the air temperature only. The radiation or comfort thermostat is an ingenious device made in various forms. All of them consist of blackened copper spheres which are affected both by radiation and by convection in the same way as the human body. For example, the Morganite radiation thermostat consists of a blackened copper sphere mounted on a suitable base in which is concealed a cylinder attached to and connected with the inside of the sphere. The sphere and cylinder are partially filled with a volatile liquid. This cylinder has a heating element wire around it and a mechanism in it so that variations of pressure inside the sphere actuate an electrical switch. The electrical input to the heating element is continuous and constant. When the sphere gives off too much heat by radiation and by convection, the pressure in the sphere is at a minimum and the electrical switch turns the heat on to the panels.

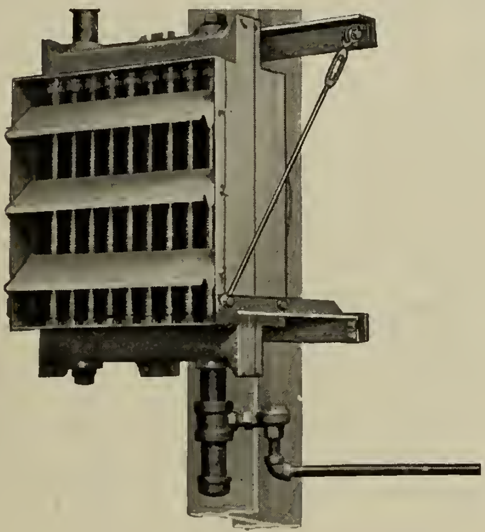


Fig. 8—Typical Unit Heater.

When the sphere gives off just the right amount of heat, the pressure in the sphere builds up and shuts off the heating current.

When controlling a panel heating system, it is necessary to control the temperature of the heating medium rather than to heat intermittently or to vary the quantity of steam admitted to the panels. Since these panels are generally as much as 12 feet long and only 18, 24 or 30 inches wide, one can readily see that if the quantity of steam is reduced materially part of the panel would give off high radiant heat, portions would not give any, and possible parts of it would actually absorb heat instead of emitting it.

While there are many panel heating installations in England, it is doubtful that they will ever be commonly used in Canada. Current engineering thought divides itself into two distinct schools upon this subject of radiant heating. In England its practical possibilities are being explored and studied whereas on this continent there seems to be a rather strong weight of favour behind heating which combines both convection and radiation principles. In England heating systems are designed to a base temperature of 30 degrees while in Montreal they must be designed to a base of −10 degrees F. This means that in Montreal the heating system must be capable of emitting just double the heat required for the same building in England. This would probably make the cost of the panel heating system prohibitive in Montreal.

Radiation

Having touched upon the major developments in complete heating systems, a few notes about the latest developments in radiators and other parts of heating systems are worth considering.

The cast iron radiator in its several forms is universally familiar. It gives off approximately 60 per cent of its heat by convection and 40 per cent by radiation. Along with pipe coil radiation used in industrial buildings, it was the sole standard type of radiation used prior to the introduction of unit heaters and concealed radiators. Its types, characteristics and capacities are so familiar as to call for no comment here.

Unit Heaters

During the last five years, unit heaters have been encroaching upon the cast iron and pipe coil market in industrial buildings. To-day they have almost entire command of the field. The unit heater radiator is usually made of copper tubes with fins or extended surfaces of copper to provide greater secondary heating surface. Aluminum and iron castings are also used both for the heat chamber and extended surfaces. The tubes may run horizontally or vertically into headers of cast iron, cast steel, bronze or aluminum. The heating medium may be either steam or water. Behind the radiator is a fan, now almost universally propelled by an electric motor, which drives a stream of air through the radiator and out into the space to be heated. The hot air delivery stream may be deflected or directed by louvres or ducts. On smaller units, fans are generally of the propeller type which characteristically deliver a large volume against low resistance with low power consumption. Larger units frequently employ multiblade type fans which will maintain a pressure head when either the inlet or outlet air stream is subjected to the resistance of ducts.

A number of reasons have accounted for the success of the unit heater. One has been the increasing percentage of glass in industrial wall and window construction which has increased heat requirements. In some factory buildings walls and even ceilings will be found literally 'plastered' with pipe coils to provide sufficient heating surface. Unit heaters, with something like twenty times the heat output per pound weight, have proven to be a solution to this problem of securing sufficient heat capacity in small space. Costs for installation are lower than for former types of radiators and lower operating costs reflect the better control of temperatures they afford. Thermostatic control of the fan operation gives an effective control over heat output. Air movement is also improved. Of note in this connection, unit heater fans are frequently operated in the summer time solely for the benefits of air movement. Cold water may also be run through the heaters to exert a cooling effect in hot weather.

Unit heaters placed as far apart as 400 feet in unpartitioned factory space have produced satisfactory heating conditions not by reason of the direction or velocity of the delivery air but by reason of the normal gravity displacement of air at different temperatures. Velocities sufficient to throw a stream of heated air 200 feet in a horizontal plane would give workmen the feeling that they were behind a propeller in the cockpit of an aeroplane.

By reference to this principle of gravity displacement and circulation, it will be seen that a large air volume through a heater is more efficient than a small volume. The greater the air volume, the lower will be the air temperature, the more moderate will be the tendency of the heated air to rise, the less will be the difference between ceiling and floor level temperatures and the greater will be the air movement throughout the space heated.

By reference to the same principle, it will be seen that the closer to the floor is the inlet duct of the heater, the more effectual will be the withdrawal of the colder strata of air from floor and knee levels and the more effective will be the cycle of gravity displacement which maintains the space at working temperatures.

Concealed Radiators

Concealed radiators are also encroaching upon the field of exposed cast iron radiation. From the point of view of comeliness, architectural fitness and adaptability, the advantages of concealed radiation cannot be gainsaid. Exposed radiators have been slenderized and camouflaged with grilles. They nevertheless occupy valuable space and add an obtrusive element to the design of interiors which in the past has been overlooked only because accepted as unavoidable.

A concealed radiator by means of its secondary or fin surface, can be given just as great heating surface and output as an exposed radiator of ten times its bulk. This can be demonstrated by actual tests of heat output using either hot water or steam in which the fall in water temperatures or the amount of condensation definitely determines the amount of heat given off by the radiator. This is the manner in which reputable manufacturers rate the capacities of concealed radiators.

A precaution seems necessary at this point. Research work recently conducted by Professor Allcut, of the University of Toronto, seems to indicate that there is a difference in the amount of heat given off by identical concealed radiators when fed by steam and hot water at identical temperatures. As between these two heating mediums at the same temperatures, the tests indicated a drop in output for hot water. No satisfactory explanation of this rather startling aberration or fact from supposition has yet been adduced but it is thought to reside in the disparate qualities of the two mediums. One practical conclusion, however, can be drawn. The rating of concealed radiators to be used on hot water installations should be based upon actual hot water test and not upon the interpolation or projection of rates established for steam. Practical experience also indicates that where concealed radiators are to be used with hot water, satisfactory heating results can be best assured by using comparatively high water temperatures in closed systems.

Some factors in design and some characteristics in operation of concealed radiation may be pertinent. Design should permit removal of the heating element through the inlet grille. Manufacturers may claim that their radiators, once in the wall, will outlast the building and in ninety-nine cases out of a hundred their claim will be substantiated. But the hundredth case may cause trouble and expense.

In radiators in which copper or aluminum fins are fitted on copper tubes, the joints should be soldered. No mechanical joint, however tight, is proof against oxidization, dust insulation and thus gradual reduction in heating efficiency of the secondary surfaces.

In operating characteristics the concealed radiator differs materially from the exposed radiator. First, the concealed radiator delivers, practically speaking, 100 per cent of its heat output by convection as against the approximately 60 to 70 per cent convection heating by the exposed radiator. Second, by reason of its comparatively small weight, the concealed radiator has only a fraction of the heat storage capacity of the cast iron type.

Concealed radiators as gravity convectors, circulate more air at lower temperatures than exposed radiators. As a result, ceiling temperatures are lower, heated air distribution is more generous, radiant heat, which is unpleasantly noticeable near an exposed radiator and imperceptible at a distance from it, is negligible and apparently the steam consumption is slightly less than for exposed direct radiation.

The second characteristic—the light weight and limited heat storage capacity of the radiator—has an important bearing upon the design of steam installations using this type of radiator. While an intermittent supply of steam will at no time produce ideal heating conditions, its ills are intensified by the use of concealed radiators. The cessation of air circulation follows more quickly after heat has been turned off.

The difference in heat storage capacity between concealed and exposed radiators presents another problem when it is proposed to use both types of radiation on one system. If steam circulation is to be continuous the problem disappears, but if circulation is to be intermittent the difficulty of maintaining temperature levels parallel in the sections heated by the different types of radiation is real if not insuperable.

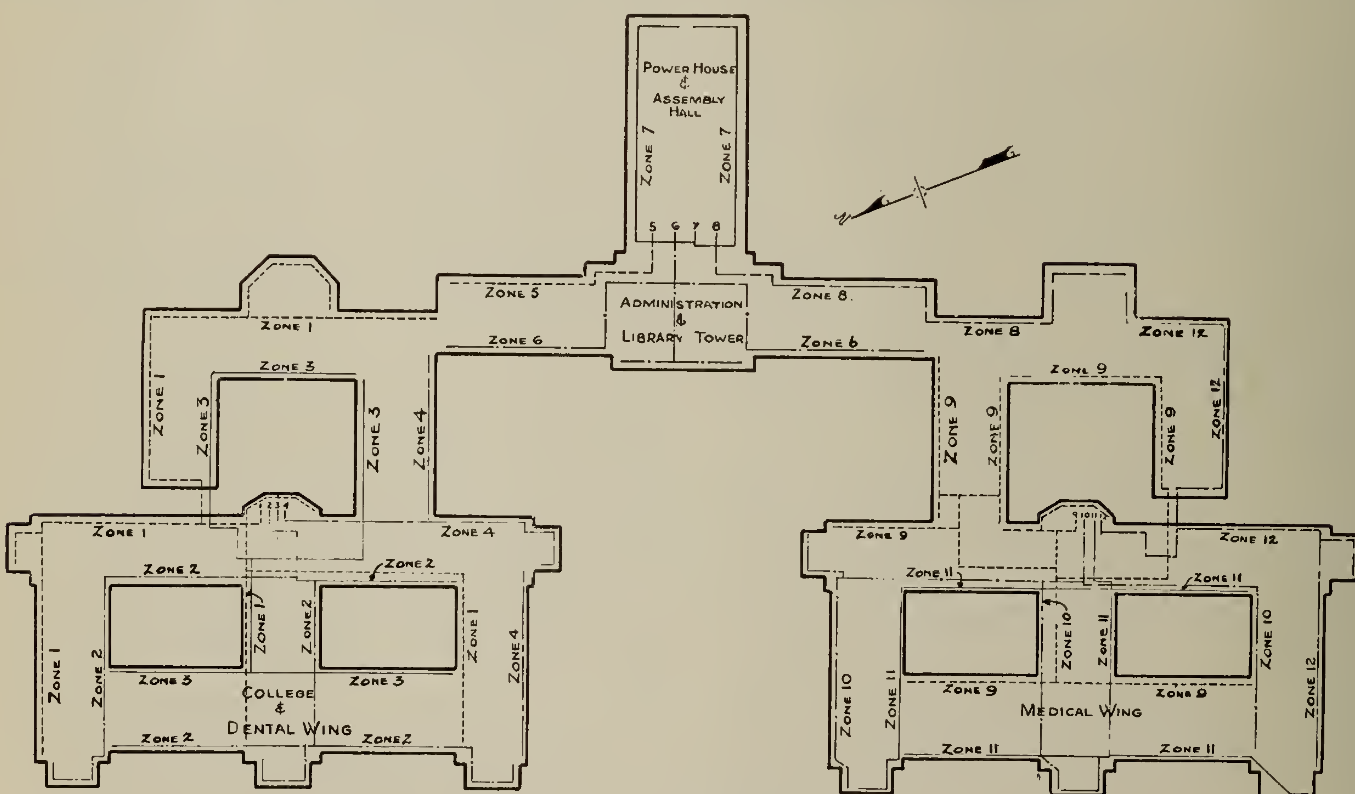


Fig. 9—Plan of University of Montreal Buildings Showing Zoning.

Humidifying Radiators

Humidifying radiators are a comparatively new development which are now being extensively used. These are usually cast iron radiators in which the sections are horizontal and so designed to hold a thin film of water on them. A small amount of water runs continuously onto the top section, the surplus spills over onto the next and so on until the last section is reached, from which the surplus runs to the drain. The radiator creates air currents which pass over the sections and absorb water vapour. The air is thus heated and humidified at the same time. The devices work extremely well and with their simplicity and their comparative low cost one or more of them should be used on all new heating systems.

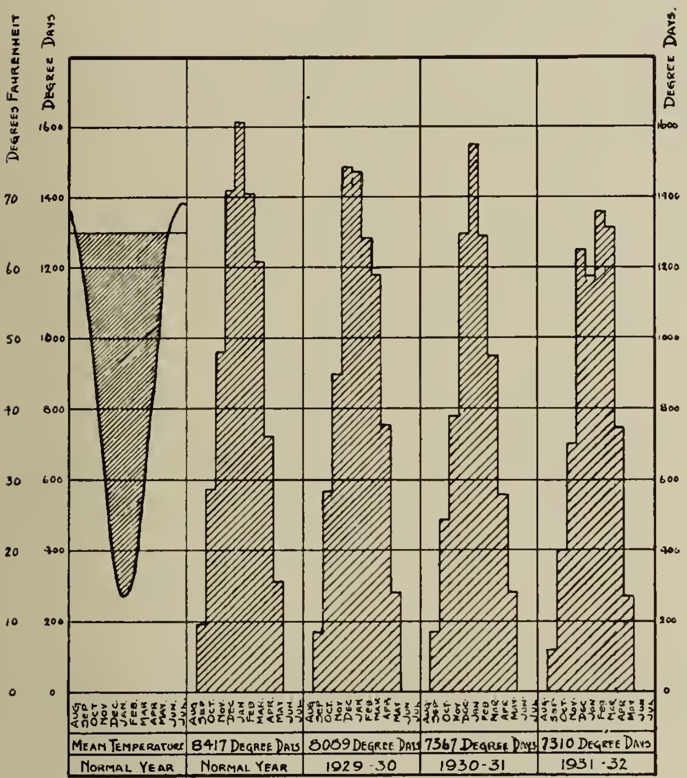


Fig. 10—Degree-Day Chart for Montreal.

Zoning

We have touched upon both system and control developments. One further element in present day heating design should not be overlooked. It is the dividing of the heating installation for a large building into several complete and separate systems.

Many large buildings house different types of services and different activities in various sections. Or it may be desired to supply heat for part of the time only to some sections. Zoning has been developed to meet these conditions. The heating installation in the University of Montreal, designed by Ernest Cormier, see Fig. 9, is a good illustration of zoning and of the factors involved in such a division of the heating installation. The university main building has twelve zones, each under separate automatic control and each capable of operation under steam pressure and temperature conditions quite unrelated to the other eleven zones. The arrangement of zones was based on exhaustive studies of wind direction and velocity, sun and light and the protection afforded some surfaces of the building by adjacent wings. For large buildings zoning affords a more precise regulation of section temperatures and thus greater fuel economy than can be secured with a one-zone installation.

Heating Costs

A great deal of work has been done during the last few years to standardize methods of computing heating costs. So many variables affect costs that the problem is a difficult one. Weather conditions, building construction, fuel and combustion efficiency, and control are variables.

Considerable success has attended efforts to standardize the degree-day method of computing and comparing costs. The degree-day is a unit measurement of heating requirements. As sponsored by the American Gas Association, a degree-day is the product of one day, times the number of degrees the average mean temperature outside is below 65 degrees F. Thus if the mean temperature on a given day were 64 degrees F. the demand for heat on that day would be stated as one degree-day. This unit was arrived at in the following way: It was found that when the mean daily temperature was 65 degrees F. the actual daytime temperature was approximately 70 degrees and no need for artificial heat normally existed. With a mean temperature below 65 degrees, however, some artificial heat was required, hence this arbitrary starting point for degree-day calculations.

Given the number of degree-days in a week, a month or a season, it is possible to reduce fuel or steam consumption to a basis upon which comparisons can be made between weeks, months, seasons or between buildings in different localities. The standardizing of this unit of demand is giving engineers a handy yardstick with which to measure and compare heating efficiency and economy.

The use of the degree-day as a basis of estimating fuel consumption is now quite general. It is used not only by the American Gas Association, but by the American Society of Heating and Ventilating Engineers, the National District Heating Association, the American Oil Burner Association, the National Electric Light Association, and by the National Association of Building Owners and Managers.

While the fuel consumption of a building varies not only with the temperature but with the wind and sun, apparently over a certain period these two factors appear to counteract each other so that the fuel consumption then is practically proportional to the degree-days.

The degree-day method of estimation when properly used is a relatively quick and simple method which results in approximations sufficiently close for most purposes.

The accompanying chart (Fig. 10) shows the monthly mean temperature and the degree-days for a normal year in Montreal, also the degree-days for the last three heating seasons.

In comparing the fuel consumption of different buildings it is general to do so in two or three different ways. The three most common units are used: (1) The fuel consumption per thousand cubic feet of gross building volume per degree-day. (2) The fuel consumption per thousand square feet of equivalent direct radiation per degree-day. (3) The fuel consumption per thousand square feet rentable area per degree-day. Others use the fuel consumption per thousand cubic feet of heated space or fuel consumption per thousand B.t.u. per hour heat loss calculated for 0 degree to 70 degrees.

In comparing the performance of a building one year with that of the same building another year, it does not matter on which basis the comparison is made, but in comparing the performance of one building with another, it is probably necessary to compare their fuel consumption in two or more different ways, because it is difficult to say which of the above units give the truest comparison.

In conclusion, the writer would point out that in such a paper as this it has been impossible to cover in any great detail the modern developments in heating practice, but an endeavour has been made to outline the principal or outstanding features.

Secondary Stresses in Bridge Trusses

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SUMMARY.—The author draws attention to the time required for the computation of secondary stresses in bridge trusses when ordinary methods are used, and describes a simplified or approximate method which will give reasonably accurate results with a small expenditure of time.

Most articles published in The Journal deal with complete projects of more or less imposing magnitude. This article is presented with the hope that it will interest the younger members of the profession, and, perhaps, induce them to reciprocate in the interchange of professional knowledge, which is a function of The Journal.

The design for the average small span highway bridge, as carried out in practice, does not usually include the determination of secondary stresses.

Most designers are guided by certain rules of proportion, such as limiting the depth of a member to one-tenth of its length. In following these rules, gained by experience in practice, the designer assumes that the secondary stresses will be within allowable limits.

The reason why these secondary stresses are so seldom determined appears to be the amount of time necessary for their computation by the commonly accepted slope deflection method.

The method described in this article can be run through in a few hours, and it would appear that a knowledge of the value of the secondary stresses is well worth the small amount of time expended.

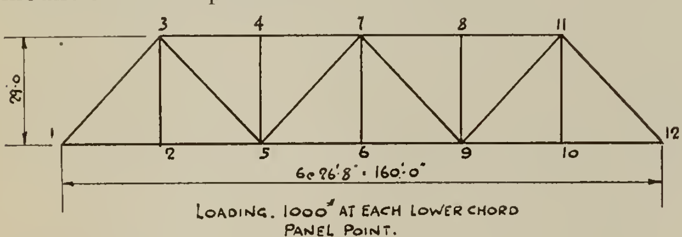

Fig. 1

1	2	3	4	5	6	7	8	9	10
MEMBER	L"	A□"	I ins⁴	K	S#/□"	S×L	ΔE	6I/L²	MF.
1·3	472·75	60·92	3612·5	7·6415	- 55·75	26380	162000	0·0969	+15700
3·4	320	56·94	3408·9	10·652	- 64·597	20650	96500	0·198	+19100
4·7	320	56·94	3408·9	10·652	- 64·597	20650	33900	0·198	+ 6710
1·2	320	36·64	2103·4	6·5732	+ 62·741	20100	146500	0·1232	+18070
2·5	320	36·64	2103·4	6·5732	+ 62·741	20100	78400	0·1232	+ 9660
5·6	320	63·2	3236·3	10·113	+ 65·473	20950	52000	0·1892	+ 9850
2·3	348	19·32	119·5	0·3434	+ 51·76	18000	82350	0·00592	+ 488
4·5	348	19·32	119·5	0·3434	0	0	41600	0·00592	+ 247
6·7	348	19·32	119·5	0·3434	+ 51·76	18000	0	0·00592	+ 0
3·5	472·75	33·72	235·34	0·4978	+ 60·431	28600	111,000	0·0063	+ 700
5·7	472·75	29·42	805·4	1·7036	- 23·088	10920	38400	0·0216	+ 830

Fig. 2

In the generally accepted method of computing secondary stresses in trusses, formulae for angular changes are determined, and related to reference angles, then a limitless number of linear equations are formulated, containing an equally limitless number of unknowns. Anyone who has attempted to solve these equations, and become immersed in a sea of figures—the significance of which it is difficult to keep in mind—will appreciate the simplicity of the method herein described. Only a knowledge of simple arithmetic is required for the running through of the calculation.

Briefly the method is as follows. Determine the relative position of the ends of each member of the truss for the loading under consideration. From these deflections compute the moments at the ends of each member, assuming the ends to be fixed.

The summation of the fixed end moments at any joint will not be zero.

These moments are now brought to a state of equilibrium throughout the truss by the extension of a method described by Professor Cross.* In his paper, the fixed end moments of a building frame, under unsymmetrical loading, are distributed, carried over and balanced by a series of successive approximations.

The direct application of this method is restricted to those cases where the joints do not translate during the process of moment distribution. It will be noted, however, that the fixed end moments in the truss are to be determined

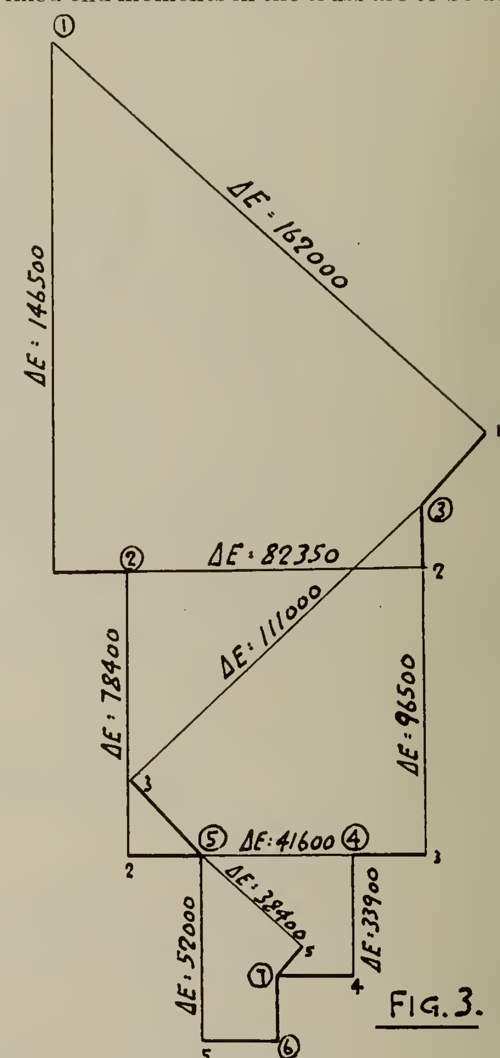

Fig. 3

from joint translations, and, as no additional translation of significant magnitude takes place during the balancing process, this method will apply.

In order to illustrate the application of this method, a truss of 160 feet span, with loads of 1,000 pounds at each lower chord panel joint, will be analyzed. A truss of these dimensions has been analyzed by W. S. Kinne, using the slope deflection method and a comparison of results can be made.

The procedure is as follows. After having calculated the strains in each member of the truss due to the loads

*Proceedings of the American Society of Civil Engineers, May, 1930.

under consideration, draw a Williot diagram as shown in Fig. 3.

In the case of unsymmetrical loading, the diagram would have to be drawn for the whole truss and in such a way that points one and twelve are at the same elevation.

The dimensions indicated by ΔE on Fig. 3 represent the displacement of one end of a member with respect to the other end, and are entered in column eight of Fig. 2.

In drawing the Williot diagram, the product of $S \times L$ instead of $S \times L \div E$ has been used to represent the strains, as E cancels out in a later stage of the calculations.

The general equation for the moment at the end A of a member AB subject to bending due to the displacement of the ends, is

$$M_{AB} = 2EK\,(2\,\theta_A + \theta_B - 3R)$$

For fixed ends there would be no rotation, therefore $\theta_A = 0$ and $\theta_B = 0$. The equation then becomes $M_F = -6EKR$. Where $R = \frac{\Delta}{L}$, L is the length of the member and Δ is the deflection of one end relative to the other. Also, K represents the stiffness of the member and is equal to $\frac{I}{L}$. Substitute in above equation

$$M_F = -\frac{6\,EI\Delta}{L^2}$$

M_F is the fixed end moment due to the displacement Δ. The minus sign indicates the direction of bending. Throughout the calculation a positive sign will indicate a clockwise moment and a negative sign an anti-clockwise moment.

Referring again to Fig. 2, values of $6\,I \div L^2$ are indicated in column nine. The product of the values in columns eight and nine will give the fixed end moments.

For fixed ends, and one end displaced relative to the other, the signs of the moments at opposite ends of a member will be the same. The moments, of course, will be equal.

For the balancing process a table as shown in Fig. 4 will greatly facilitate the calculation, and prevent any errors due to the omission of carrying over the induced moments. Also, any joint can be checked after each balance to see that the sum of the moments equals zero.

The fixed end moments with their proper signs are entered in Fig. 4, and the unbalanced moments at each joint written to the right. These unbalanced moments are now balanced by moments of opposite sign, distributed in proportion to the relative stiffness of the members of each joint. Visualizing this as a physical occurrence in the structure, each joint has been rotated till a state of equilibrium has been reached, each member of a joint having rotated through the same angle.

Due to this joint rotation, moments will have been induced at the opposite end of the connecting members. As the moment of inertia of each member is constant throughout its length, the magnitude of the moment induced will be plus one-half of the moment caused by rotation.

The induced moments are indicated opposite "carry over" in Fig. 4. These moments carried over are now balanced by moments of opposite sign, distributed in proportion to the relative stiffness of the members.

This carrying over and balancing process can be repeated as often as desired, until the required degree of accuracy has been obtained. The degree of accuracy can be estimated from the magnitude of the quantities being carried over.

JOINT	1			2				3					4			
MEMBER	1·3	1·2		2·1	2·3	2·5		3·1	3·2	3·5	3·4		4·3	4·5	4·7	
K	7·64	6·57		6·57	0·343	6·57		7·64	0·343	0·498	10·65		10·65	0·343	10·65	
PER CENT	53·7	46·3	UNBALANCED	48·73	2·54	48·73	UNBALANCED	40·0	1·8	2·6	55·6	UNBALANCED	49·21	1·58	49·21	UNBALANCED
FIXED MOMENT	+15700	+18070	+33770	+18070	+ 488	+ 9660	+28218	+15700	+ 488	+ 700	+19100	+35988	+19100	+ 747	+ 6710	+26057
BALANCING	-18130	-15640		-13750	- 718	-13750		-14395	- 648	- 935	-20010		-12822	- 413	-12822	
CARRY OVER	- 7197	- 6875	-14072	- 7820	- 324	- 3640	-11784	- 9065	- 359	- 276	- 6411	-16111	-10005	- 190	0	- 10195
BALANCING	+ 7550	+ 6522		+ 5742	+ 300	+ 5742		+ 6444	+ 290	+ 418	+ 8959		+ 5017	+ 161	+ 5017	
1ST Σ	- 2077	+ 2077		+ 2242	- 254	- 1988		- 1316	- 229	- 93	+ 1638		+ 1290	- 195	- 1095	
C.O.	+ 3222	+ 2871	+ 6093	+ 3261	+ 145	+ 1290	+ 4696	+ 3775	+ 150	+ 98	+ 2509	+6532	+ 4480	+ 67	0	+ 4547
B.	- 3272	- 2821		- 2288	- 120	- 2288		- 2613	- 118	- 170	- 3631		- 2238	- 71	- 2238	
2ND Σ	- 2127	+ 2127		+ 3215	- 229	- 2986		- 154	- 197	- 165	+ 516		+ 3532	- 199	- 3333	
C.O.	- 1306	- 1144	- 2450	- 1410	- 59	- 540	- 2009	- 1636	- 60	- 41	- 1119	- 2856	- 1815	- 28	0	- 1843
B.	+ 1318	+ 1132		+ 979	+ 51	+ 979		+ 1142	+ 51	+ 74	+ 1589		+ 907	+ 29	+ 907	
3RD Σ	- 2115	+ 2115		+ 2784	- 237	- 2547		- 648	- 206	- 132	+ 986		+ 2624	- 198	- 2426	
C.O.	+ 571	+ 490	+ 1061	+ 566	+ 26	+ 216	+ 808	+ 659	+ 26	+ 17	+ 454	+ 1156	+ 795	+ 12	+ 0	+ 807
B.	- 571	- 490		- 394	- 20	- 394		- 463	- 21	- 30	- 642		- 397	- 13	- 397	
4TH Σ	- 2115	+ 2115		+ 2956	- 231	- 2725		- 452	- 201	- 145	+ 798		+3072	- 199	- 2873	

JOINT	5						6				7					
MEMBER	5·2	5·3	5·4	5·7	5·6		6·5	6·7	6·9		7·6	7·5	7·4	7·8	7·9	
K	6·57	0·498	0·343	1·70	10·11		10·11	0·343	10·11		0·343	1·70	10·65	10·65	1·70	
PER CENT	34·2	2·59	1·78	8·84	52·59	UNBALANCED	49·165	1·67	49·165	UNBALANCED	1·37	6·78	42·535	42·535	6·78	UNBALANCED
FIXED MOMENT	+ 9660	+ 700	+ 247	+ 830	+ 9850	-21287	+ 9850	0	- 9850	0	0	+ 830	+ 6710	+ 6710	- 830	0
BALANCING	- 7280	- 552	- 379	- 1882	- 11194		0	0	0		0	0	0	0	0	
CARRY OVER	- 6875	- 467	- 206	0	0	- 7548	- 5597	0	+ 5597	0	0	- 941	- 6411	+ 6411	+ 941	0
BALANCING	+ 2580	+ 195	+ 134	+ 666	3973		0	0	0		0	0	0	0	0	
1ST Σ	- 1915	- 124	- 204	- 386	+ 2629		+ 4253	0	- 4253		0	- 111	+ 291	- 291	+ 111	0
C.O.	+ 2871	+ 209	+ 81	0	0	+ 3161	+ 1987	0	- 1987	0	0	+ 333	+ 2509	- 2509	- 333	0
B.	- 1081	- 82	- 56	- 279	- 1663		0	0			0	0	0	0	0	
2ND Σ	- 125	+ 3	- 179	- 665	+ 966		+ 6240	0	- 6240		0	+ 222	+ 2800	- 2800	- 222	
C.O.	- 1144	- 85	- 35	0	0	- 1264	- 831	0	+ 831	0	0	- 139	- 1119	+ 1119	+ 139	0
B	+ 432	+ 33	+ 23	+ 112	+ 664		0	0	0		0	0	0	0	0	
3RD Σ	- 837	- 49	- 191	- 553	+ 1630		+ 5409	0	- 5409		0	+ 83	+ 1681	- 1681	- 83	
C.O.	+ 490	+ 37	+ 15	0	0	+ 542	+ 332	0	- 332	0	0	+ 56	+ 454	- 454	- 56	0
B.	- 185	- 14	- 10	- 48	- 285		0	0	0		0	0	0	0	0	
4TH Σ	- 532	- 26	- 186	- 601	+ 1345		+ 5741	0	- 5741		0	+ 139	+ 2135	- 2135	- 139	

Fig. 4

In balancing joint number one, it will be noted that the unbalanced moment is distributed to members 1-3 and 1-2 only. This means in effect that the end bearing is of a type that allows for rotation.

Had the end bearing consisted of a wide shoe plate securely bolted to the abutment, the condition at joint number one would approach complete fixture. In this case the abutment could be considered as being of infinite stiffness. The unbalanced moments would then be distributed in their entirety to the abutment.

The magnitude of the resulting moments in members 1-3 and 1-2 clearly indicates the necessity of a hinge bearing at this point.

Fig. 4 shows the calculation carried out to the fourth summation, and the degree of accuracy obtained is probably sufficient to indicate the magnitude of the secondary stresses to be considered in designing the structure.

In order to compare results with those obtained by the slope deflection method, two further summations have been carried through, and the results are shown in Fig. 5.

A comparison of results will show that this simple method, involving no mathematics, gives reasonably accurate results obtained with a very small expenditure of time.

An extension of the method dealt with in this article, applied to the general problem of continuity would, perhaps, provide an interesting and profitable field for discussion.

Joint	Member	Moment After 6th Σ	$\frac{I}{C}$	Secondary Stress		$\frac{f_s}{f_p}$
				Approx. Method.	By W.S. Kinne	
1	1·3	−2115	436T	−4·86	−4·93	8·72
	1·2	+2115	196	+10·80	+10·99	17·21
2	2·1	+2911	196	+14·85	+15·21	23·65
	2·3	−232	19·3	−12·02	−12·15	23·2
	2·5	−2679	196	−13·67	−14·0	21·78
3	3·1	−502	281B	−1·79	−1·71	3·22
	3·2	−201	19·3	−10·42	−10·51	20·15
	3·5	−141	37·2	−3·80	−3·83	6·28
	3·4	+844	267B	−3·16	−3·09	4·9
4	4·3	+2931	407T	−7·18	−7·1	11·1
	4·5	−199	19·3	−10·31	−10·49	-
	4·7	−2732	407T	−6·70	−6·6	10·38
5	5·2	−654	196	−3·34	−3·37	5·32
	5·3	−31	37·2	−0·84	−0·85	1·39
	5·4	−188	19·3	−9·75	−9·96	-
	5·7	−590	107·5	−5·48	−5·45	23·75
	5·6	+1410	301	+4·68	+4·87	7·15
6	6·5	+5656	301	+18·82	+18·85	28·8
	6·7	0	19·3	0	0	-
7	7·6	0	19·3	0	0	-
	7·5	+725	107·5	+1·16	+1·15	5·02
	7·4	+2017	407T	−4·95	−5·07	7·67

Fig. 5

Future Mineral Development in Alberta

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Paper presented before the Calgary Branch of The Engineering Institute of Canada, February 11th, 1932.

SUMMARY.—After a brief historical sketch of the discovery of minerals in Alberta, the author points out that the mineral resources of that province are almost entirely non-metallic. He discusses past and present production and registers a warning against the misrepresentation and wrong information which have led in the past to such unsatisfactory results in the case of certain projects. The cost of development in mining is necessarily large, and errors in judgment have had serious financial results. Data are presented on the principal mineral products of Alberta and future possibilities with regard to their development.

A knowledge of the mineral resources of Alberta has been slowly acquired, and more slowly developed and there is yet much to find out.

In 1786 Edward Umfreville discovered coal on the North Saskatchewan river east of the Alberta boundary. This coal occurred as "float" in the gravel on the river bed, but this explorer records his belief in the mineral possibilities by his words: "I am of the opinion that abundance of this mineral must be in the country above us, as a person once brought me a piece he had taken from the earth, where it was piled up in heaps." He was also optimistic in the future mineral possibilities of what is now Alberta when he said: "What other treasures (than coal) may be concealed in the unknown repository, or what valuable ores may be intermixed with the coal, I will not take upon me to determine."

Alexander Mackenzie was the first to discover coal in place on August 2nd, 1789, in the banks of the lower Mackenzie river. He first saw smoke, then experienced "a very sulphurous smell, and at length discovered that the whole bank was on fire for a very considerable distance." In May 1793 he discovered coal on Peace river in the canyon. He writes: "Along the face of these precipices, there appears a stratum of bituminous substance which resembles coal; though while some of the pieces of it appeared to be excellent fuel others resisted, for a considerable time, the action of the fire and did not emit the least flame." This is the first mention of anthracite coal in western Canada.

Coal in the Drumheller district on Rosebud creek was discovered by Peter Fidler in 1791. David Thompson was the first explorer to record the occurrence of coal in the Edmonton district in 1800 and the Saunders creek coal was discovered by Alexander Henry, Jr. in 1810.

The occurrence of gold in Alberta was first recorded by Sir George Simpson 1841-42, when fourteen men remained at Fort Edmonton to wash gold from the North Saskatchewan river. This was the first gold rush in Alberta and there have been several since that date.

The first set back to the coal industry in Alberta was given by a member of Sir Sanford Fleming's party, on the Canadian Pacific Railway survey through the Yellowhead in 1872. After examining the coal at Edmonton the question was asked, "Is it coal or not." The dirty qualities of the coal were emphasized, and it was compared to Pictou coal which was said to yield "two tons of ash to one ton of coal." It is possible that had such an erroneous opinion not been so innocently expressed about this coal the eastern Canada market might have been secured in the seventies. The need for further research on the coal discovered was expressed by Sir Sanford Fleming as he says: "It is desirable that the whole truth should be known on the subject, for if there is an abundance of good coal, the point most important, next to the water supply on the plains, the future of our north-west will be decided in our favour." Although these remarks were made sixty years ago, the same remarks, are in a measure, being repeated even today.

About the same time coal was discovered in the Lethbridge district, and in 1880 George M. Dawson in the employ of the Geological Survey of Canada first describes the occurrence of coal in the Canmore-Bankhead district and in the Crows Nest pass.

Of the other mineral discoveries in Alberta the first well to encounter natural gas was drilled in the Medicine Hat district in 1885. The first oil well was drilled in the valley of Cameron creek north of Waterton lake by John Lineham in 1898.

The early history of the clay industry is not very clear. The industry would appear to be about thirty years old although the first production figures obtainable are in 1906.

This brief historical sketch is given to emphasize the fact that although the mineral industry in Alberta is comparatively youthful, yet the mineral possibilities in this part of Canada were realized almost a century and a half ago.

Past and Present Production

The mineral development in Alberta to date coupled with the geological knowledge that has been obtained, would indicate that Alberta is essentially a fuel province. Mineral production statistics show that 90 per cent of the value of minerals produced in Alberta has been derived from fuels, of which coal in value represents 80 per cent, natural gas 8 per cent and petroleum 2.6 per cent. Of the other minerals, clay products represent 3.3 per cent, cement 3.8 per cent, other structural materials, gold, salt and bituminous sand the remaining 2.3 per cent.

Since 1887, Alberta has produced minerals to the value of $524,827,603, which represents 0.9 per cent of the total mineral production in Canada for the same period. (Fig. 1.)

On the other hand in 1930 Alberta produced 11 per cent of the mineral value of Canada of which coal represents 34 per cent, natural gas 50 per cent and petroleum 95 per cent. In order of quantity Alberta produced 38 per cent of the coal, 70 per cent of the natural gas and 92 per cent of the petroleum in Canada in 1930. This indicates how important Alberta is or should be to Canada as a fuel province. If markets were available for the fuel products, Alberta with its present mining equipment could increase the coal output by 100 per cent, or with the available gas under control, could increase the present production by ten to fifteen times. With the utilization of the gas the petroleum production would be greatly increased, possibly trebled.

Alberta ranks fourth in Canada in the value of minerals produced, whereas the capital invested in coal mining, in petroleum and natural gas industries, and in the development of clay and structural materials, represents approximately 15 per cent of that invested in mining in Canada. In 1930 the total value of minerals produced in Alberta is made up of five mineral products as follows: coal, 57 per cent; petroleum, 16 per cent; natural gas, 16 per cent; clays, 4 per cent; and structural materials, 7 per cent.

With the exception of a few tons of bituminous sand, Alberta produces no non-metallic minerals. There are no metallic minerals produced in Alberta other than a few ounces of gold extracted from placers. On the other hand approximately 41 per cent of the value of fuels produced in Canada come from Alberta. (Fig. 2.)

Some Factors Influencing Future Development

Without assuming prophetic ability or instinct, the possibilities of increased mineral production will be considered and interpreted. It is not to be assumed that the solution in every case is easy or can be obtained immediately.

The future mineral development in Alberta will depend on a number of factors of which the following are important:

1. Raw material available as mineral deposits.
2. Capital necessary to develop the deposits.
3. Regulations that are fair and equitable to both investor and to the public.
4. Intelligent expenditure of capital on the exploration and development of the deposit.
5. Market facilities for the product mined.

If nature has not endowed the province with a particular mineral, or in deposits rich enough to be worked, then capital should not be wasted in this direction. To recover and frequently to locate workable deposits, the expenditure is great, and may exceed the revenue for some considerable time. Until a mineral industry is established, more capital will be put into the ground than will be recovered. This means that prospecting and exploration must be encouraged. In this respect it is necessary and important that all mineral development should be at least indirectly under government regulations, but those regulations must encourage capital to invest in the mineral development of the country, must give the investor a fair degree of protection and a fair "run for his money," but at the same time must protect the public or government interest in those resources which actually belong to the country and not to the investor.

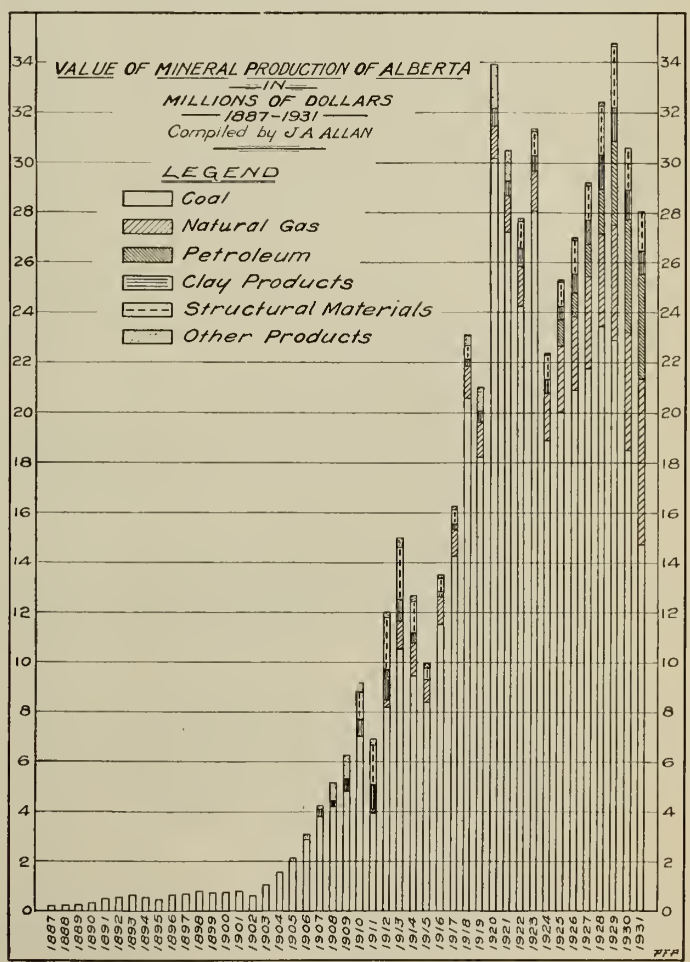

Fig. 1

Unfair regulations to the investor will without a doubt prevent available capital from exploring and developing the mineral wealth of a country, but it is vastly important that the interests of the people who own those resources should also be protected, in order that the mineral wealth of a country does not become dissipated. One should not be allowed to destroy his neighbour's property; on the other hand if one is only a tenant, as a mining company is, one should not be allowed to destroy the property of which one is temporarily in possession.

It is necessary that there should be fair play and justice to both parties, to the party who is risking the capital on the mineral development, and to the party who is desirous of having its mineral resources developed. Probably this idea is Utopian, but history and experience have been responsible for this attitude of mind.

An intelligent expenditure of money on the development of any mineral resource is an important factor on the future of the mining industry. There has been altogether too much camouflage mining in the past. Too much money has been spent on mining ventures where even a small amount of engineering intelligence would have avoided or at least advised against the expenditure. There is romance in mining. A new discovery, or reported indications of mineral, will always create interest, and capital can always be found to explore the venture. The more distant the field, the greater the lure, regardless of the outcome of the venture. The opportunities may be better near home, in most accessible territory and yet the attraction is not as great. The greater the gamble on the mineral possibilities, the easier it is to get financial assistance. This condition applies equally to the earlier, or exploratory stages, in the development as to the production stages.

Misinformation, unduly exaggerated statements frequently by unqualified parties, have done more to retard mineral development than the lack of mineral substance. Many mining ventures have been commenced, even in Alberta, which were doomed to failure before starting. Failure to succeed in one or more ventures makes it more difficult to secure capital for projects where there is a chance of success. External capital naturally becomes wary of returning to a province where they have previously drawn a "dud." It can be repeated without fear of contradiction that in many cases expenditures have been made with outside capital on mining projects in Alberta where the chances of success were nil, even before the expenditure was made.

Another important factor in the mineral development in any country is market facilities of the mineral products. Geography, local competition, mining considerations, cost of recovery of mineral product, are all factors that enter into the success or failure of the project. Some of these factors can and should be foreseen before the expenditure is incurred. In other cases conditions detrimental to development arise after mineral production has started, or after the outlay is so large that it is cheaper to continue the project than to withdraw or quit development with reduced returns, or with the hope of overcoming the difficulty.

In Alberta instances might be cited where mines have been opened up, wells have been drilled, clay deposits have been worked, for a time, then due to financial difficulties, or excessive transportation charges, or various other reasons, the project has been dropped, causing another blow to the mining development of the country. This does not mean that the mineral does not occur or that future mineral possibilities are non-existent.

In a time such as this a pessimistic attitude is apt to be taken. The author has always had faith in Alberta and in its mineral possibilities. There are many mineral products that do not exist in that province, but there are others that do occur in large quantities, and it is intended to use every effort to encourage successful development of those mineral resources. There are and will be temporary set backs, but from a geologist's point of view they are only temporary. The mineral resources in the province are not going to be depleted during the lifetime of the present

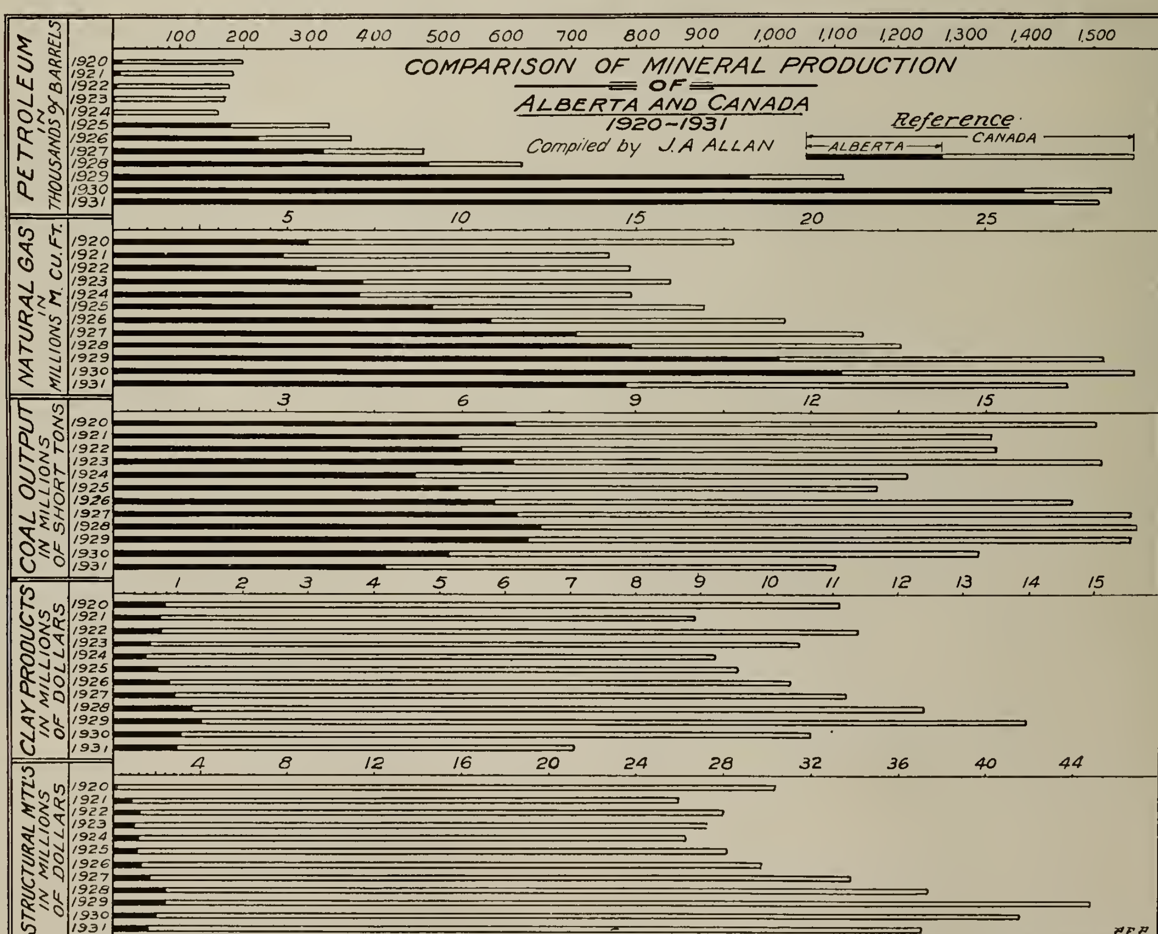

Fig. 2

generation, though in some cases one is forced to think that endeavours are made to use up resources as rapidly as possible regardless of economy in mining or marketing the product.

Possibilities of Future Mineral Development

Iron — It is generally conceded that nations are ranked according to certain mineral standards. Out of a very long list of minerals that enter into commerce there are certain minerals which are essential to large industrial developments, or to the maintenance of agriculture.

The minerals of prime importance in the ranking of nations are iron ore and mineral fuels. One reliable authority (C. K. Leith) has stated that "The industrial position of a nation may be very well gauged by its consumption of power, which in turn is a function of the use of machines and fuels. Consequently it is hard to overemphasize the importance of iron products out of which machines are made, and of the mineral fuels which propel them." Statistics show that in 1930 the value of world's pig iron production was over three times that of gold and the value of mineral fuels was nearly fifteen times as great as that of gold. The value of gold in 1930 was $405,000,000 approximately.

Alberta is essentially a mineral fuel province with large reserves of coal, estimated at over sixty billion tons, natural gas, and petroleum.

The importance of iron to a province such as Alberta, so richly endowed with coal and natural gas wealth, needs no argument, but if commercial deposits of iron do not occur in Alberta, the geologist should not be blamed for not finding such deposits. Optimistic press statements, glowing reports by uninformed, irresponsible people of elaborately designed prospectuses, no matter how oft repeated, are not going to place the mineral wealth in the ground if it is not there previously. This is one of the most vital reasons why the development of those minerals present in Alberta are not more advanced today and on a more remunerative basis. There are other reasons too, but outside capital is required to develop the mineral wealth of Alberta. Mining ventures have so often failed largely on account of misinformation that it is becoming more difficult to interest capital in mineral development. These derelicts of misinformed directors are common in Alberta. Here a coal mine has been opened at great expense where the quantity of minable coal was negligible, or a cement plant has been erected to find that the raw material would not make cement, or a brick plant has been started to find that the material was sand instead of clay, or coke ovens were built to find that the coal would not coke, or a smelter was constructed at great expense to find that there was no ore to smelt, or a well has been drilled 5,000 feet to find that it would be necessary to go 12,000 feet or deeper to encounter the productive horizons, and so on. But none of these expenses have been incurred on the advice of competent scientific or technical men.

The Alberta Geological Survey was started on a search for iron within that province. A report that received undue publicity in 1919 stated that on Sheep river west of Okotoks and Turner valley, "this property possesses two veins of clay iron-stone, one of which measures approximately 400 feet across, aggregating a width of 100 feet of vein." An estimate of the ore available according to this report was 2,400,000,000 tons of iron ore. The report was backed up with a single analysis in which the metallic iron content was only 29.9 per cent. The report further stated that if this ore were mined at the rate of only 10,000 tons per day, mining operations could continue for 766 years on this property.

This property was examined and it was found that the iron content of these ordinary shales was between 4 and 5 per cent metallic iron.

The report on this concluded by stating, "Instead of there being billions of tons of iron ore in this locality, there is not a single ton of rock exposed in this section which would be classed as iron ore."*

In spite of this report one of the largest iron interests in the United States was enticed to investigate this property on the optimistic report referred to.

A few years later a company was organized by some Albertans in Chicago, to mine and smelt iron ore from Athabaska lake. Fortunately for Alberta, before the smelter was erected or the machinery shipped, the author and Dr. A. E. Cameron were instructed to investigate the deposit. Small lenses of iron ore carrying a maximum of 16 per cent metallic iron were found, but it was also discovered that glacial boulders stained on the outside with iron oxide were taken to represent part of the deposit. "The percentage of metallic iron in the average samples ranged from 4.22 to 34.02 per cent, and in the specimens, from 6.86 to 38.22 per cent. With the exception of the carbonate rocks, the other analyses show that the rocks are highly siliceous quartz-rich rocks low in iron content. The term iron ore cannot be applied to any of these rocks, according to the generally accepted definition of ore. There is no commercial deposit of iron ore exposed around Fishhook bay, and, furthermore, the surface exposures do not indicate that enrichment can be expected at depth which would produce an economic deposit of iron. The long distances separating these possible ores from the necessary fuel and other materials incur high transportation charges—and the possible market for pig iron and steel products produced from Lake Athabaska ores is limited. These factors prohibit for the present the commercial development of any iron ore deposits which might be found about Lake Athabaska."

Another company was organized and full page advertisements were run in the local press and elsewhere showing smelters and steel works from which emitted heavy black clouds of smoke encircling the Parliament buildings and obliterating the visibility of the university. This corporation intended to obtain the bulk of their ore from Athabaska landing. On investigation it was found that the deposits consisted of small quantities of ochre and ochre-rich soil derived from iron springs, but the entire deposit could have been removed with a wheelbarrow within a week and without having to work overtime.

Space does not permit to relate other instances of endeavours made to start industries in Alberta without available raw material and where the author had the unpleasant duty of reporting the actual facts and thereby contradicting unreliable statements and reports.

Since 1910 the occurrence of iron in the vicinity of Burmis, Alberta, has been known. Like the measles there has been a recurrence of interest in the possible utilization of this iron ore. As part of a field programme during the past summer, an investigation was conducted of the occurrence, the extent and the quality of the Burmis iron deposits.

Burmis station is on the Crows Nest branch of the Canadian Pacific Railway 18 miles west of Pincher, 9 miles east of Blairmore and 6 miles east of Hillcrest and Bellevue where the coal mines are situated.

The Burmis district is within the foothills belt which is here characterized by a series of sub-parallel ridges with a general north-south trend. Burmis station has an elevation of 4,000 feet above sea level and these ridges rise about 1,000 feet above the intervening valleys.

The iron-bearing rocks examined outcrop at several places in these ridges north of the railway. The most southerly outcrops occur about half a mile north of Burmis station and a few hundred yards north of the highway.

*Rept. No. 1, Research Council of Alberta, 1920, p. 66.

The most northerly outcrops examined occur about 10 miles north of Burmis station.

The area examined included about 1,920 acres, and this is most of the iron-rich rock exposed. The iron occurs with the sandstone toward the base of the Belly river formation. The thickest bed is about 15 feet, but in other places is only two or three feet thick.

The ore is a siliceous titaniferous magnetite. The iron, chiefly magnetite, occurs as one of the mineral constituents of the sandstone.

Analyses of twenty samples show that the iron content ranges from 14.7 per cent to 54.8 per cent metallic iron. At the same time the silica content ranges from 4.8 per cent to 45.2 per cent. This iron-bearing rock is all titaniferous with the titanium oxide ranging from 4.6 per cent to 12.0 per cent. The presence of titanium is detrimental to the utilization of the ore unless it can be separated from the iron. Tests are now being made to determine the form in which the titanium occurs. This deposit has been formed as a beach sand and on this account the quantity is small.

This deposit can not be considered a commercial source of iron. The Burmis deposit was the only possible iron deposit in Alberta, but it is now known to be too small to be worked.

There is a small ochre deposit close to the Banff-Windemere highway, in British Columbia near the Alberta boundary. This ochre has been used successfully in Calgary, by the Rocky Mountain Paint Company. There are many other small ochre deposits in Alberta that could be used in the paint industry but not as a source of iron. Quite a large ochre deposit occurs north of Peace river at Hudson Hope, but this is removed from present lines of transportation.

It is with regret that it must be recorded that Alberta does not contain commercial deposits of iron ore, but the geologist can not be blamed for the non-existence of iron ore deposits in Alberta.

Coal — Alberta is referred to as the "Fuel Province" of Canada. Ninety per cent of the total mineral value in Alberta has been derived from the sale of fuels, of which 80 per cent represents the value of coal produced. In 1930 Alberta produced 38 per cent of the coal mined in Canada.

In the last two years there has been a decrease of about $8,000,000 in the value of coal produced in Alberta. This is serious, but only temporary. This decrease is due to various causes, including competition from natural gas as fuel from transportation costs and from coal and coke imported into Canada. In 1930 Canada produced 14,878,728 tons of coal and imported 17,620,074 tons of coal and 2,489,352 tons of coke.

Alberta is in the fortunate position of having very large reserves of coal. A few years ago a careful estimate was made of the actual available reserves in coal beds that are known to exist, and the reserve is over 61 billion tons, of which 59 per cent is bituminous, 23 per cent is sub-bituminous, and 18 per cent lignite. It is known that there is a larger coal reserve under Alberta than the above figure, but it is not considered available for immediate development. Considering all classes of coals, even that which is not of commercial consideration at the present time, the estimate amounts to over 327 billion tons, of which 12 per cent is bituminous, 16 per cent is sub-bituminous and 72 per cent is lignite.

There are two hundred and forty-six coal mines in operation, but of these twenty-four are producing 73 per cent of the coal mined, fifty-eight mines produce 26 per cent, and only one per cent of the coal produced in Alberta comes from the remaining one hundred and sixty-four mines. A considerably larger output of coal could be produced with the present mining equipment if a larger market was available. The quality of the coal available ranges from lignite to high grade bituminous, so that there is coal available for every fuel purpose.

Disease has become established in the coal industry, but these ailments can and will be remedied. Alberta has the coal in reserve and Canada needs the coal. Alberta has too many mines. Government regulations now prevent the opening of new mines. Many of the present mines will have to be closed, or consolidated operations established. Lower mining costs, and increased efficiency in mining will bring larger markets. Conservation is not a popular word these days, but the wastage in some coal mines today is regarded as excessive. New uses and improved treatment of coal will enhance the value of the mineral product.

Recent investigations carried out by Dr. E. H. Boomer on the hydrogenation of coals from southern Alberta, show that an oil yield of 70 per cent has been obtained.

Petroleum — Alberta to date has produced $17,500,000 worth of petroleum representing about 4,500,000 barrels or a line of barrels end to end extending from Calgary to Halifax. This indicates the progress made by the industry in about seven years. The history of petroleum development in Alberta is too well known to repeat here. In 1930 over 53 miles of drilling was accomplished, which indicates the activity in exploration, but it does not indicate the number of oil wells obtained. Although drilling has been going on since 1910 with varying degrees of activity, and continously since 1924, yet it is estimated that not over 5 per cent of the possible oil territory in Alberta has been proved or tested thoroughly. Unfinished wells, or one or more wells in a district, although requiring months to drill and an expenditure of hundreds of thousands of dollars, do not indicate that those areas have been proved.

It has been proved definitely, that oil occurs in Alberta, with a wide range in composition. Development to date has not proved the possibilities in Alberta. The author does not wish to be misunderstood when he states that the small area represented by Turner valley, although bringing much wealth to Alberta, has distracted attention from other possible areas in Alberta both in the plains and within the foothills. The highest commendation must be extended to all the various oil companies who have expended freely in a conscientious search for petroleum reservoirs.

The investment in the industry to date is no criterion of the future investment. Past experience, the knowledge of drilling difficulties, and the knowledge of certain structural conditions should reduce the cost of petroleum exploration in the future. Under most favourable conditions it is a fact that the cost of exploration in the field of petroleum must remain high.

This is all the more reason why every possible consideration must be given to the companies, both small and large, that are prepared to carry on petroleum exploration. Inducement should be given to capital expended within the province either by the individual or by the large corporation in the search for oil, but not for the promotion of oil companies that are not sincere in their endeavour to find oil. The prospects are bright for the increased production of oil when the financial market approaches normality again and if this industry does not advance it will not be due to the lack of petroleum within Alberta.

Natural Gas — The recorded sale of natural gas within Alberta since 1898 amounts to a total of $46,320,000. It is unnecessary to discuss the available gas supply today, but it is of some interest to note that the natural gas marketed has been derived from less than 50 square miles of Alberta. This is no criterion for advocating unnecessary wastage. The gas reserves are limited. There are many known gas fields today but their geographical distribution is a factor against immediate utilization. Markets for natural gas will be supplied in the future and other uses, possibly more remunerative than the present, will be found. There are no doubt latent uses for natural gas that no one has yet contemplated. Natural gas is an important asset to Alberta, and the industry must and will progress.

Clay Products — The clay products industry since 1906 represents $18,000,000 of materials produced or only 3.3 per cent of the total produced mineral value in Alberta. Only a very small part of this came from Alberta clays, because much of the clay used today is imported from Saskatchewan and manufactured in Medicine Hat where there is cheap gas.

The clay resources so far as known are extensive and varied. Although high grade kaolinitic clays in Alberta are unknown, yet, brick and pottery clays are available. There are clays for new and small industries; of these one might mention beauty clays, medicinal clays, fullers earth, talcum powder, and cleansing powder from volcanic ash. In the McMurray district there are clays suitable for the manufacture of insulators.

Structural Materials — The structural materials include cement, lime, sand, gravel and building stone. Alberta has produced about $32,000,000 of these products, of which cement accounts for two-thirds. These resources are extensive and opportunities for development will come. An excellent building stone has been examined and tested last summer from Cochrane. This has been opened in the Oliver quarry. Moulding sands are abundant and are replacing imported sands. Investigation should outline the occurrence of glass sands, grindstones and whetstones.

Bituminous Sands — The extent, quality, and characteristics of the McMurray bituminous sands are known and are measured in cubic miles. It is only a question of treatment. A successful separation process has been obtained, and the investigations being carried out by Dr. K. A. Clark and Dr. D. S. Pasternack indicate that products more valuable than petroleum may be anticipated from these deposits. Dr. Boomer has also determined that by hydrogenation, at least 75 per cent of the bitumen in these sands can be reduced to gasoline and light oils, 10 per cent to gas and 15 per cent to stable asphalts. These researches indicate large possibilities in the bituminous sand deposits.

Salt — The most promising latent industry in Alberta today is the salt industry. Canada is today manufacturing about 278,000 tons per year and importing over 128,000 tons per year. Much of this output should be produced in Canada.

There are important salt deposits at McMurray awaiting development. These salt beds occur at 600 to 650 feet in depth, but are quite pure. A plant has been erected and produced about 32,000 tons; it was then abandoned because the location was not economical. There are deposits of salt from springs at the north boundary of Alberta, 25 miles west of Fitzgerald.

Gypsum — One of the most important undeveloped minerals in Alberta is gypsum. Canada is the largest producer of gypsum in the British Empire, and third in the world. Production in Canada is from five provinces as follows:—

Nova Scotia...........	78 per cent
Ontario...............	7 per cent
New Brunswick.......	7 per cent
Manitoba.............	3 per cent
British Columbia	3 per cent

There are three extensive deposits known in Alberta. The largest of these outcrops along the sides of Peace River valley below Fort Vermilion and about five miles below Peace Point for a distance of 15 miles. Dr. A. E. Cameron estimates the deposit as over one billion tons, in beds up to 50 feet in thickness. Geography is against the immediate use of the deposit, but it must be considered a potential mineral asset.

Last summer the author examined another large deposit of gypsum at the north boundary of Jasper Park and about 35 miles north of the railway. Pockets of gypsum analyzed 100 per cent pure gypsum.

A third deposit of gypsum and anhydrite is associated with the salt beds at McMurray. Other mineral deposits of possible future value include: alum on Smoky river, sodium sulphate at the east boundary of Alberta and phosphate rock at several points within the Rocky Mountains.

Metallic Deposits — Iron has been referred to particularly and it has been indicated that extensive deposits need not be expected to occur in Alberta.

Gold is the only metallic mineral in Alberta that requires consideration. Gold occurs in the gravels in certain rivers as placer gold. This is not local, as it has been carried by glaciers and rivers from the Gold ranges in the interior of British Columbia. There is no gold in the Rocky mountains, so that no gold can be derived from that source.

An occasional flake of gold might be found in any gravel deposit in Alberta but no quantity of gold can be

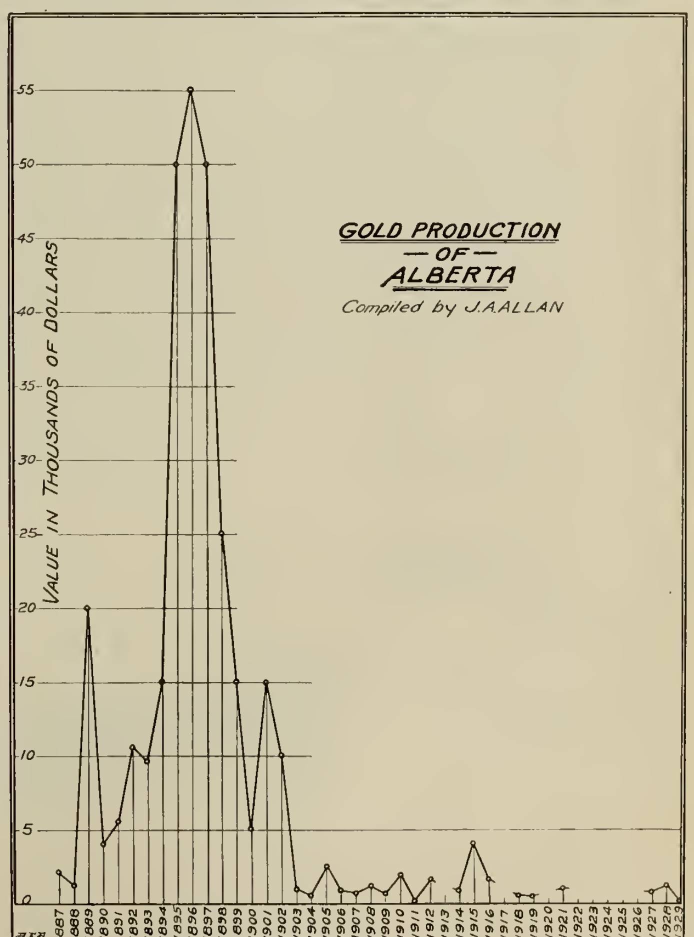

Fig. 3

expected south of the North Saskatchewan river. On this river placer gold occurs from about Fort Saskatchewan to a point about 50 miles upstream from Edmonton. It also occurs on McLeod river, where the McLeod River Mining Company is erecting a dredge and will be operating this spring. There is a little gold on the Athabaska and also on the Peace west of the town of Peace River.

Alberta has produced about $315,000 worth of gold and most of this came from the North Saskatchewan in the vicinity of Edmonton. (Fig. 3.) The gold is of the flour variety. The gold at Edmonton runs about three hundred and fifty colours to the value of one cent. There is very little platinum with the gold in the North Saskatchewan river, but more on the McLeod river, where the gravels are reported to carry a gold value of about 17 cents per cubic yard. Last summer there were scores of men washing gold on the Saskatchewan including a number of students but no one has been heard of who made over $2.00 per day; however their methods were very crude, as the gold pan and the rocker were most generally used.

According to statistics the gold recovered from the North Saskatchewan river in 1895-96 and 97 amounted to $50,000, $55,000 and $50,000 respectively. There is just as much gold in this river today as there was in 1896 and during these slack times there is an opportunity of increasing the gold production to the amount produced in 1896 or even considerably higher.

There have been various gold and platinum excitements in Alberta but as the gold was not there, the results were only what could be expected.

In the north-eastern corner of Alberta, north of Lake Athabaska, there are about 10,000 square miles of Precambrian rocks. Field explorations in this area have not yet discovered mineral deposits of commercial importance. The feverish interest and increased enthusiasm in the northland, as a result of the discoveries of very rich silver and pitchblende (radium) ores at the east end of Great Bear lake, should encourage further prospecting on all Precambrian rock areas in the north including those in Alberta.

Dredging the St. Mary's River

Owen M. Frederick,
Engineer, United States Engineer Office, Sault Ste. Marie, Mich.

Paper presented before the Sault Ste. Marie Branch of The Engineering Institute of Canada, September 25th, 1931.

SUMMARY.—The author gives a brief description of the work done by the United States government on the 60 miles of the St. Mary's river between Sault Ste. Marie and Lake Huron, through which channel over 80,000,000 tons of cargo have passed in one year. Work is being carried on which will give a 24-foot channel, and the methods adopted in laying out the work and letting contracts for United States government work are given, together with information as to the actual costs of the contracts let.

The St. Mary's river is the connecting link between Lake Superior and Lake Huron, the two largest of the Great Lakes. About 10 miles from its source at the easterly end of Lake Superior it is obstructed by the famous St. Mary's Falls, where the level of water drops about 20 feet in a distance of about one and one-half miles. Below the falls the river flows smoothly for 50 miles to its mouth at the westerly end of Lake Huron.

At St. Mary's Falls are the cities of Sault Ste. Marie, Ontario, and Sault Ste. Marie, Michigan. Ships pass these falls through one canal and one lock on the Canadian side and through two canals and four locks on the American side.

For purposes of navigation the first 25 miles of river below the falls is divided into three separate channels. The north channel was the original natural channel and was improved and used for all major navigation until 1894, when the Middle Neebish channel was opened to two-way vessel traffic. This new channel provided greater depth and shortened the haul by 14 miles. In the year 1908 the West Neebish channel was opened and this third channel permitted the separation of upbound and downbound traffic over a distance of about 16 miles and materially aided in the safe and expeditious passage of large numbers of vessels. Of the 60 miles of river about 35 miles have been improved to enable ships, continuously increasing in size and numbers, to move a constantly mounting tonnage of freight between the ports of the Great Lakes.

Fig. 1—St. Mary's River.

Beginning in the year 1855 and extending over a period of seventy-three years to 1928, the United States has spent about $27,000,000 on the improvement of the St. Mary's river. Of this sum about $15,000,000 has been used for construction of locks and canals at St. Mary's Falls and about $13,000,000 for improvement of navigation channels through the 60-mile length of the river.

The result of this expenditure has been the development of a water system of transportation the like of which does not elsewhere exist. Channel depths in the river, which in 1855 were less than 12 feet in many localities, have been increased to a uniform least depth of 21 feet. Channel widths have been established to provide a minimum of 300 feet for one way traffic. And bounding these channels is a system of aids to navigation which reduces hazards to a minimum.

In 1928 a total of 679 commissioned vessels traversed the river. In 1855, 14,503 tons of freight were transported, which, increasing at an average rate of about 1,250,000 tons per year, reached the enormous total of 87,000,000 tons in 1928. In 1887 the cost of freight per ton mile was 2.3 mils. This cost steadily declined until 1914, when it reached a low point of 0.60 mils and in 1928 was still low at 1.16 mils.

Not only does the propaganda for improved channels continue, but the economic necessity for them also continues. Further improvement of St. Mary's river was considered wise in 1925 and resulted in the authority to widen the upbound route around Neebish Island from a 300- to a 500-foot width. Estimated to cost $4,000,000, it was believed that this Middle Neebish channel would always be used as an upbound one-way channel; at a 500-foot width it could be used for two-way traffic if the West Neebish or downbound channel was blocked; and it would provide a two-way channel if and when the downbound channel was improved.

Almost before this work was begun, the Corps of Engineers, United States Army, was investigating the need for deeper channels throughout the Great Lakes system. The result of this survey was a report submitted in 1928

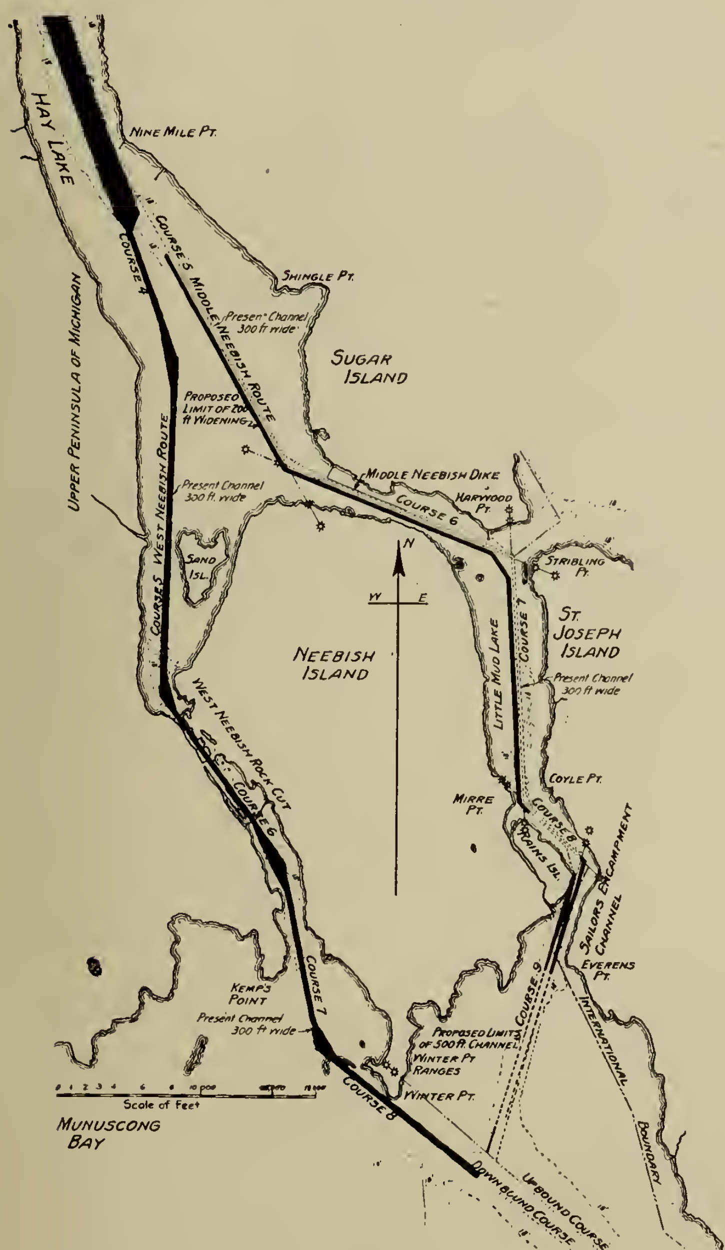

Fig. 2—Proposed Widening of Middle Neebish Route.

recommending the deepening of all downbound channels to provide for 24-foot navigation. Estimating the cost of deepening from the head of St. Mary's river to the foot of the Detroit river at $28,000,000, it was believed that it would permit the full use of the two newest locks at St. Mary's Falls and the new Canadian Welland canal; would be a logical beginning of a possible future lakes to ocean project; and would effect an economic saving of $2,800,000 per year—thus amortizing the total cost in a period of ten years.

The initiation of actual work under a project of this sort consists of the following items:

1. Hydrographic surveys to measure the work.
2. Specifications and drawings to govern the work.
3. Cost estimate to determine a fair price.
4. Competitive bidding to obtain the best price.

The hydrographic surveys consist of soundings, probings and computation of quantities. Soundings are usually made in the winter through the ice. They are

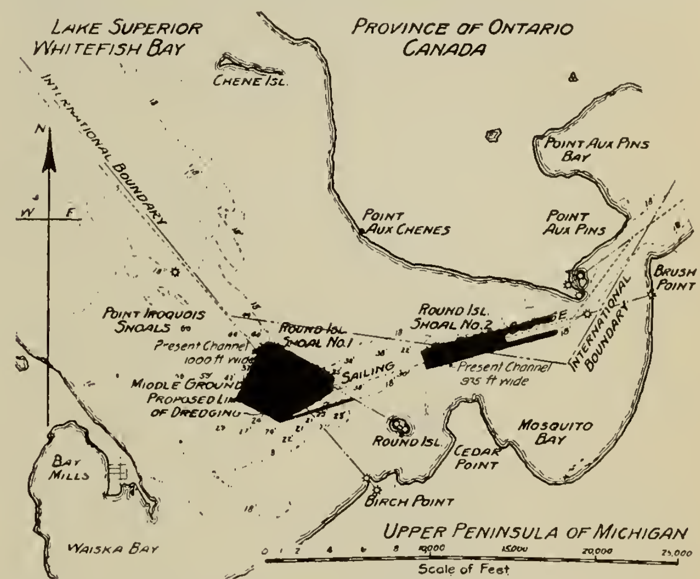

Fig. 3—Proposed Dredging at Round Island Middle Ground.

spaced 10 feet apart across the channel and at longitudinal intervals of 20 feet in hard material, and of 50 feet in soft material. During the winter of 1930-31, 300,000 of these soundings were made at a cost of 5⅓ cents each.

Probings to determine the character of the river bottom are also made in the winter through the ice. In hard material these are spaced as low as 20 feet by 50 feet and in soft material as high as 200 feet by 200 feet. During

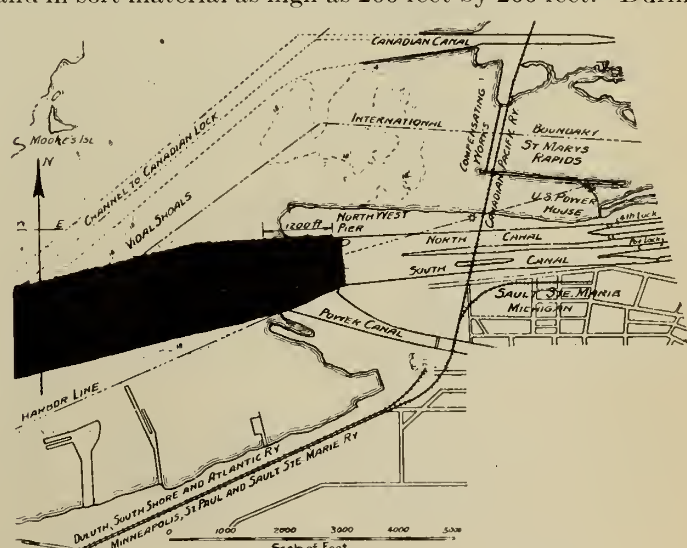

Fig. 4—Proposed Extension of Northwest Pier, St. Mary's Falls Canal.

the winter of 1930-31, 6,550 of these probings were made at a cost of $1.32 each.

The unit of pay quantity is usually the cubic yard of material measured in place. From the soundings and probings the quantities of material to be removed within fixed grades and limits are accurately computed. The final survey made after completion of the work then determines the pay quantities actually removed.

The contract drawings show all soundings and all probings made, a contour map shows the general condition and the submarine contours, and a probing map shows as nearly as possible the character of material to be removed.

The specifications contain a complete description of the work to be done and instructions for the conduct of the work. The areas to be covered are specified, average depth of cut, pay quantities above grade, pay quantities of overdepth and limits of pay quantities. It is at present customary to specify a pay overdepth of two feet below a definite swept depth and limiting sideslopes of one vertical to two horizontal in hard material or one vertical to four horizontal in soft material.

The cost of doing the work, based on the use of actual or assumed government plant and of hired labour, is estimated and is presented at the time of opening of bids. In general no contractor's bid exceeding the cost estimate in excess of twenty-five per cent is considered acceptable. All of the work considered in this paper has been, is being and will be done by publicly advertized competitive bidding.

Thus the years 1928 and 1929 saw the project to widen the Middle Neebish, or upbound, channel from 300 feet to 500 feet awarded in the following four major contracts:

Location	Material and Dredging Method	Pay Quantity Cu. Yds.	Total Final Cost $	Unit Contract Cost	Estimated United States Unit Cost	Remarks
Lower Lake Nicolet	Sand, clay. Hydraulic	1,438,000	220,000	13.5¢	13.7¢	5 bids—23¢ to 34¢ rejected 4 bids—13.5¢ to 18¢
Middle Neebish Dike	Sand, clay, boulders, ledge rock. Dipper	1,756,000	2,441,000	98.0¢ Earth $2.37 Rock	0.70¢ Earth $2.30 Rock	4 bids—for rock $2.37 to $3.91
Munuscong Channel	Clay. Dipper	877,000	230,000	24.5¢	32.0¢	8 bids—24.5¢ to 58¢
Sailors Encampment Channel	Sand, clay, boulders, ledge rock. Dipper	159,000	650,000	$1.45 Earth $6.80 Rock	$1.01 Earth $5.46 Rock	4 bids—for rock $7.90 to $8.40 rejected. 4 bids—$7.20 to $7.85 rejected. Informal bid by low bidder accepted.
Totals		4,230,000	3,541,000	84.0¢		

The contracts were executed as follows:

Location	Plant	Contractor	Period	Pay Quantity per Dredge per Hour—Cu. Yds.	Drilling per Frame Hour—Lin. Ft.
Lower Lake Nicolet	20″ hydraulic dredge "Niagara"	Duluth-Superior Dredging Co.	Sept. 1, 1928 to Dec. 13, 1928	650	....
Middle Neebish Dike	4 dipper dredges 1 hydraulic dredge 3 derrick boats 4 drill boats	United Dredging Co.	Sept. 11, 1928 to Oct. 24, 1930	91	One drillboat—6 feet. Each of 3 drillboats—28 feet.
Munuscong Channel	Dipper dredge "Old Hickory"	Duluth Superior Dredging Co.	Sept. 24, 1928 to June 30, 1930	369	....
Sailors Encampment Channel	Dipper dredges "Mogul," "M-No. 9" Derrick boat "No. 56" 2 drillboats	Great Lakes Dredge and Dock Co.	July 2, 1929 to Nov. 13, 1930	64	5 feet.

During the execution of the contracts for widening Middle Neebish channel preparations were commenced for deepening the downbound route to provide for 24-foot navigation, which was estimated to cost, for St. Mary's river, about $8,000,000. This work was originally planned to be done over a period of about eight years, but, due to the depression and the government's desire to get all projected work immediately in progress, this period has been cut in half and it is expected that the deepening of St. Mary's river will be completed in four years, or by 1934.

Eight contracts under this project have thus far been authorized, bids for which have yielded the following results:

Location	Material and Dredging Method	Pay Quantity Cu. Yds.	Contract Cost $	Unit Contract Cost	Estimated United States Unit Cost	Remarks
Round Island Middle Ground	Sand, clay, boulders. Dipper	2,162,000	510,000	27¢	60¢	5 bids—27¢ to 58¢
Round Island Shoal No. 1	Sand, clay, boulders. Dipper	462,000	220,000	47¾¢	53¢	3 bids—47¾¢ to 79¢
Round Island Shoal No. 2	Sand, clay, boulders. Dipper	578,000	231,000	40¢	45¢	3 bids—40¢ to 50¢
Vidal Shoals	Sand, clay, boulders, ledge rock. Dipper	540,000	596,000	$1.07 Earth $5.00 Rock	$1.69 Earth $9.49 Rock	5 bids—$596,000 to $873,000
Lake Nicolet	Sand, clay. Hydraulic	3,704,000	418,000	8.6¢	16.2¢	6 bids—8.6¢ to 19¢
West Neebish Channel C's. 4-5-7-8	Sand, clay. Hydraulic	3,219,000	322,000	10¢	15.8¢	5 bids—10¢ to 23¢
West Neebish Channel Angle Courses 5-6 and 6-7	Sand, clay, boulders, ledge rock. Dipper	552,000	324,000	79.2¢	$1.60	3 bids—79.2¢ to $1.10 Cofferdams and pumping excavation in the "dry."
Course 6 Rock Cut	Ledge rock. Gas-air shovels	540,000	790,000	$1.37	$2.56	13 bids—$1.37 to $2.87
8 contracts		11,757,000	3,411,000	29¢		

These contracts are being executed as follows:

Location	Contractor	
Round Island Middle Ground.	Great Lakes Dredge and Dock Co.	Dipper dredges "Mogul" and "M-No. 9." Derrick boat "No. 56."
Round Island Shoal No. 1.	Great Lakes Dredge and Dock Co.	Dipper dredges "Mogul" and "M-No. 9." Derrick boat "No. 56."
Round Island Shoal No. 2.	Great Lakes Dredge and Dock Co.	Dipper dredges "Mogul" and "M-No. 9." Derrick boat "No. 56."
Vidal Shoals.	Duluth Superior Dredging Co.	Dipper dredge "Old Hickory." Derrick boat "No. 1."
Lake Nicolet.	R. A. Perry	Work not commenced.
West Neebish Channel—Courses 4, 5, 7 and 8.	Great Lakes Dredge and Dock Co.	24" Hydraulic dredge "New York."
West Neebish Channel—Angle C's. 5-6, 6-7.	Dunbar and Sullivan Dredging Co.	Dipper dredges "Omadhaun" and "Tipperary Boy."
West Neebish Channel—Course 6, Rock Cut.	Connolly Contracting Co.	3 gas-air shovels. 1 steam dragline. 23-7½ ton gasoline trucks. 2-10 frame drill trucks. 10 jackhammer drills.

These results present the recent improvement of St. Mary's river to the present time. There remains to be placed under contract some six miles of work below the falls, exclusive of five widely separated areas in the more extreme parts of the lower river. Surveys of all of these areas will be made during the winter months of January, February and March, 1932, and it is expected that the improvement work will commence early in the summer of 1932.

Isaac DeYoung, senior engineer, is in charge of the United States Engineer Office at Sault Ste. Marie, Michigan, this office being a part of the Detroit district, of which Major D. McCoach, Jr., Corps of Engineers, United States Army, is district engineer.

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The Institute's War Memorial

Shortly before the close of the War steps were taken by the Council of The Engineering Institute of Canada, then the Canadian Society of Civil Engineers, to commemorate fitly the patriotic services rendered by its members during that great conflict. This movement was initiated in February, 1917, when the matter was referred to an Honour Roll Committee, composed of Lieut.-Colonel C. N. Monsarrat, M.E.I.C., and Fraser S. Keith, M.E.I.C., who were asked to report as to the desirability of preparing an official record or Honour Roll to be installed in The Institute's Headquarters building. This Committee was later enlarged by the addition of the name of Colonel A. E. Dubuc, M.E.I.C.

In accordance with their recommendations, a record containing nearly one thousand names of members of all classes known to be serving overseas was engrossed and these records, in a large oak frame, were placed in the entrance hall of The Institute's Headquarters, being unveiled on the occasion of the Annual Meeting of 1918. It was felt, however, that at a later date, when final and more complete information should be available, a more permanent and detailed record would be desirable. Accordingly, in 1920, the Committee was reconstituted, Brig.-General C. J. Armstrong, C.B., C.M.G., M.E.I.C., becoming chairman, with Brig.-General G. Eric McCuaig, Colonel Dubuc and Fraser S. Keith as the other members. Under the name of the Honour Roll and War Trophies Committee, this committee undertook the collection of the necessary further information regarding service records, and was also able to secure a number of interesting war trophies which now find a place in The Institute's Headquarters.

Early in 1924, after due consideration, the committee reported to Council and recommended that The Institute's official memorial should take the form of two bronze tablets, one, the War Memorial, giving the names, ranks and decorations of those members of The Institute who lost their lives on overseas service, and a second larger bronze tablet, the Honour Roll, recording the names and decorations of all who served overseas in a combatant capacity and who belonged to the Canadian Society of Civil Engineers, or The Engineering Institute of Canada, prior to the armistice.

The committee suggested that the expense of these monuments should be defrayed by a general subscription from the membership, limited to a maximum of ten dollars, and the committee's proposals, after approval by Council, were announced to the membership in The Engineering Journal for March, 1924.

The committee further recommended that members of The Institute be asked to prepare competitive designs for the two tablets, a suitable prize being awarded to the designer whose work was adjudged most suitable for adoption. This recommendation was carried out, the competition took place, and in February, 1925, the prize was awarded to Major F. G. Cross, A.M.E.I.C., of Brooks, Alberta, for his designs, which were published in the April, 1925, issue of The Journal.

In the meantime, funds were being subscribed in response to Council's appeal, although it was not until 1927 that the sum necessary for the completion of the bronze memorial and honour roll was secured.

The long and difficult task of compiling a complete and accurate list for the two records has been in progress since that time, and several years of patient enquiries have been necessary before the correctness of all the entries could be definitely established.

The War Memorial contains one hundred and nineteen names, the Honour Roll nearly one thousand, and in each case confirmation has been sought and obtained from all available official records, a task particularly difficult in instances where our members served in units belonging to forces other than those of the Canadian and Imperial services.

Tenders having been obtained, the contract for the Memorial was awarded in November, 1931, to a well-known firm of bronze founders, the Robert Mitchell Company, of Montreal, and the bronze tablet is now in position in the entrance hall of the Headquarters building.

A photograph of the War Memorial appears on page 481 of this issue and on page 480 appears an account of the unveiling ceremony which took place on September 6th, 1932.

It is hoped that the checking of the Honour Roll list, which was published in the September issue of The Journal for the information of members, will be completed shortly, so that the bronze tablet can be put in hand.

Policy and Development

What course shall we steer? This question has now been before The Institute's Committee on Development for more than twelve months, and the preparation of an answer to it has required careful thought and investigation. The task of studying the various factors on which The Institute's future well-being depends has been rendered difficult by the present economic and industrial crisis, and further, in preparing the recommendations designed to give effect to its views, the committee has had to make an examination of the whole structure of The Institute. Some of the problems confronting the committee were outlined in the editorial columns of The Journal in January 1932, and it is gratifying to note that since that time such effective progress has been made that an interim report is ready and has now been presented to Council. By Council's directions this is published in this issue of The Journal for the information and consideration of the membership.

A glance at the report shows at once that the committee's recommendations, most of which involve changes in our present by-laws, are of two kinds; some of them, such as, for example, those affecting the management of The Institute or suggesting changes in the various classes of The Institute's membership and the qualifications for admission, are of a fundamental character, because their acceptance would bring about major changes in the course of The Institute's development. It is believed, for instance, that these changes would lead to closer relationship with the Professional Associations than has hitherto been possible, and would afford an opportunity, as the committee thinks, for a marked increase in The Institute's influence and usefulness to the profession. There are others of the committee's proposals, however, which are not of such primary importance, because a decision not to act upon them would not necessarily affect the main features of the report. Among these would be included such items as changes in the duties of the various standing committees, or modifications to the rules regarding expulsion and discipline.

To make the work of the committee effective it will be necessary to draft a set of amended by-laws, after which the proposed changes have to be submitted to an annual general meeting, and then to a letter ballot of the membership. It is evidently desirable that the more important proposals, when submitted to the membership, shall be in such form that they can be voted on as a whole, and the committee wishes to insure, as far as possible, the submission of a final draft of the new by-laws in a shape which will meet with general approval, thus avoiding the rejection of the whole programme because the membership may be opposed to some one item, possibly of minor importance. As has already been pointed out, some of the recommendations are independent of others and can, therefore, be varied to meet the ideas of the membership without affecting the main purpose of the changes proposed. Others, perhaps of greater importance, form a group which should be accepted or rejected as a whole.

Council, therefore, proposes to adopt the following procedure. As soon as possible after the present publication of the interim report each member of The Institute will receive a letter explanatory of the proposals, together with a reply form giving him an opportunity to express his opinion for or against each one of the proposed changes item by item. Council asks every member of The Institute to give careful study to this matter, and to make a point of stating his views in reply. If this is done, an analysis of the replies will indicate those proposals which meet with general approval, and those to which exception is taken by a considerable proportion of the membership. As a result, it is hoped to prepare and submit to the next annual general meeting a set of amendments to the present by-laws, based on the committee's report and on the membership's opinions thereon, which can be voted on en bloc and will have every prospect of meeting with general approval so as to secure on ballot the two-thirds majority required for any amendments to our by-laws.

The Committee on Development includes in its membership men who have been connected with The Institute for many years, who have seen the successful operation of other changes in our constitution, and who have at heart the real well-being and progress of The Institute. Their proposals deserve and will receive the most careful attention, and Council is confident that in regard to them the decisions to be rendered by our members will reflect the good sense and trained judgment of our membership.

Annual Meeting 1933

At the meeting of Council held on September 20th, the invitation of the Ottawa Branch to hold the Forty-Seventh Annual General and General Professional Meeting of The Institute at Ottawa was accepted with appreciation. Tuesday and Wednesday, February 7th and 8th, 1933 were tentatively approved as the dates for this gathering.

Report of Committee on Unemployment

The following is a summary of the report of The Institute's Committee on Unemployment, D. C. Tennant, M.E.I.C., chairman, submitted to and approved by a special meeting of Council held on September 1st, 1932.

On May 17th the forming of unemployment committees in each Branch of The Institute and outlining a method of gathering information regarding unemployment among our members by means of questionnaires was approved by Council. Accordingly, questionnaires "C" were issued to all members of The Institute and fairly complete reports regarding the information received has been forwarded to Headquarters by twenty-one of the twenty-five Branches.

These reports cover a Branch membership of 3,953. They indicate that as of July 1st, 1932, 85.3 per cent of the membership of those Branches either stated that they were employed or were assumed to be so since they did not return the questionnaire. The proportion definitely stating that they were unemployed was 9.8 per cent.

It is evident from the information received that conditions vary greatly in different Branches. Generally speaking, unemployment is most prevalent in the larger centres and these Branches are anxious to proceed with relief work directly or in co-operation with some kindred agency, while in a number of the smaller centres, no need is reported and the Branches are not in favour of appeals being made. Several Branches do not state their views regarding the necessity for relief measures.

In view of this the committee recommended:—

(1) That Branch Unemployment Committees carefully investigate present conditions and recheck their findings periodically-say once a month, so that relief measures may be adopted promptly, as soon as any need is evident. Not one case of need in any Branch is to be neglected.

(2) That the appeal for funds, when necessary, should be made by each Branch from its own employed members and for its own needy ones, and not by headquarters, and that the distribution of relief be also handled by the Branch.

(3) In order to guide the various Branch Committees in their estimates of needy cases, it is suggested that direct relief should not be given without very careful enquiry to make sure that the unemployed member has exhausted all personal resources.

(4) That each Branch committee should take special steps by personal canvass or special meeting of the Branch, to make sure that the urgency of the need is well realized by those members to whom an appeal is made for funds.

(5) That each Branch committee follow the suggestion in Report A of this Committee to Council, dated May 17th, 1932 and letter B of the General Secretary to Branch Secretaries, dated May 25th, 1932, regarding the collecting of information on needy cases, appealing for funds, handling of finances, direct relief and "made work;" it being understood that the work will be done by each Branch separately and not by Headquarters and that the outline given in report A is in the form of suggestion, as it is realized that conditions in Branches will differ.

(6) That Headquarters send to each Branch Secretary the names of those in the district who have been placed on the Suspended List owing to their financial stringency, that questionnaires "C" be sent at once to them from headquarters, and that they be treated as to unemployment in the same way as members in good standing.

(7) That Branch committees be encouraged to co-operate with other relief agencies where they deem

this advisable in collecting information or in appealing for funds and distributing them, always, however, bearing in mind that The Institute is anxious that, so far as possible, its own members should contribute to the relief fund and that no one of its own needy members should be overlooked.

(8) That Branches and Branch committees keep Headquarters at all times fully advised as to just what relief work is being undertaken by them, so that Council and this Unemployment Committee may keep in close touch with the work of each Branch, with a view to helping in whatever way is possible.

OBITUARIES

Edwin Victor Deverall, A.M.E.I.C.

It is with deep regret that we record the death of Edwin Victor Deverall, A.M.E.I.C., which occurred at the Orillia Memorial Hospital on August 30th, 1932,

Mr. Deverall was born at Toronto, Ont., on August 19th, 1890, and graduated from the University of Toronto in 1915 with the degree of B.A.Sc. Following graduation, Mr. Deverall was for fifteen months on the staff of the Dominion Bridge Company in Toronto and Montreal as structural engineer. From January, 1917, to July, 1919, he was on active service overseas, holding the ranks of lieutenant and captain in the 62nd and 89th Field companies of the Royal Engineers, and being awarded the Military Cross in 1917 and bar in 1918. After returning from overseas Captain Deverall was structural engineer with the Dominion Bridge Company, and later was on the engineering staff of the Canadian and General Finance Co. Ltd., Toronto. In 1928 he entered private practice as a structural engineer in Toronto, and later entered partnership with A. B. Crealock, A.M.E.I.C., forming the firm of Deverall and Crealock.

Captain Deverall joined The Institute as a Student on February 10th, 1914, and was transferred to the class of Associate Member on August 24th, 1920.

Albert Henry Eager, A.M.E.I.C.

We regret to record the death, at Winnipeg, Man., on September 25th, 1932, of Albert Henry Eager, A.M.E.I.C.

Mr. Eager was born at Waterloo, Que., on July 15th, 1868. Beginning his railway career as an apprentice in the shops of the Canadian Pacific Railway Company at Farnham, Que., he became locomotive foreman at Farnham in 1899, being transferred to Megantic in 1901 in the same capacity. During the years 1903-1906 he was general foreman at Cranbrook, B.C., and in 1906-1907 occupied the same position at Calgary, Alta. In 1907-1908, Mr. Eager was district master-mechanic at Kenora, Ont., and in 1908-1910, was again located at Calgary, this time as locomotive foreman. In 1910 he entered the service of the Canadian Northern Railway as superintendent of shops at Winnipeg, Man., and in 1915-1918 was assistant superintendent of rolling stock, western lines. In 1919 he was placed in full charge of the motive power and car equipment of the western division. When the Canadian Northern and the Grand Trunk were amalgamated in 1923, to form the Canadian National Railways, Mr. Eager was given the same position in the merged system.

Mr. Eager joined The Institute as an Associate Member on March 25th, 1919.

Sir Edouard Percy Cranwill Girouard, Hon.M.E.I.C.

The announcement of the death of Sir Edouard Percy Cranwill Girouard, Hon.M.E.I.C., in London, England, on September 26th, 1932, after a brief illness, will be received with widespread regret.

Colonel Sir Percy Girouard was a Montrealer, having been born in that city on January 26th, 1867. He graduated from the Royal Military College, Kingston, in 1886, and was afterwards employed for a time by the Canadian Pacific Railway Company as rodman and assistant engineer. In 1888 he joined the Royal Engineers, being stationed at the School of Military Engineering at Chatham, England. In 1896 Sir Percy was sent to the Soudan, where he served under Lord Kitchener in the Dongola Expeditionary Force, being appointed to look after the entire problem of railway transportation as Director of Soudan Railways. While there, he showed exceptional ingenuity in making possible the building of a railway through 500 miles of desert. For this and other services in the Nile Expedition in 1897 he was promoted Major in 1899, and was awarded the Distinguished Service Order, receiving also the British medal and the Khedive medal with two clasps. He was given the rank of Bimbashi in the Turkish army at the same time. After the successful ending of the Soudan campaigns, Sir Percy was appointed President of the Egyptian Railway Board, holding this post until the South African War, when he was sent for by Lord Kitchener to go to Africa and take charge of the railway transportation as director of railways. For his services in South Africa Sir Percy was awarded the K.C.M.G. and at the conclusion of the War in 1902 he was appointed Commissioner of Railways, Transvaal and Orange River Colony. Further honours were conferred upon Sir Percy a few years later in 1907, when he was created High Commissioner of the Protectorate of Northern Nigeria. Railway problems again faced him, a line 800 miles long into the interior being necessary, which was completed within a very short time. In British East Africa Sir Percy acted as Governor and Commander-in-Chief of the Protectorate. He occupied the latter position during 1909-1912, after which he joined the board as a director of the firm of Sir W. G. Armstrong-Whitworth at Newcastle-on-Tyne. In 1913 he established the firm of Armstrong-Whitworth of Canada Ltd., at Longueuil, Que., of which organization he was the first president.

During the Great War, Sir Percy was Director-General of Munitions Supply from 1915 to 1916, and after 1916 he rejoined the Armstrong-Whitworth Company in England in the capacity of managing director.

Sir Percy joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on December 6th, 1888, and was made an Honorary Member on October 8th, 1903.

Thomas Turnbull, M.E.I.C.

Members of The Institute will learn with regret of the death of Thomas Turnbull, M.E.I.C., which occurred at his home in Winnipeg, Man., on September 14th, 1932.

Mr. Turnbull was born in the county of Grenville, Ontario, on May 26th, 1857, and was educated in Perth, Ont. During the years 1881 to 1884 he was assistant engineer on location and construction of the Ontario and Quebec Railway from Toronto to Perth, in the following year he held the same position on the Manitoba Southwestern Colonization Railway, and in 1886-1887 was engaged on the Smith's Falls to Montreal line of the Ontario and Quebec Railway. From October, 1887, to February, 1889, Mr. Turnbull was assistant engineer on the construction of the International Railway of Maine, and in 1889 was for several months locating engineer on the Toronto, Hamilton and Buffalo Railway, later in the same year being assistant engineer, maintenance of way, of the western division of the Canadian Pacific Railway. In 1889-1891 he was locating engineer and divisional engineer in charge of construction of the Hall's Bay Railway in Newfoundland, and in 1891-1895 returned to the Canadian Pacific as assistant engineer, maintenance of way, with the western division. Mr. Turnbull was later for a time with Mackenzie and Mann, and in 1904 was appointed assistant chief engineer in the engineering department of the

Canadian Northern Railway. In July, 1910, he became chief engineer in charge of the construction of the Hudson Bay Railway, and in April, 1912, returned to Winnipeg as assistant chief engineer. In June, 1919, Mr. Turnbull was made engineer in charge of maintenance of way Canadian National Railways, which position he held until his retirement on August 1st, 1931.

Mr. Turnbull joined The Institute (then the Canadian Society of Civil Engineers) on October 8th, 1908.

Arnold Mayne Olsen, S.E.I.C.

Deep regret is expressed in recording the death of Arnold Mayne Olsen, S.E.I.C., at Burlington Beach near Hamilton, Ontario. Death occurred on September 1st, 1932, and was due to a heart atack while swimming in Lake Ontario.

Mr. Olsen was born in North Dakota on April 7th, 1904, but lived in Bowell, Alberta, for a number of years. He graduated from the University of Alberta in 1931 with the degree of B.Sc. in Electrical Engineering. From September 1931 till the time of his death Mr. Olsen was employed by the Canadian Westinghouse Co. as an engineering apprentice. He was well liked by his fellow apprentices, and will be deeply missed by all who knew him.

Mr. Olsen joined The Institute on January 20th, 1931.

PERSONALS

H. A. F. Gregory, Jr.E.I.C., is now attached to the Wayagamack division, Consolidated Paper Corporation, Three Rivers, Que. Mr. Gregory graduated from McGill University with the degree of B.Sc. in 1927, and following graduation was for several months engineer on construction with the Murray Bay Paper Company. From 1927 to 1930 he was with the control department of the Anglo-Canadian Pulp and Paper Company at Quebec, and in 1930-1931 was mill efficiency engineer with the same company. In 1931 he joined the staff of the Aluminum Company of Canada at Shawinigan Falls, Que., as technical assistant.

Gordon Sproule, A.M.E.I.C., has recently been promoted from the rank of assistant to that of associate professor of metallurgy at McGill University. Mr. Sproule graduated from McGill University in 1908 with the degree of B.Sc., and from 1908 to 1910 was demonstrator at the same university. During the years 1910-1915 he was inspector and assistant engineer of tests and in 1915-1916 engineer of tests, with the Canadian Pacific Railway Company. In 1916 Mr. Sproule became assistant inspector of steel, Imperial Ministry of Munitions, Department of Inspection, Canada, retaining that position until 1918, when he was appointed lecturer and assistant professor of metallurgy at McGill University.

N. Marshall, M.E.I.C., has recently retired from the service of the Alberta Provincial Government, having held the office of provincial boiler and machinery inspector since 1908. Mr. Marshall was born in Belfast, Ireland, on October 25th, 1862, and came to this country in 1906, joining the staff of the Canadian Northern Railway at Winnipeg as machinist at that time. From December, 1907, to June, 1908, he was master mechanic with Hillcrest Collieries at Hillcrest, Alta., and at that time received the appointment from which he has now retired.

A. F. Stewart, M.E.I.C., chief engineer of the Atlantic region of the Canadian National Railways, with headquarters at Moncton, N.B., has retired. Mr. Stewart, who is a member of The Institute of long standing, having joined as a Member on December 9th, 1897, has held the position from which he now retires since 1920.

H. T. Hazen, M.E.I.C., assistant chief engineer, Operation Department, Canadian National Railways, Montreal, succeeds Mr. Stewart.

F. E. Regan, Jr.E.I.C., formerly Montreal sales engineer for Lancashire Dynamo and Crypto Company of Canada, Ltd., has been transferred to the Toronto office of that company as assistant manager. Mr. Regan graduated in electrical engineering from the Royal Technical College, Salford, England, in 1923, and served his apprenticeship course, consisting of a complete works training, with the Lancashire Dynamo and Crypto Limited at their Trafford Park and Willesden works. In 1927 he joined the Canadian organization and has been located at their head office at Montreal.

J. A. Heaman, M.E.I.C., chief engineer of the Grand Trunk Western at Detroit, Mich., has been appointed office engineer, Canadian National Railways, at Montreal.

R. A. Baldwin, M.E.I.C., who formerly held the position of office engineer with the Canadian National Railways at Montreal, has been appointed district engineer at North Bay, Ont.

Meetings of Council

A special meeting of Council was held at Headquarters on Thursday, September 1st, 1932, at eight o'clock p.m., with Councillor J. A. McCrory, M.E.I.C., in the chair, and four other members of Council present.

This meeting was held to consider the information received from the Branches regarding unemployment, and the recommendations from The Institute's Committee on Unemployment thereon. It was decided that a summary of the report be published for the information of the membership.

The Committee's report was discussed and as a result it appeared that for the present it will not be advisable for Council to make a general appeal for funds; it was considered that if the necessity for direct relief for members arises, as it may do in some of the larger centres, the matter can be more efficiently handled by the local Branch unemployment committees.

The Council rose at nine thirty p.m.

A meeting of Council was held at Headquarters on Tuesday, September 20th, 1932, at eight o'clock p.m., with President Charles Camsell, M.E.I.C., in the chair, and five other members of Council present.

The membership of the medal committees of The Institute for the year 1932, as submitted by the chairmen, was approved as follows, one additional name to be submitted for the Gzowski Medal Committee:

Gzowski Medal Committee
- P. L. Pratley, M.E.I.C., Chairman
- C. N. Monsarrat, M.E.I.C.
- J. W. Roland, M.E.I.C.
- A. S. Wall, M.E.I.C.

Leonard Medal Committee
- H. J. Roast, M.E.I.C., Chairman
- D. E. Blair, M.E.I.C.
- L. F. Goodwin, M.E.I.C.
- F. T. Kaelin, M.E.I.C.
- A. Stansfield, M.E.I.C.

Plummer Medal Committee
- L. H. Cole, M.E.I.C., Chairman
- F. D. Adams, Hon.M.E.I.C.
- C. V. Corless, M.E.I.C.
- A. E. MacRae, A.M.E.I.C.
- R. A. Strong, A.M.E.I.C.

In connection with the report of the Finance Committee, discussion took place on the general question of the treatment to be accorded to members in arrears, particularly with reference to ninety-four members who had written requesting Council's consideration. In the cases of those who had written it was decided that no action should be taken under Section 37 of the By-laws until the end of the year.

An interim report of the Committee on Development was presented by the chairman, J. L. Busfield, M.E.I.C. After discussion, Council directed that this report, together with an accompanying memorandum, should be printed in The Journal, following which each member should be asked for his opinion of the changes proposed, this with a view of modifying such of the Committee's proposals as appear not to have the general support of the membership.

The dates for the Annual General and General Professional Meeting of The Institute were tentatively fixed as Tuesday and Wednesday, February 7th and 8th, 1933, in accordance with the recommendation of the Ottawa Branch, the meeting to be held at the Chateau Laurier, Ottawa.

A representative was appointed to a committee being formed by the Canadian Engineering Standards Association to consider the preparation of a safety code for passenger and freight elevators.

Ten resignations were accepted; one Life Membership was granted, and ten special cases were considered.

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

Elections		*Transfers*	
Members	2	Assoc. Member to Member	3
Associate Members	6	Junior to Associate Member	4
Juniors	3	Student to Junior	6
Students admitted	4		

The Council rose at eleven fifty-five p.m.

The Institute's War Memorial Unveiled

The message of a War Memorial inevitably changes in its appeal as the years go by. Fourteen years ago the great conflict ended, and during that time the world's activities have been gradually passing into the hands of younger men who have had no personal experience of the hostilities. In their minds the economic and political consequences of the war naturally tend to overshadow the memories of its tragic events, and to them a War Memorial is a record of endurance and sacrifice in which they had no opportunity of sharing, but whose grandeur they willingly recognize. To the men who served in the War, however, such a Memorial recalls their fallen comrades and has a far deeper meaning. Recollections of battle, hardship and adventure crowd upon their minds, and to such men the list of those who never returned has an appeal which time cannot efface.

In the entrance hall of The Institute's Headquarters building there has just been erected a bronze tablet bearing the names of those members of The Institute who laid down their lives during the Great War. It was unveiled by the President of The Institute on Tuesday, September 6th, 1932, in the presence of a gathering which included the Chief of the General Staff and officers of the Department of National Defence, members of The Institute Council and members of The Institute's Honour Roll Committee.

At the commencement of the ceremony the tablet was formally handed over to The Institute by Brig.-General C. J. Armstrong, C.B., C.M.G., M.E.I.C., chairman of the Honour Roll and War Trophies Committee. He was followed by President Camsell, who spoke as follows: "It is with a deep sense of gratification that as President of The Engineering Institute of Canada I take over, on behalf of the Council, the Memorial, which, with the Honour Roll still to be erected, commemorates the service rendered by members of The Engineering Institute of Canada to Canada and the Empire during the Great War. It is nearly fourteen years since the War ended, but the work entailed in the preparation of this Memorial, in order that the record should be full and accurate, was of such a nature that it could not be finished at an earlier date. The record is now complete and The Institute owes a debt of gratitude to General Armstrong and his associates on the Honour Roll and War Trophies Committees for the time and energy they devoted to this work, and for the patience and thoroughness with which they have carried it out."

After a brief review of the course of events leading to the completion of the Memorial, Dr. Camsell continued, "The War Memorial which I am to unveil contains the names of one hundred and nineteen members of The Institute who were killed in action, or died of wounds. It has been placed here in the entrance hall of the Headquarters building by our members in recognition of the supreme sacrifice made by their comrades. 'To the glory of God, and in memory of the gallant members of The Engineering Institute of Canada who gave their lives in the Great War, I unveil this Memorial in the name of the Father, Son and Holy Ghost.' "

When the Union Jack had been drawn aside from the tablet a brief dedicatory address, followed by a dedicatory prayer, was given by Lieut.-Colonel the Venerable Archdeacon Almond, C.M.G., C.B.E., Chaplain, 2nd Field Brigade, Canadian Artillery. In that address the Archdeacon dealt with memories of the past, their meaning in life and their spiritual nature. "We are asked to-day to forget the War," he said, "and to blot out the memory of the past. How can we? The men who were overseas seldom speak of it, because it was unspeakable, but do they forget? Their silence is the greatest evidence of the part they played, but they do *not* forget. There is no language adequate to give the faintest expression of that night of Hell, which we call the Great War, but surely we must attempt always to remember those who paid the price, and inculcate in the youths of to-day that spirit of loyalty, endurance and sacrifice that inspired those who served, and who, when they fell, flung to the hosts of youth to come this challenge, 'Play up, play up, and play the game.' "

Immediately after the benediction a bugler of the Canadian Grenadier Guards sounded Last Post, followed, after an impressive interval of silence, by the notes of Reveille.

ELECTIONS AND TRANSFERS

At the meeting of Council held on September 20th, 1932, the following elections and transfers were effected:

Members

GIBB, Sir Alexander, G.B.E., C.B., (Univ. of London), senior partner, Sir Alexander Gibb & Partners, Queen Anne's Lodge, Westminster, London, England.

MARTIN, Edward Newcome, B.Sc., (McGill Univ.), manager for Canada, British Steel Export Association, 1538 Sun Life Bldg., Montreal.

Associate Members

GROSS, Philip Norcross, B.Sc., (McGill Univ.), vice-president and manager, Anglin Norcross Ontario Ltd., 57 Bloor St. West, Toronto, Ont.

JOHNSTON, James Homer, D.L.S., A.L.S., (Queen's Univ.), dist. engrg., Dept. Public Works Alta., Peace River, Alta.

O'BRIEN, Fredric Gordon, B.Sc., (N.S. Tech. Coll.), 4982 Queen Mary Road, Montreal, Que.

ROBERGE, Antonio, B.A.Sc., Chem. Engr., (Ecole Polytech.), res. engr., Battlefields Reservoir, City of Quebec, Que.

VOKES, Christopher, Capt., R.C.E., (Grad., R.M.C.), B.Sc., (McGill Univ.), Dist. Engr. Officer, Mil. Dist., No. 12, Regina, Sask.

YORGAN, William James, Supt. Gas Mains, Montreal Light, Heat & Power Cons., Montreal, Que.

Juniors

GONZALEZ, Louis Carlos, B.Sc., (McGill Univ.), junior designer Beauharnois Constrn. Co., 1610 Sherbrooke St. West, Montreal, Que.


TO THE MEMORY
OF THE MEMBERS OF
THE ENGINEERING INSTITUTE
OF CANADA
WHO GAVE THEIR LIVES
IN THE GREAT WAR
1914 — 1918
(F) FOREIGN ORDERS
(F) FOREIGN ORDERS
NOT VAIN YOUR SACRIFICE - NOR LOST YOUR WORK

MASSE, Fernand Andre, B.A.Sc., (Univ. of Toronto), asst. chemist, Abitibi Paper Company, Sault Ste Marie, Ont.

PATERSON, Raymund Gordon, (Royal Australian Naval College), map dftsman., geol. dept., Canadian Western Natural Gas, Light, Heat & Power Co., Calgary, Alta.

Transferred from the class of Associate Member to that of Member

BISHOP, Reginald Worth, Lt.-Col., (Grad., R.M.C.), bridge engr., City of Hamilton., Ont

FINDLAY, Reginald Hudson, (Assoc., Royal Tech., Coll., Glasgow), mech., engr., Dominion Bridge Company, Ltd., Montreal, Que.

STUART, William Henry, (Univ. of Minn.), supt. of facilities, C.N.R., Montreal, Que.

Transferred from the class of Junior to that of Associate Member

CLEVELAND, Harry Roland, B.Sc., (McGill Univ.), sales specialist, Northern Electric Co. Ltd., Montreal, Que.

CYR, Seraphin Adelard, (Passed E.I.C. exams., B. & C.), asst. supt., Eastern Steel Products, Ltd., Montreal, Que.

FLEMING, Canmore Drake, B.Sc., (McGill Univ.), asst. gen. outside supervision on constrn. works, Anglin Norcross Ontario Ltd., Toronto, Ont.

JONES, John Hugh Mowbray, B.A.Sc., (Univ. of Toronto), res. engr., asst. gen. supt., Mersey Paper Co. Ltd., Liverpool, N.S.

Transferred from the class of Student to that of Junior

CHANDLER, Edward Sayre, B.Sc., (N.S. Tech. Coll.), provincial elect'l. inspr., P.E.I., Board of Fire Underwriters, Charlottetown, P.E.I.

CORNISH, Charles Rischman, B.A.Sc., (Univ. of B.C.), 323, 26th St. East, North Vancouver, B.C.

EMERSON, Robert Alton, B.Sc., (Univ. of Man.), locating engr., Dept. of Northern Development, Kenora, Ont.

LUCAS, John William, B.Sc., (Univ. of Alta.), tester of bldg. materials, Dept. Public Works, Ottawa, Ont.

MacDONALD, Murray Vickers, B.Sc., (Univ. of Sask.), temporary city engr., Swift Current, Sask.

SCHULTZ, Charles Davies, B.A.Sc. (Forest Engrg.), (Univ. of B.C.), asst. chief of party, forest surveys divn., Vancouver, B.C.

Students admitted

DAVIS, Charles Wesley, Jr., (McGill Univ.), 630 Grosvenor Ave., Westmount, Que.

JOLLEY, Malcolm Porter, (McGill Univ.), 3535 Mance St., Montreal, Que.

KERR, Robert Allen, (McGill Univ.), 4765 St. Catherine St. East, Montreal, Que.

NANTEL, Maurice, (Ecole Polytech.), 1441 Pie IX Blvd., Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Royal Society of Canada: List of Officers and Members and Minutes of Proceedings, 1932.
The Institution of Civil Engineers: List of Members, July 1, 1932.
Minutes of Proceedings, Vol. 232, 1930-1931.
The Society of Naval Architects and Marine Engineers: Year Book, 1932.
The Institution of Municipal and County Engineers: The Handbook, 1932-1933.

Reports, etc.

Dominion Bureau of Statistics, Canada:
The Canada Year Book, 1932.
Department of the Interior, Topographical Survey, Canada:
[Map of] Miminiska, Ontario. 1932.
Publications of the Dominion Observatory, Ottawa, Vol. 10: Bibliography of Seismology, No. 14, April, May and June, 1932.
National Research Council, Canada:
Report No. 25: The Drying of Wheat, Second Report, 1932.
Report No. 26: Weed Survey of the Prairie Provinces. 1932.
Report No. 27: Weeds and Their Control. 1932.
Department of Mines, Mines Branch, Canada:
Gold in Canada. 1932.
Department of National Defence, Canada:
List of Officers, Defence Forces of the Dominion of Canada, Part 1, April, 1931.
Department of Labour, Canada:
Labour Legislation in Canada, 1931.
Department of Mines, Ontario:
Bulletin No. 83: Twenty-five Years of Ontario's Mining History.
Geological Survey, United States:
Professional Paper 161: Quaternary Geology of Minnesota and Parts of Adjacent States.
Professional Paper 170-E: The Geologic Importance of the Lime-Secreting Algae.
Bureau of Mines, United States:
Technical Paper 530: Accidents at Metallurgical Works in the United States, 1930.
Petroleum in 1930.
National Research Council, Division of Engineering and Industrial Research, Highway Research Board, United States:
Proceedings of the Eleventh Annual Meeting, Washington, D.C., December, 10-11, 1931, Part 1: Reports of Research Committees and Papers.
Ohio State University:
Eng'g Experiment Station Bulletin No. 70: Equilibrium Studies in Systems Containing Magnesium Oxide, Iron Oxide and Magnesium Aluminate.
Eng'g. Experiment Station Bulletin No. 71: Radio Transmission Characteristics of Ohio at Broadcast Frequencies.
Eng'g Experiment Station Bulletin No. 72: The Effect of Size of Specimen on the Strength and Elastic Properties of Cast Iron.
National Electric Light Association:
Electrical Apparatus Cttee., and Foreign Systems Co-ordination Cttee.: Generator Wave Shape.
Accident Prevention Cttee., and Underground Systems Cttee.: Safe Practices in Cable Identification.
Rural Electric Service Cttee.: Progress in Rural and Farm Electrification.

Technical Books, etc.

Presented by Blackie & Son, Ltd.:
Steel and Its Practical Applications, by Barr and Honeyman. 1932.
The Physics of Solids and Fluids, by Ewald, Poschl and Prandtl. 1930.
Metallurgy, by Edwin Gregory. 1932.
Presented by D. Van Nostrand Company, Inc.:
The Wichert Truss, by J. C. Olsen. 1932.
Presented by E. & F. N. Spon, Ltd.:
Modern Coal Cleaning Plant, by Sydney H. North. 1932.
Presented by Canadian Industries, Limited:
Chemistry and Industry, Vol. 50, 1931.
Presented by J. L. Busfield, M.E.I.C.:
F.B.I. Register of British Manufacturers, 1931-32.
Presented by Aluminum Company of America:
Supplement to the Structural Aluminum Handbook, 1932.
Presented by Universal Oil Products Company:
The Cracking Art in 1930-1931 [229 pp.].—Reprinted from Journal of the Institution of Petroleum Technologists, April, 1932.
March of the Octanes [13 pp.].
Presented by Hydro-Electric Power Commission of Ontario:
Supplement "D" to List of Electrical Equipment Approved by the Commission, May, 1932.
Presented by Institution of Electrical Engineers:
The Electrification of the Suburban and Certain Main-Line Sections of the Great Indian Peninsula Railway (Reprint of a Paper read by Mr. F. Lydall before the Institution of Electrical Engineers on April 28, 1932).
Purchased:
"Unit Processes and Principles of Chemical Engineering," by J. C. Olsen. Published by D. Van Nostrand Company, Inc.
"Total Eclipse of the Sun, August 31, 1932," by A. Norman Shaw and A. Vibert Douglas. Published by Renouf Publishing Co.

Catalogues, etc.

Priestman Brothers, Ltd.:
Priestman Grab Dredgers [4 pp.].
Vickers, Limited:
[Exhibits at Canadian National Exhibition, Toronto, 1932] [24 pp.].
Pressure Pipe Co. of Canada, Ltd.:
[Bonna Pipe] [19 pp.].
Kingsbury Machine Works, Inc.:
Bulletin S: Horizontal Mountings [35 pp.].
De Laval Steam Turbine Company:
De Laval Single Suction Multistage Pumps [24 pp.].
Baldwin-Southwark Corporation:
High Pressure Hydraulic Pumps [12 pp.].
Huggenberger Tensometers [12 pp.].
I. P. Morris Propeller Turbines [8 pp.].
Canadian Sheet Piling Co. Ltd.:
Bridge Over Richelieu River at Sorel, Que. [8 pp.].

William Hamilton Limited, Montreal, have recently completed an agreement with the Couch Manufacturing Company of Grant, Fla., whereby the Canadian company is to manufacture Hydrolite. Hydrolite is the trade name for a complete self-contained hydro-electric unit consisting of an efficient turbine mounted on a cast iron base and directly connected to a generator mounted on the same base. These turbines are manufactured in two different types for operation under heads of from four feet up. The William Hamilton Company is distributing a twenty-four page booklet entitled "The Couch Hydrolite," which describes and illustrates this equipment.

Interim Report of the Committee on Development, September, 1932

Note

At the Plenary Meeting of Council held in September 1931, it was decided that a Committee on Development should be appointed with a view to recommending a policy for the further development of The Institute. In due course the following committee was named:

J. L. Busfield, M.E.I.C., Chairman
W. C. Adams, M.E.I.C. (Ex-Treasurer)
F. A. Combe, M.E.I.C. (Ex-Councillor)
A. R. Decary, M.E.I.C. (Past-President)
G. H. Duggan, M.E.I.C. (Past-President)
J. M. R. Fairbairn, M.E.I.C. (Past-President)
A. J. Grant, M.E.I.C. (Past-President)
C. H. Mitchell, M.E.I.C. (Past-President)
O. O. Lefebvre, M.E.I.C. (Vice-President)
S. G. Porter, M.E.I.C. (Past-President)
R. A. Ross, M.E.I.C. (Past-President)
J. C. Smith, M.E.I.C. (Past-President)
A. Surveyer, M.E.I.C. (Past-President)
H. H. Vaughan, M.E.I.C. (Past-President)
G. A. Walkem, M.E.I.C. (Past-President)

After months of deliberation this committee has prepared an interim report dealing with the re-organization of The Institute, the general idea being that the proposals contained therein will form the basis for definitive recommendations to be made later regarding the future of The Institute.

The Interim Report is now published by direction of Council, in order to enable every member to study its recommendations before the submission to ballot of an amended set of By-laws.

Attached to the report there is a memorandum by the chairman of the committee containing explanatory comment, which should be considered with the report itself.

The text of the report follows:—

Objects

1. The "objects" of The Institute as given in Section 1 of the present By-laws were given serious consideration, particularly as to whether they indicated the most useful line of activity along which The Institute should be developed, whether they were as concise as possible, and whether any improvements could be made.

2. It was felt to be of importance that the "objects" should be stated in some sequence of relative importance so far as it was possible to form an opinion in this connection, and after careful study, the conclusion was reached that some of the existing "objects" were redundant or that they were of such secondary nature as not to warrant inclusion under this heading, and furthermore that it would be only proper to write into the "objects" some reference to the members' own obligations.

3. With the above ideas in mind, it was decided to recommend that the "objects" be cited as follows, special reference being drawn to the new object "*c*":—

The objects of The Institute shall be:—

(*a*) To facilitate the acquirement and the interchange of professional knowledge.
(*b*) To collaborate with universities and other educational institutions for the advancement of engineering education.
(*c*) To provide a means whereby its members may be of service to the profession and to the community in general.
(*d*) To co-operate with other technical societies for the advancement of mutual interests.
(*e*) To enhance the usefulness of the profession to the public.
(*f*) To promote the general welfare of its members and generally to maintain high ethical standards in the profession.

This would reduce the number to six instead of eight as at present.

Membership

4. Having determined the objects of the organization, the next logical step is to prepare a specification to define the qualifications that members should have in order to carry out the said objects to the fullest possible advantage.

5. One of the basic principles upon which all discussions were based was the existence of the Associations of Professional Engineers, and the desirability of The Institute giving them official recognition. It was also felt that while every possible step should be taken to develop The Institute along its own natural lines, primarily for the acquirement and interchange of professional knowledge, nevertheless care must be taken to ensure that in this development no opportunity should be lost which would put The Institute in a position to be of service to the professional associations in the carrying out of their various functions. This point should be especially taken into account in the consideration of the recommendations contained in this report.

6. The average member of The Institute expects something more from the organization than a mere means of interchange of knowledge—he has the right to expect that membership will give him some prestige, and will give him opportunities of service to his profession and to the community, which he would not have as an isolated individual. In order that these expectations may be met to the fullest possible extent, it is necessary that the membership in the organization must be comprehensive, for in general the greater the membership of an organization, the greater is the influence it can exert on public affairs.

7. Purely from the point of view of the interchange of professional knowledge one might develop an argument favouring the admission of anybody who was sufficiently interested to pay the fees, but this would obviously be unsound in principle, as the organization might quite easily become cluttered up with dead wood and would therefore fail to function properly. Furthermore, this is not the only function of The Institute—and so a happy medium has to be struck between the strictly professional requirements which have to be given precedence in such organizations as the Associations of Professional Engineers, and the above mentioned limit of no requirements at all. The committee's aim has therefore been to determine membership qualifications which would enable The Institute to carry out its objects to the fullest possible extent and at the same time to ensure that its members will retain the prestige to which they have the right.

8. The present membership qualifications leave a good deal to be desired. No useful purpose has been served by the attempt to grade practising engineers into Members and Associate Members—but on the other hand many difficulties and annoyances continually occur through this differentiation. After due analysis of the requirements of the case it was felt that the best possible results would be obtained by having the bulk of the organization made up of the one class, "Member," but that it would be beneficial to give special recognition to men who had become leaders in the profession by providing a special class of "Fellow"—limited in number and with strict requirements for admission. It was also thought advisable to retain Honorary Members—but to limit membership in this class to eminent and distinguished people not actually practising the profession, thus making engineers who were still practising ineligible—but if they had retired they would be eligible.

9. Provision has to be made for the student and young man who is entering the profession—not necessarily as a mark of differentiation, but rather to provide a means for a lower fee—more in keeping with his lack of earning power. The class "Junior" would be available, with the alternative of membership in Branch Student Sections.

10. Then finally there is the group of those on the fringe of the profession—who are not actually practising the profession, yet who are desirable people with whom to associate,—provision is therefore made for "Associates," who would include present "Affiliates" and also those "technicians" who are not as yet really doing engineering work—some of this group would ultimately transfer to the class of Member—but many would be following lines of activity which would never qualify them for this grade.

11. Summarizing therefore, it is recommended that the membership of The Institute be constituted as follows:—

Honorary Members
Fellows—not to exceed two per cent of the total membership
Members
Juniors
Associates—not to exceed twenty per cent of the total membership.

Of these, only Fellows and Members would have Institute voting privileges, but Associates would have the Branch franchise.

Qualifications for Membership

12. In giving consideration to qualifications for membership, the method of admission must also be studied, as it is the combination of both professional and personal characteristics which have finally to be taken into account. The following recommendations are therefore made.

13. Honorary Members shall be selected only from eminent people who are not practising the engineering profession.

14. Fellows shall be at least forty years of age, shall have been Members of The Institute for at least four years, and shall have reached positions of eminence or distinction in the engineering profession. Provision should be made to cover individuals who have passed through the usual engineering channels to high executive offices.

15. If a President of The Institute is not a Fellow on his election to office, he shall automatically become a Fellow thereon.

16. Members shall be at least twenty-six years of age, and professional requirements for this class shall be covered by the following alternatives:—

(*a*) Membership in the Association of Professional Engineers in the Province in which the applicant resides, or

(*b*) At least one year in an engineering position following graduation from a school of engineering recognized by the Council, or

(*c*) In the case of an applicant who does not fulfil either of the above requirements at least eight years in an engineering position, the applicant producing evidence satisfactory to Council to the effect that he has made substantial advancement in the profession, and showing that he has attained a standard equivalent to requirements (*a*) or (*b*) above. If there is any doubt regarding the attainment of these qualifications, Council may require the applicant to appear before a Committee of Council.

17. Juniors shall be at least eighteen years of age. Students who have been enrolled at a recognized engineering college, or graduates of recognized colleges with less than one year in an engineering position, following graduation, shall be eligible as Juniors.

18. In the case of applicants who have not attended a recognized engineering college, they shall present a certificate of having passed an examination equivalent to the final examination of a High School, or

matriculation in a school of engineering recognized by the Council, and furthermore they shall have been at least two years in the employ of engineers or organizations where they have had the opportunity of laying the foundations for an engineering career.

19. In no case shall Juniors remain in this grade for more than four years after graduation unless they are under the age limit for Member, nor after reaching the age of thirty years. The foregoing age limit may be waived by Council in cases where special circumstances arise.

20. Associates shall be at least twenty-one years of age and not qualified for admission as Member of The Institute, but shall be (*a*) qualified to fill a subordinate position in engineering work, or (*b*) persons whose pursuits, occupation, scientific attainments or practical experiences qualify them to associate with engineers in the practice of the engineering profession or in the advancement of professional knowledge.

21. Before admission, candidates shall not only possess the qualifications for membership outlined above, but shall also comply with the requirements for admission as provided in the following paragraphs under "Method of Admission."

Method of Admission

2. Personal characteristics must be given considerable weight in considering prospective applicants and therefore the method of admission must have fairly stringent requirements regarding sponsorship and so forth.

23. *Honorary Members* shall be elected by a unanimous vote of Council by letter ballot.

24. *Fellows* shall be elected by letter ballot of Council, and they should be selected from the list of Members by a "Fellows Committee"—composed of a select number of Fellows, who would after conferring with Branch Executives and, say, once a year, submit the names and records of a limited number of men whom they would recommend for transfer; finally the nominee would become eligible for transfer provided three-quarters of the votes cast were favourable, with the requirement that at least one-half of the Councillors must have voted. There would be no way for a member to apply for transfer to this grade.

25. Applications for admission as Member, Junior, or Associate, or for transfer from Junior or Associate, should be made generally as at present, but while requiring five sponsors for Members, two only would be required for Juniors—one only for Juniors when the applicant is at a university or an engineering college—and three for Associates. Each application form must be signed personally by a Member or Fellow acting as "Proposer," and forwarded by him to the Secretary of The Institute.

26. In the case of all residents of Canada, the favourable recommendation of the Executive Committee of the Branch to which the applicant belongs must be obtained. In the case of non-residents of Canada the applicant must be a member of a recognized engineering society, of the country in which he resides.

27. Apart from the above changes, the general procedure for admission and transfer would be much the same as at present.

Management

The Council

28. Considerable thought and study has been given to the composition of the Council of The Institute, and comparisons made with many other organizations. The conclusion that has been reached is that there is room for improvement in the present arrangements but that there are a number of obstacles which make it difficult to give effect to many ideas for improvement which have been discussed.

29. One of the most important points, however, can readily be put into effect, and that is the de-centralization of authority to a greater extent than is now the case. The proper organization is in existence to a great extent, but sufficient advantage is not taken thereof. It is proposed that the regional or Zone Vice-Presidents should be expected to take far more responsibility upon their own shoulders than has been customary heretofore. In the first instance men should only be elected to the Vice-Presidencies for their proved leadership, for their public standing, for their ability to make decisions on pressing matters, for their knowledge of Institute policies, for willingness to take responsibility on their shoulders—and not, on the other hand, just as an honour or reward for past services, nor as a mere promotion. It is hoped that future nominating committees will pay attention to these points, as the successful development of The Institute will depend to a great extent on the personal characteristics of the individuals elected to the higher offices. If it is desired to give recognition to a member for some particular services, other means must be found rather than election to office, unless the individual in question is capable of fulfilling the functions of the particular office.

30. On accepting nomination to a Vice-Presidency, the nominee must appreciate that the position is not a sinecure, but that he will be expected to devote his best energies, much thought, and considerable time to the welfare of The Institute, to take action on many matters without waiting for the guidance or instructions of Council, to advise and guide the Branches within his territory, to uphold the dignity of the profession, to encourage the interest of The Institute's members, to develop the activities of the organization and to undertake many other responsibilities.

31. Development along these lines cannot be provided for in by-laws, but can only be promulgated by word of mouth and by written reports for the guidance of the membership, but if the requirements of the position are definitely known, it is not anticipated that there will be any difficulty in finding men of the right calibre. They will, of course, not be able to make decisions in cases of applications for admission or transfer, nor on matters of general policy, except under a local emergency, nor on financial matters. There will, however, be many activities in other lines. Furthermore, it would be far better for a Vice-President to err on the side of doing too much or of taking too much responsibility on his shoulders, than for him to do nothing of importance through fear of criticism or through lack of interest.

32. A review of the present Vice-Presidential zones would indicate that one at least, the western zone, is a very large territory with widely varying conditions for which one man can hardly be expected to assume responsibility, and it is therefore recommended that the western zone be divided so as to provide for one Vice-President for the three prairie provinces and another for British Columbia. This would increase the number of Vice-Presidents from five to six.

33. With regard to the composition of Council, it appears that it is far greater in numbers than any comparable organization. This does not seem to be a desirable feature, especially as it adds to the expense of operation without necessarily having any greater value than a smaller Council. The present Council consists of 3 Past-Presidents, 1 President, 5 Vice-Presidents and 33 Councillors, making a total of 42. (Each Branch having less than 200 members is entitled to one Councillor, between 200 and 400 members, two Councillors, and one additional Councillor for each 200 members over 400.) Apparently the only feasible ways to reduce the size of Council would be either to provide for the alternation of Councillors between some of the smaller branches, or to have Councillors representing geographical areas without reference necessarily to Branches within these areas. Under the former alternative it is questionable at present whether the disadvantage and dissatisfaction which might be created would be worth the advantage of a reduction in numbers, and under the latter alternative other similar difficulties would be created. While therefore the Committee is of the opinion that it would be advantageous to reduce the number of Councillors, no recommendation is made in this regard for the present.

34. On the other hand, care must be taken that the present number of Councillors is not unduly increased, and the existing system of proportioning the number in relationship to Branch membership would result in an increase in the size of Council if there were a material increase in the membership. This is a very undesirable feature of the present system, which also has the disadvantage of requiring a careful analysis of the Branch membership for the purpose of determining the number of Councillors to which each Branch is entitled. It is therefore recommended that the present allocation of Councillors be adhered to, for the present. The by-laws would therefore provide for the following Councillors:—

Branch	*Councillors*	*Branch*	*Councillors*
Halifax	1	London	1
Cape Breton	1	Niagara Peninsula	1
St. John	1	Border Cities	1
Moncton	1	Sault Ste. Marie	1
Saguenay	1	Lakehead	1
Quebec	1	Winnipeg	1
St. Maurice Valley	1	Saskatchewan	1
Montreal	6	Lethbridge	1
Ottawa	2	Edmonton	1
Peterborough	1	Calgary	1
Kingston	1	Vancouver	1
Toronto	3	Victoria	1
Hamilton	1		

35. Provision would be made in the by-laws that in the event of the formation of a new branch such branch would be entitled to one Councillor, more than this being unnecessary in view of the extreme improbability of a large new branch springing up.

The President

36. The present by-laws define the duties of the President, namely,—"general supervision of the affairs of The Institute and ex-officio a member of all Committees." It would not appear necessary or advisable to make any change.

The Vice-Presidents

37. Under the present by-laws Vice-Presidents are not given any specific duties other than to take the place of the President at Council meetings and so forth. Under the new by-laws definite reference should be made to the duties of the Vice-Presidents on the lines previously discussed, so as to make it quite clear that they are to take responsibility for acting on behalf of The Institute within their own territories.

The Secretary

38. Some modification and additions might well be made to the Secretary's duties as defined; for example, there is no reference to his editing The Journal, although it is specifically stated that he shall be responsible for editing the Transactions. The by-law covering his duties also specifies the method of signing cheques and as will be explained later it is proposed to make a small change in the present method of operation.

39. With regard to the Secretary's term of office, there are two by-laws at present, namely Sections 16 and 18, which conflict, the former stating that the Secretary holds office subject to removal by an affirmative vote of the majority of the members of Council, while Section 18 calls for the Secretary to be appointed at the first Council meeting subsequent to the Annual Meeting. In view of the nature of the employment it is recommended that definite provision be made in future to cover the first of these methods, eliminating the requirement of annual appointment.

The Treasurer

40. Under the present by-laws, Section 17, the Treasurer is not given many duties except to attend Council meetings, present an annual statement and such other reports as may be prescribed. He also has to join the Secretary in investing the funds of The Institute as ordered by Council. This is not very satisfactory, and it is felt that the Treasurer can be made to function more usefully by adding to his duties the requirement that he shall sign all cheques, after he has satisfied himself that payments have been properly authorized. The presentation of the Annual Statement may be deleted from his duties and referred to the Finance Committee. He should be an ex-officio member of the Finance Committee.

41. Under the present by-laws there is the same conflict regarding his term of office as appears in the case of the Secretary. In this case, however, it is recommended that the appointment be an annual one as covered by Section 18, and not continuous as suggested in Section 17 of the present by-laws.

42. In view of the facts that the position of Treasurer is purely honorary, that the Treasurer is required to attend all Council meetings, and that he must naturally be thoroughly acquainted with Institute affairs, it is recommended that in future he be included in the "officers" of The Institute and thereby become entitled to vote at Council meetings

Executive Committee

43. There are occasions when it may be desirable for Council to appoint an executive committee with power to take action on urgent matters between meetings of Council, and provision should be made whereby Council may appoint such a Committee at its discretion, but it should be definitely stipulated that the Executive Committee shall not have the power to deal with applications for admission or transfer, nor to fill vacancies in the Council nor pass on any matters which according to the by-laws require the majority vote of Council. Such an Executive Committee should be selected from among the officers of The Institute.

Finance Committee

44. The present duties of the Finance Committee, as defined in Section 19 of the by-laws, would appear to be satisfactory, with the exception that the last paragraph, requiring a member of the Finance Committee to countersign all cheques drawn by the Secretary, should be changed. The general procedure in this connection which is now recommended is as follows:—all invoices, vouchers or bills shall be certified by the Secretary as to their accuracy and correctness, no payments shall be made until approval has been given by the Finance Committee or its duly authorized representative, and finally the cheques shall be signed first by the Secretary, and second, by the Treasurer after he has verified that proper certification has been made. In order, however, to provide for the absence of the Secretary and/or the Treasurer it should be arranged that the signature of any two members of the Finance Committee will be acceptable as substitutes.

45. The Annual Financial Statement should be presented to Council by the Finance Committee.

46. It has been customary to include the Treasurer in the membership of the Finance Committee, and as this would seem very desirable it is recommended that in future, the Treasurer be an ex-officio member of this committee.

Library and House Committee

47. No change is recommended with regard to the functions of this Committee except in so far as the provision that it "shall direct the expenditure for books and other articles of permanent value of such sums as may be appropriated for these purposes." Under present day conditions where additions to the library are only of a routine character this particular function might well be omitted in order to avoid confliction of authority.

Papers Committee

48. With the idea of simplifying the by-laws as far as possible, it is recommended that the by-law covering the work of the Papers Committee should read as follows—

"The Papers Committee shall advise and assist in obtaining papers for the meetings of The Institute or its Branches."

49. The second paragraph of the present by-law, Section 21, which really covers rules regarding papers, should be published in The Institute's booklet or elsewhere, but should not be included as a by-law of The Institute.

Publication Committee

50. The present by-law, Section 22, dealing with the Publication Committee was probably written prior to the present development of The Institute publications and should therefore be changed to meet present day conditions.

51. The Journal of The Institute has a Board of Management to which reference is made on the Editor's page, but which has never functioned. Nevertheless, it is desirable that there should be some authoritative committee to whom the Editor of The Journal may refer when he needs advice and assistance. It is therefore recommended that the by-law covering the Publication Committee shall make the same reference as at present regarding the composition of the committee, but shall specifically state that the committee shall act in an advisory capacity to the Secretary or Editor, with regard to all The Institute's publications, and shall select all papers for the transactions as heretofore.

52. The second paragraph of Section 22, providing an appeal from the decision of the committee should be deleted. There is no feasible way for such an appeal to be made or handled.

By-laws and Legislation Committee

53. In recent years the function of the Legislation Committee as defined in the present Section 23 of the by-laws, namely to watch legislation affecting engineers has become somewhat of a dead letter. On the other hand this committee has been performing the useful function of passing upon all proposed amendments to the by-laws, especially with regard to the effect of such amendments on other by-laws. It is therefore recommended that the name and duties of this committee be definitely set forth in future as the By-laws and Legislation Committee, to which all amendments to by-laws proposed by the membership at large shall be submitted for investigation and report to Council, such report covering not only questions of conflict, but also questions of policy. When amendments emanate from Council, the Committee will only be required to pass upon questions of conflict and wording.

54. The present function of watching legislation should be continued.

Adoption of Specifications

55. The function of preparing and issuing standard specifications is now the purpose of the Canadian Engineering Standards Association, so there is no object in retaining Section 24 of the by-laws and this section should be entirely deleted.

Nomination and Election of Officers

56. Under the present by-laws, Sections 64 to 72, provision is made for the appointment of a Nominating Committee, which consists of one member appointed by each Branch, and a chairman appointed by Council. It is obviously impossible for this body to meet as a committee, so the procedure is that each individual obtains recommendations from his Branch Executive and passes such recommendations to the chairman. This procedure is not provided for in the by-laws, and actually there is nothing to prevent the individual member of the committee making the nomination without reference to anybody. This would not be so serious if it were incumbent upon him to make at least two nominations for any vacancy, in which case the final decision would be made by ballot of the membership. It is permissible, however, for only one nomination to be made, in which case an election by acclamation is effected, unless the rather remote possibility of a number of members getting together and making an independent nomination is put into effect.

57. Although not covered by by-laws, what is actually in effect today, and furthermore, what seems to be a very desirable procedure, is that nominations for Councillor are made by the Branch Executive committees. If such a committee decides to make a single nomination, thereby electing by acclamation, except with the remote proviso referred to above, there is no objection. It should be still permitted, as heretofore, for two nominations to be made for each vacancy so that the membership at large would make the final decision. The procedure recommended, therefore, with regard to the nomination for Councillors in future is that each Branch Executive submit one or more names for each vacancy direct to Council together with the acknowledgement of the nominee as now provided. The nominations would be published as heretofore and opportunity provided for the addition of new nominees by any group of ten corporate members.

58. With regard to the nomination of Vice-Presidents, a somewhat different condition is introduced, because each Vice-President represents a zone including a number of Branches. Under our present system, although not provided in the by-laws it is apparently customary for the members of the Nominating Committee resident in any particular zone to confer together, generally by correspondence, and submit to the chairman of the Nominating Committee their recommendations. In order, however, to comply with the general procedure outlined above, whereby the Branch Executives are brought more prominently into the picture, it is recommended that the chairmen of the Branches within a particular zone act as the nominating committee for the Vice-President of that zone and that the Branch chairman who has priority of admission to corporate membership of The Institute be chairman and organizer of the committee. In the remote possibility of there being two chairmen with the same date of admission, provision should be made for the Council to nominate the chairman of the committee. In the case of the Montreal Vice-Presidency as there is only one Branch involved, the zone nominating committee should be replaced by the Montreal Branch Executive Committee. This would only be in effect provided there were no other Branches in this zone.

59. Although not specifically covered in the by-laws, the nomination of the President has almost always been left to the three immediate

Past-Presidents who were ex-officio members of the Nominating Committee. It is recommended that this procedure be given definite recognition by making the three Past-Presidents directly responsible for the Presidential nomination. One nomination only should be submitted as heretofore. There is one difficulty which might arise and that is that the three Past-Presidents might unwittingly nominate a man for the office of President who was also being nominated as a Vice-President. This could be avoided by requiring the Presidential nomination to be made prior to the nominations of the other officers.

60. It is not proposed to make any changes in the present procedure regarding the submission of the nominations to Council, except that it will be done by the Branch Executive committee for chairmen and Past-Presidents, instead of by the chairman of the Nominating Committee as at present. The nominations should be published in The Journal and the provision that ten corporate members may make a special nomination should be retained.

61. The second paragraph of Section 69 of the by-laws dealing with the officers' ballot, provides that voters may strike out names and substitute other names therefor. As this only leads to confusion, is obviously futile and is quite unnecessary after provision for such nominations as referred to above, it is recommended that this provision be deleted.

62. In the case of a tie resulting in a ballot between two or more nominees for the same office, the present by-laws require a further ballot to be taken at the annual meeting. Experience has shown that this procedure is unsatisfactory, and it is recommended that it would be better for ties to be settled by priority of admission to corporate membership in The Institute. If a tie should still exist, the presiding officer at the annual general meeting should cast a deciding vote.

FEES

63. The following is the recommended schedule of entrance and annual fees. There should be no entrance fee for Honorary Members, nor transfer fee for Fellows.

Entrance Fees

Members	$25.00
Juniors	10.00
Associates	10.00

Annual Fees

		If paid on or before March 31st.
Montreal Branch Residents		
Fellows	$26.00	$25.00
Members	14.00	13.00
Juniors	7.00	6.00
Associates	11.00	10.00
Branch Residents		
Fellows	$26.00	$25.00
Members	11.00	10.00
Juniors	5.00	4.00
Associates	8.00	7.00
Branch Non-Residents		
Fellows	$26.00	$25.00
Members	9.00	8.00
Juniors	4.00	3.00
Associates	6.00	5.00

Note that the above fees are *exclusive* of the subscription to The Journal, which is compulsory and will be $2.00 to all members as heretofore.

64. In recommending the foregoing schedule, many considerations were taken into account, such as making the rates proportionate to the possible service rendered, leading to the three different groups as indicated above. There seemed no reason, however, for any distinction to be made in the class of Fellow and the fee for this class should be $25.00 if paid before March 31, regardless of location.

65. The fee recommended for Members, it will be noted, is the same as today, which will mean that all present Associate Members will become "Members" and will have to pay a somewhat higher fee. While this may be objected to by some members, there are the countervailing facts that it is hoped that The Institute will be developed into a more valuable organization, that the rates are not unduly high, (in fact in comparison with other organizations they are low), that the membership very nearly voted in favour of increasing the fees two years ago, and that means must be found for increasing The Institute's revenue.

66. In the case of the class of Junior—a new conception arises, and it was felt undesirable to continue the present almost gratuitous service to the Student class—but rather to institute a worth while entrance and annual fee. This action will undoubtedly result in a reduction in members in this class, but this will not be any loss financially but rather the reverse. It was appreciated, however, that it was of vital importance that means should be provided whereby the student can obtain Institute benefits at a nominal fee, and to this end it is recommended that in future, Branches take "Students" into their organizations charging them a nominal fee of say $1.00 or $2.00 per year. In this way Branches would obtain more revenue than at present and The Institute would be relieved of the responsibility of carrying a number of Students at a nominal fee. After graduating, the Branch Student would have to apply for Junior membership in The Institute—or earlier if he so desired.

67. The fees for Associates were fixed at a fairly low scale in order to give preference to the class of subordinate engineers, rather than to the higher and wealthier class such as belong to the grade of Affiliate today.

Compounding of Fees

68. In the past there has been some criticism of the present Section 39 of the by-laws, providing for the compounding of fees. It has been thought that the scale was too low, but even so it has not been taken advantage of to an undue extent. For example at the present time sixteen members have compounded their fees, of whom two are not resident in Canada.

69. The by-law now provides a single payment of $250.00 upon admission to corporate membership, $150.00 after 10 years of corporate membership or $100.00 after 15 years of corporate membership, with the additional requirement that an Associate Member will have to pay the usual transfer fee when he becomes a Member. These provisions are obviously a very rough guess at the theoretically correct amount, which should not only be based upon mortality tables, but also on the various rates of annual fee. Furthermore, it is hard to provide for the compounder who changes from a resident to non-resident or vice versa. In other words, in order to provide a schedule of rates reasonably accurate and fair both to the member and to The Institute it would be necessary to prepare a series of tables giving various payments covering a variety of different conditions. The alternative, of course, with the advantage of simplicity, is to utilize the present system. The present rates are all in favour of the compounder and absolutely against the financial interest of The Institute. For example, the $100.00 rate is at least one-half of what it should be for a Montreal member, unless he is very well advanced in years. If the rates were materially increased presumably nobody would take advantage of compounding.

70. A serious objection might well be raised to the whole principle of compounding of fees. How is a compounder going to be expelled or suspended for a breach of ethics or other serious offence? This is an action which rarely takes place, but nevertheless it must always be looked upon as a possibility.

71. In view therefore of the foregoing considerations, and especially in view of the small numbers that have taken advantage even of low rates, it would appear to be a simplification if the provision for compounding of fees were dropped entirely. In the past it has been of little advantage to The Institute—perhaps even a financial loss—and the membership certainly cannot claim very much interest in the matter one way or the other. It is therefore recommended that Section 39 be eliminated.

Arrears, Exemptions and Life Membership List

72. There would appear to be no reason for changing the conditions applicable to "Arrears, Exemptions and Life Membership List." This section of the by-laws has recently been remodelled and it is too soon to ascertain whether or not it is in the best interests of all concerned.

Meetings

73. There is very little need to change the by-laws regarding meetings, except to make a few modifications, especially owing to the elimination of provincial divisions as will be recommended later. Section 45, providing for meetings of the Nominating Committee, can be eliminated.

Branches

74. The group of by-laws covering the activities of Branches does not need very much alteration. Section 52—second paragraph should provide that a Students' section shall be formed at each Branch where there are universities or training centres, and that the Branch may at its option, charge a fee not exceeding $2.00 per annum for membership in such a section.

75. The Branches' annual financial reports should be more uniform than they are today, and it would therefore be wise to provide that the financial reports be made in a form approved by Council.

76. The scale of rebates should not be changed at present. With the new schedule of fees there will be an increase in revenue to the Branches and it is not desirable to alter the rebates until further experience has been gained as to the effect of the new conditions.

Provincial Divisions

77. The establishment of provincial divisions led to the formation of the Provincial Associations of Professional Engineers, and it would appear as though there is no further useful function to be performed by such divisions; indeed they have practically become a dead letter. It would therefore appear desirable to eliminate Sections 58 to 63 of the present by-laws covering provincial divisions.

Expulsion and Discipline

78. Section 31 of the By-laws deals with the methods for expelling or disciplining a member, and is a very important section, even though it is very rarely utilized. It is a matter for congratulation that very few

engineers "run foul of the law," but nevertheless if they do there is little difficulty about applying part (*a*) of Section 31.

79. Breaches under part (*b*) however, are very difficult to deal with and the by-law is usually found quite ineffective when some case does come up. In fact this by-law is used so rarely that it is not possible to get sufficient experience in its operation to develop a line of procedure which will meet all the requirements of the case. It would seem that nearly every time a case does come up for consideration the by-law is found ineffective and so it is changed, and then some years slip by before there is any possibility of it being applied.

80. In studying this whole problem today, consideration has to be given to changed conditions For example, it must be noted that the Associations have the right in most cases to discipline their members, and it would seem right and proper for The Institute to recognize such action.

81. Getting down to basic requirements, the following are the essentials:—

(*a*) Means for immediate dismissal of a member convicted of a felony, etc.

(*b*) Means for giving advice to members regarding professional conduct.

(*c*) Means for reproving members unintentionally or deliberately ignoring professional practice.

(*d*) Means for the expulsion of members flagrantly disobeying by-laws or professional codes.

82. Item (*a*) is already suitably provided for in (*a*) of Section 31.

83. Item (*b*) is not provided for at all, and is something which should be developed to the fullest possible extent. A means for carrying out this function would be the appointment of a Standing Committee on Conduct.

84. Many members might take advantage of this committee to obtain advice on all kinds of matters, and in addition complaints might well be laid before it for further action, thereby complying with requirement (*c*).

85. One of the greatest difficulties in getting any action on breaches of professional conduct, whether of minor or of major importance, is that of getting some member to make a complaint, because of the possible reactions against himself, while obviously anonymous complaints cannot be dealt with. A solution of this difficulty might be obtained by providing that a request for guidance, or a complaint against a member might be made with the writer's name submitted to the Secretary only and not transmitted to the Committee or to Council without the writer's permission. In the case of minor complaints it should be possible for the Committee on Conduct to communicate the nature of the complaint to the offender and after giving him opportunity to reply thereto, draw his attention to the undesirability of his actions, if such reference seems justified.

86. In the case of a really serious complaint Council should certainly have the right to suspend or expel a member, but there is no sound reason why the offender should be faced with the complainant. The exigencies of the case and of British justice would be met if a copy of the complaint were transmitted to the offender, giving him the opportunity to defend himself. If he failed so to do, to the satisfaction of the Committee on Conduct, Council could then decide on the necessary disciplinary measures.

87. The present by-law is framed to take care of really serious cases which very seldom occur, and make no provision for action with regard to minor matters, nor to guiding members who are honestly in doubt. It would appear therefore that development along the above lines with a Committee on Conduct, with a degree of privacy for the member seeking advice or making a complaint would materially enhance the usefulness of The Institute.

88. The new sections of the by-laws covering expulsion and discipline of members should include reference to professional codes, as will be made later herein.

Code of Ethics

89. The foregoing discussion on discipline naturally leads directly to consideration of the Code of Ethics. A review of the situation in Canada today reveals that in addition to The Institute's Code, the eight professional associations have Codes of Ethics or regulations regarding conduct. They vary from six to fifteen paragraphs in length, but generally speaking cover the same points in different phraseology. It can at least be said that they do not actually contradict each other.

90. The present Institute Code of Ethics sets forth in ten commandments a series of ideals towards which presumably everybody strives. If the Code was definitely recognized as something unattainable but just a beautiful objective perhaps it would perform a useful function, but unfortunately the Code of Ethics is supposed to be adhered to by all members, as a breach of the Code makes a member liable to censure, suspension or expulsion. How many members have been censured, suspended or expelled from The Institute for a breach of the Code of Ethics? Very, very few, and none at all since the adoption of the present code. Further, when a case does occur where a member's conduct is apparently unprofessional it is usually found that there is no section of the Code which exactly covers his particular sin, and therefore nothing is done about it. The result of such a situation is that the Code has to be interpreted, and it is very easy to interpret it not to mean what it says. In nearly every clause there is some word or phrase which is indefinite, and which may be interpreted in entirely different ways under different circumstances. For example clause 2, the word "questionable," clause 3, "dignified" and the general phraseology of other clauses when applied to any given set of circumstances resolve themselves very much into a matter of opinion.

91. The fact that the Code of Ethics can be violated with impunity under certain circumstances, and, indeed, is almost universally violated, nullifies its value. The majority of engineers have an inborn professional spirit which instinctively guides their footsteps in the proper path, and as far as the others are concerned it is doubtful if any written document has much value. Much good, however, can be done in fostering the proper professional spirit by proper guidance and association. This is where The Engineering Institute can render valuable service by providing the means for personal associations, and through these personal associations the man who is inclined to act unprofessionally will soon find that he is liable to be an outcast. Professional practice is not very different from sportsmanship. A sportsman knows instinctively how to act under given circumstances, it is bred into him, those new to the game learn from the actions of the older adherents—similar procedure takes place in the engineering profession.

92. It is therefore recommended that the Code of Ethics as now published by The Institute be abolished and that the by-laws on Expulsion and Discipline include the following paragraphs:

> 93. Every member shall conduct himself at all times in accordance with the Codes of Ethics or regulations regarding conduct effective or in force in the province or country where he resides, interpreting its provisions in a spirit of fairness, fidelity and devotion to high ideals.
>
> 94. Expulsion or Suspension from a provincial professional association, or in the case of non-residents of Canada from an institution or society comparable to The Engineering Institute, for a breach of ethics or similar cause, shall be sufficient reason for Council to expel or suspend the member without any further investigation of the case.

Memorandum on the Interim Report of the Committee on Development

Historical

The purpose of the committee has been essentially to look to the future, to develop ways and means for the betterment of The Institute, and generally speaking the policy has been to study matters from the viewpoint of basic principles rather than to look around and copy other peoples' ideas, or simply to continue in the same groove as heretofore. Possibly there may be little to be learned from the past history of The Institute—nevertheless unless one does have the background of some knowledge of the past it is difficult to formulate any worth-while plans for the future.

Although we are accustomed to seeing "Founded 1887," steps were actually taken quite a number of years previously which led to the final Incorporation by Dominion Act of the Canadian Society of Civil Engineers, "having for its objects and purposes to facilitate the acquirement and interchange of professional knowledge among its members, and more particularly to promote the acquisition of that species of knowledge which has special reference to the profession of civil engineering, and further, to encourage investigation in connection with all branches and departments of knowledge connected with the profession."

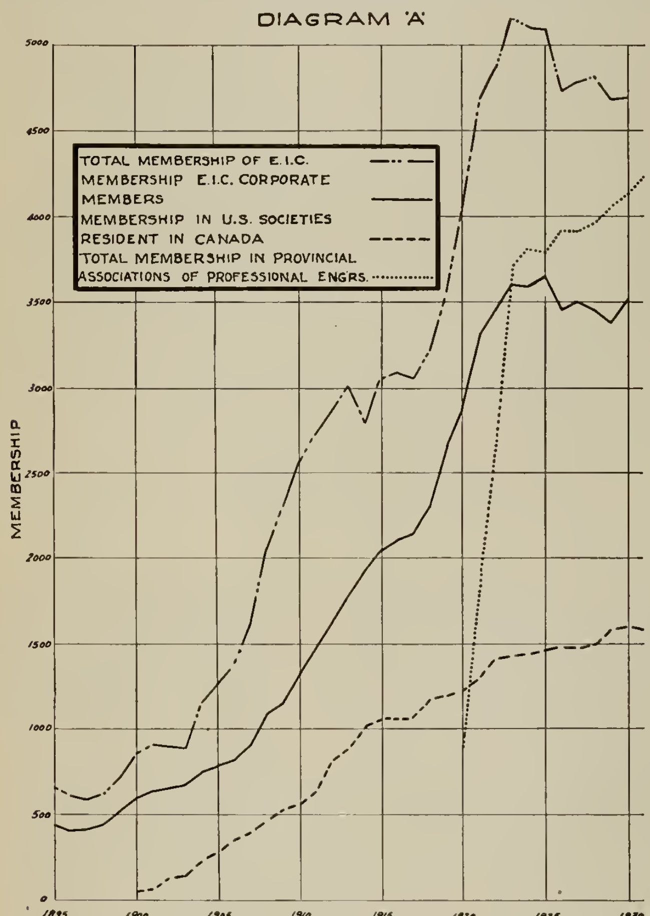
The first headquarters of the Society were in leased premises over the West End Branch of the Bank of Montreal, St. Catherine-Mansfield streets, which were occupied from 1890 to 1899, following which a house was purchased on Dorchester street west, a few doors east of Mansfield street. These premises, which remain familiar to many members today, were occupied until 1913, at which time their acquisition by the Canadian Northern Railway interests for the Mount Royal tunnel took place. As a result of the enforced move, the Society acquired a house at 176 (now 2050) Mansfield Street, and constructed at the back thereof a building including lecture hall, office and library space, the original structure being retained for other offices, reading room, lounge, janitor's quarters and so forth. These premises have continued to fulfil the needs of The Institute, although with the increase in activities which has occurred in recent years, the accommodation is rapidly becoming inadequate.

In order to provide for the meeting of engineers at centres where members were congregated, "Branch Societies" were formed, starting with Toronto in 1890. The movement however did not spread for quite a number of years, until the formation of the Cape Breton Branch in 1905, Quebec and Winnipeg in 1907, Ottawa and Vancouver in 1909, Kingston in 1911, Victoria in 1912, Calgary in 1913, Edmonton in 1914, Saskatchewan in 1915. Subsequent to the reorganization in 1918, fourteen other Branches were formed, including Montreal. Previous to this date all meetings at Montreal were held in the name of the Society, but with the reorganization, a Branch was formed at Montreal with its own independent executive and organization just as though it were not located at Headquarters.

The Canadian Society of Civil Engineers pursued a more or less smooth and uninterrupted course from 1887 until 1915, when, possibly due to abnormal conditions created by the War, it was felt that the time had arrived for the Society's house to be put in order. To this end a Committee on Society Affairs made exhaustive studies, followed by a comprehensive report presented in 1917, the outcome of which was the reorganization of the Society in 1918 into The Engineering Institute of Canada, the employment of a whole-time Secretary, the inauguration of The Engineering Journal, and a general broadening of the activities of the organization.

Only two years elapsed, however, before there was some feeling that great care should be taken that The Institute should be further developed along the lines of a definitely conceived policy, and to this end, in April, 1920, Council appointed a comprehensive Committee on Policy to prepare for the consideration of Council a statement of the policies and objects of The Institute. This committee reported in 1922.

During the time that the Committee on Policy was preparing its recommendations, a new movement was under way, namely the formation of Associations of Professional Engineers in the various provinces with legislation covering the practice of the engineering profession. The year 1920 saw the real inception of this movement and by 1922 the majority of provinces had their acts passed and associations established. While these associations were the outcome of Provincial Divisions of The Engineering Institute, it was not very long before The Institute had no further control in their development or management, and moreover each association, through force of circumstances, was developed along lines of its own to a very large extent, with the result that there was a large number of organizations with no co-ordination of their activities. It might be said that all of them had the ultimate objective of the welfare of the engineer, but that The Institute dealt more with his technical welfare, while the associations were dealing more with his professional welfare. The undesirability of this lack of co-ordination was soon recognized by Council, with the result that at the Plenary Meeting held in October 1927 a Committee on Relations of The Engineering Institute of Canada with the Provincial Associations of Professional Engineers was appointed, and this committee made its report at the Annual General Meeting held early in the year 1930, recommending a closer association between The Institute and the Associations.



Some considerable time was spent in an attempt to work out a scheme of coordination, but without very much success. The committee responsible for this work reported to the Plenary Meeting of Council in September 1931 to the effect that the Associations of Professional Engineers, speaking through the medium of their "Committee of Four," were in favour of the creation of a body representative of all Provincial Associations but independent entirely of The Engineering Institute of Canada. The Council of The Institute then expressed the hope that the Associations' efforts would be continued to a successful conclusion, and offered to continue to cooperate with the Associations to the fullest possible extent.

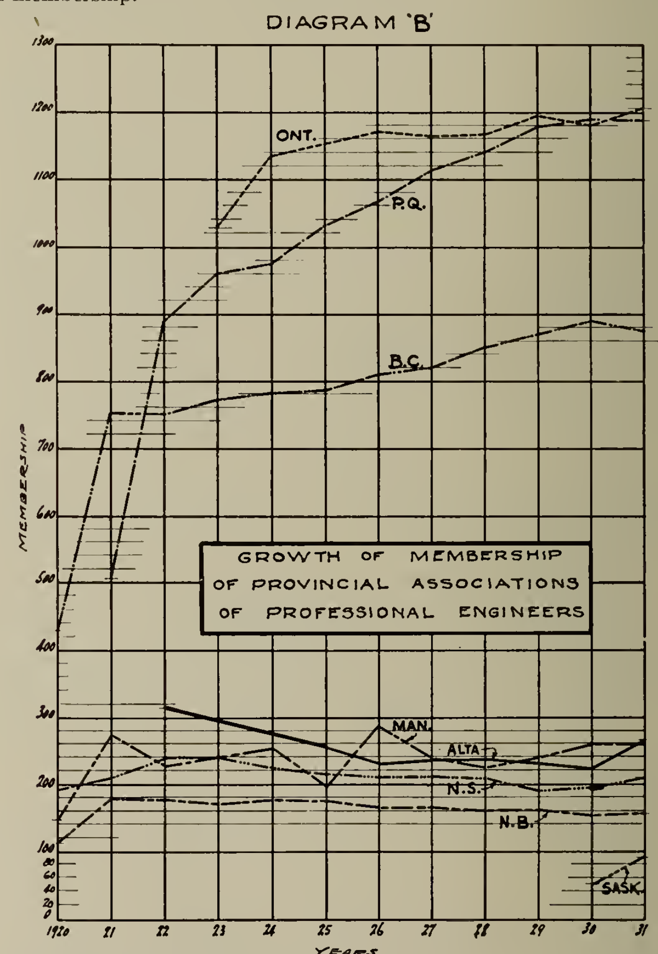
For some time prior to this date, the Council of The Institute had had in mind a complete coordination of The Institute and of the Associations, and many questions of policy had been decided with this in view. In many cases it was found impossible to take any constructive action, owing to uncertainty as to the future line of development. This condition, however, was changed by the report of the Committee of Four, and there was a clear-cut situation to be faced, namely, that the Council of The Institute had the responsibility of developing The Institute on its own logical lines for the benefit of its own members, with the possibility of a future "confederation" relegated somewhat to the background.

The outcome of this definite situation was the appointment of the Committee on Development, with the object of reviewing conditions as they exist today and formulating plans for the constructive development in the future of The Engineering Institute of Canada.

The Growth of The Institute

In the year of its incorporation the Society had a total membership of 370, and a glance at diagram A shows a remarkably steady growth from the early nineteen hundreds until 1923, with a small set-back occurring during the War period. From 1923, however, until the present time there has been a marked recession in the membership, and this recession occurred while the membership of the professional associations was increasing. It will also be noted on the same diagram that membership of Canadian residents in the four major American societies has somewhat increased during the same period.

The growth of membership in the various provincial associations is indicated on Diagram B, and it will be noted that the province of Quebec is the only group which has had a material growth since getting established; British Columbia has grown, but not to so great an extent. The other provinces have remained nearly stationary or even receded in membership.



The following table gives the relationship of membership in The Institute and in the Associations.

	Total Membership in Associations	Members of Associations who are Members E.I.C. Total	Members of Associations who are Members E.I.C. Per cent	Total Corporate Members E.I.C. in Province
Nova Scotia.....	212	110	52	146
New Brunswick..	157	85	54	99
Quebec..........	1,188	667	56	927
Ontario..........	1,206	475	39	1,179
Manitoba.......	260	204	78	166
Saskatchewan....	71	55	77	94
Alberta..........	262	113	43	161
British Columbia	876	190	22	212
Total......	4,232	1,899	45	2,984

This table indicates that there are a great many men, namely 2,333, legally qualified to practise as engineers who are not members of The Institute, and also that there are 1,065 corporate members of The Institute who do not belong to professional organizations.

There is no doubt that the development of the Professional Associations has had the direct result of loss of members in The Engineering Institute, as many engineers feel unable to contribute fees to two organizations. However, all of the loss in membership cannot be attributed to this cause, but some part of the loss within recent years must be attributed to causes under the control of The Institute.

An examination of the reasons for failure to reach a reasonable curve of membership growth in recent years may be given as follows. (*a*) Failure to obtain sufficient new members to counteract *normal* reductions through deaths and resignations. (*b*) A greater number of resignations than should normally occur or can be really attributed to the existence of professional associations.

Both of these reasons are under the control of The Institute.

The fundamental cause for both the above reasons for lack of growth is the same and can be summed up in a few words — it is because The Institute is not sufficiently attractive to make every engineer in the country feel that he is missing something really worth-while if he does not belong. Hundreds of engineers in Canada feel that they can get along quite well in the engineering profession without belonging to The Institute and, moreover, hundreds of engineers who have belonged to The Institute have felt that they can get better value for their dollars somewhere else.

In the case of resignation (to which category must be added "dropped for non-payment of fees") a majority of members give financial reasons for resigning—a few, of course, leave the country or the profession. It is sad to note however that hundreds of men have not found membership in The Institute to be worth the small sum of eight, or ten, or fifteen dollars per annum. This is obviously a wrong condition. Surely it is possible to, develop The Institute in such a manner that every engineer in the country will feel that he *must* belong, even if he has to dispense with some other thing in order that he may retain his membership. Surely there are really worth-while services which The Institute can render, services which may not as yet have been fully developed. Surely its "objects" gives it a scope whereby it can render valuable service of an entirely different nature to that rendered by the professional association. Surely there is a lack of appreciation on the part of many of the men who have resigned of what The Institute may do for them. And, in the final analysis, from a purely mercenary point of view is there not every possibility that through the means provided for members to improve themselves, through the contacts provided, through the broadening influence of associations with other engineers, every member may get an increased remuneration which will many times over pay the picayune fee. Taken as a whole under past conditions it would be fair to state that the engineering profession has benefited financially by membership in The Institute. There are many known cases in which members have obtained perhaps fifty or one hundred dollars per month higher salaries, directly attributable to some Institute service or contact, and it does not take many such cases to represent a larger sum of money than the total annual fees paid to The Institute.

The Development of The Institute

The function of the Committee on Development is to provide a plan for the future development of The Institute which will ensure the maintenance of its position of supremacy in the engineering profession in Canada, and development of its activities on such lines as will make it worth far more to its individual members than any annual fees they are called upon to pay.

In order to carry out this objective, the first requirement is the laying of a solid foundation, meaning in this case the preparation of the best possible rules and regulations for its membership qualifications, organization and management, to which should be added, particularly in view of the existence of other associations, a clear-cut definition of its "objects."

The objects of the organization have been changed from time to time so far as phraseology is concerned, but generally speaking have remained the same in principle, and while somewhat more lengthy, are generally parallel with the objects of similar organizations. In the minds, however, of many engineers there is one purpose for which The Institute exists which has never been written into its "objects" and has never been written into the "objects" of any other society—and that is the establishment of a special prestige for its members. If this were to be the real objective of The Institute, an entirely different viewpoint would have to be taken as compared with the objective of the interchange of professional knowledge. The whole structure would be different, membership qualifications, organization, management would all have to be on different lines. Therefore before commencing the task of developing The Institute, this question has to be settled—is the objective of The Institute the establishment of prestige for its members —or is it the improvement of its members? The two things are so opposite in the principles involved that they cannot be efficiently combined in one organization.

In the writer's opinion the engineer who wants to belong to The Engineering Institute because it will give him "prestige" is an undesirable type of member. Every engineer must look upon the organization as a means for him to improve himself and as a means for him to render some service to his fellow engineers or to the community. Then, if he fulfils his obligations, prestige will automatically come to him. In other words, if members of The Engineering Institute of Canada, no matter whether they are of high standing or of humble station, fully utilize its services, they will find that prestige will come to them unsought—but conversely, the man who seeks prestige will find it very hard to obtain.

For an engineer to reach the highest possible plane in the profession, he must improve himself continuously, and he must help others to improve themselves. The Engineering Institute of Canada provides the means whereby its members are aided in both these functions.

By keeping the function "interchange of professional knowledge" definitely to the forefront of The Institute's activities, the unwritten objective of prestige will follow, whereas prestige can not be obtained by a policy of restriction of membership.

In considering, therefore, the future development of The Institute with the primary function of interchange of knowledge, first consideration had to be given to the definition of the type of people who should be admitted to the privileges of The Institute, and especially as to whether the existing definitions were satisfactory. It was easy to reach a negative decision on the latter point, for two reasons, one being the existence of two grades of corporate member with comparatively little difference in status, the other being the lack of any recognition of membership in an Association of Professional Engineers.

For the primary purpose of interchange of professional knowledge it was felt that close professional gradings are of little advantage, and that therefore the organization should consist largely of one class, "Members," for whom a requirement for technical qualification should be membership in the Association of Professional Engineers in the province in which the member resides. Conditions of a comparable nature would also have to be specified in order to make it permissible for engineers who are not members of provincial associations to belong to The Engineering Institute of Canada.

It is also necessary to make provision both above and below this datum—and this would be met by a class of "Fellow" for a limited number of engineers who have reached a high plane, and "Junior" for those who are only just entering the profession.

Furthermore, there are a number of men not fully trained engineers, but with whom engineers cooperate or associate in their work, and therefore a class of "Associate" is suggested, so that the benefit of admission to The Institute would be granted to this group, without admitting them to corporate membership. In order that the Associate class may not become unwieldy, it was thought that their numbers should not exceed twenty per cent of the total.

Among the advantages to be obtained from the proposed system, some are of prime importance and some of only small significance. The feature, however, of outstanding significance is the adoption of the Associations' standard of admission as a basis from which to work, which would obviate many difficulties that arise today, clarify the requirements for admission, simplify the work of the Council and staff of The Institute, and, finally, facilitate an ultimate co-ordination of the Associations and of The Institute.

Recognition of professional eminence, by admission to the class of "Fellow," would provide an objective within the reach of every engineer entering the profession,—something for him to look forward to. Our present class of "Member" carries so little significance that many fully qualified engineers do not transfer from the lower grade of "Associate Member." The proposed class should also be a means of increasing The Institute's revenue, by the provision of a higher fee, which should not be a hardship among those who have "arrived"—and which many of the "old-timers" would feel only too glad to contribute as helping the welfare of the younger men.

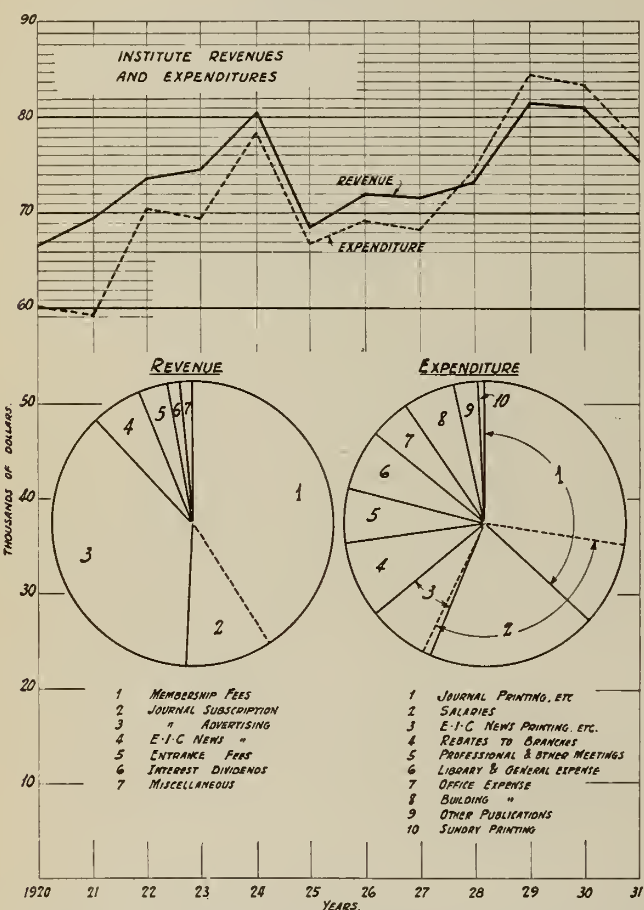
The encouragement of students to join The Institute during the third and fourth years of their courses has always been looked upon as extremely desirable, in order to get their interest at an early age and to provide material for the future. It has not been generally recognized, however, that heretofore every student has been a financial liability to The Institute, because the fee paid by him is insufficient to pay for the actual expense involved in carrying him. For example, a Student at Montreal pays a fee of one dollar, of which the Montreal Branch receives fifty cents. The Branch actually spends about sixty-five cents in mailing him notices of meetings. Under the arrangement proposed by the Committee on Development, The Institute class of "Student" would be abandoned, and the requirements for "Junior" lowered to permit the entry of students, but with the higher entrance and annual fees for "Junior," it seems improbable that many students would belong to that class. In order to avoid the resulting loss of student interest, provision should therefore be made whereby Branches may enroll student members, charging them the same fee as at present, and retain the whole of this fee in the Branch funds. In this way, really live Branch student organizations could be formed, and the development of such activities would lead to the student becoming educated to the advantage of membership in The Institute and entering the class of Junior as soon as he has graduated.

A careful analysis of the proposed requirements for admission to membership will indicate that extreme measures are not being advocated, but simply a modification of requirements for admission based on recognition of conditions as they exist today with a distinct "tightening up" of the personal requirements. For example, under today's conditions, a Branch recommendation is asked for in connection with each application for admission or transfer, and these recommendations are only used as a guide by Council—it is now proposed that a Branch recommendation be compulsory, with the effect that if the applicant is in the opinion of a local Branch Executive undesirable as a member, he will not be admitted. On the other hand, the Branches will not have the power of accepting admissions—this power will remain positively in the hands of Council.

Management

The management of The Institute is in the hands of the Council, and various standing committees. In the various re-organizations that have taken place the Council has grown in size, until today it is larger than the corresponding body of any other comparable organization.

DIAGRAM - 'C'.



This in itself is not necessarily an argument against the present size, but nevertheless there would be many advantages in a smaller Council. The large Council is unwieldy, ineffective in many ways, and costly. A smaller Council of, say, twenty members would be far more effective, could be equally representative, and would facilitate the financing of Plenary Meetings. The adoption of a small Council, however, would mean taking away direct representation from some of the Branches and it was not thought opportune to make this recommendation for the present.

A point, however, of paramount importance and one which cannot be covered by by-law, is the quality of men elected to Council. It cannot be too strongly impressed upon the membership that the Council is The Institute's managing and administrative body, and that therefore Councillors should only be appointed as a result of their proved ability to direct the affairs of The Institute and not simply as a reward for past services in other ways. This is particularly important with regard to the offices of Vice-President and it is hoped that in future each Vice-President will act to a greater extent in many matters on his own responsibility.

This problem is one which cannot be covered by by-laws or regulations, but which every member should take seriously to heart. Nominating committees and Branch Executives especially should bear in mind the qualifications required for holding office as a Vice-President or Councillor.

No radical changes are being proposed regarding the management, but simply a "bringing-up-to-date" of the by-laws.

Fees and Finances

In recommending a schedule of fees for the new conditions a number of different features had to be given consideration. For example, it is essential that The Institute's revenue be maintained at a reasonable scale in order that it may render adequately the various services undertaken. It was also felt desirable to recognize the fact that members are served by The Institute in various degrees depending on their proximity to centres where meetings are held. It was also necessary to consider the general financial standing of members in the various classes so as to recommend fees suitable to their purses. The final proposals are quite modest, so that it should be no hardship for members to meet the fee requirement—and, furthermore, the services rendered by The Institute will undoubtedly be of far greater value than the amount of fee involved.

During the past history of the organization there have not been very many changes in the annual fees. Taking for example, Associate Members, as representing the greater portion of the membership, we find that from 1888 to 1910 they paid $8.00 per annum resident, and $6.00 per annum non-resident fees. During 1911 and 1912, these were increased to $10.00 and $8.00 respectively, for the two classes. In 1913 however, Montreal residents were further increased by $2.00, making the fees $12.00 for Montreal, $10.00 for other Branch residents, and $8.00 for non-residents. In 1919, the fees were all reduced in amount, but a $2.00 compulsory subscription to The Journal was added, making the total payment the same as before. (It might here be noted that in any consideration of fees and The Journal revenues, the amount given in financial statements as "Journal Subscriptions" is really part of the fee, but is kept separate for bookkeeping purposes.) In 1927 an additional dollar was added to all fees which were not paid prior to March 31st.

For some years past, the membership has been advised regarding the difficulty of carrying on The Institute's activities under the present scale of revenue. A few facts as to the finances of The Institute may therefore be of interest. In Diagram C is shown the revenue and expenditure over the past few years. It will be noticed that they have been running very close together, and that there has been no possibility of building up a reserve for any special undertakings. Furthermore many desirable activities have had to be foregone or curtailed purely for financial reasons. On the same diagram is shown the allocation of revenue and expenditure to its sources, averaged over the years 1929, 1930 and 1931.

The Future.

The development of The Institute may be negative or positive in character. Those who seriously have the welfare of The Institute and of Canadian engineers at heart will do all in their power to prevent a negative development. The proposals now submitted by the Committee on Development have the objective of providing a stronger, better and broader foundation upon which to build a future structure which will leave no doubt regarding the positive development of The Institute.

J. L. BUSFIELD,
Chairman, Committee on Development.

September, 1932.

BRANCH NEWS

Calgary Branch

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

GOLF TOURNAMENT

It is frequently remarked that the ordinary Branch meetings do not afford much opportunity for social intercourse among the members. The Calgary Branch have found that golf is one solution to this difficulty and on Saturday, 27th August, 1932, the fifth annual golf match was held at the Earl Grey course.

The principal event was an eighteen hole twosome, in which the chairman of the Branch was paired with Past-President Porter and there was a strong contingent from Strathmore who joined the Calgary enthusiasts in spending a most enjoyable afternoon.

The arrangements were made by courtesy of the Board of Management and officials of the Earl Grey Golf Club and the weather was beyond reproach.

Mrs. G. H. Patrick officiated in presenting the prizes, which were awarded as follows:—

Best net score for 18 holes—(1) G. P. F. Boese, A.M.E.I.C., (2) R. C. Harris, M.E.I.C.
Best gross for 18 holes—(1) W. H. Greene, M.E.I.C., (2) D. T. Townsend, A.M.E.I.C.
Best net score 1st 9 holes—(1) R. L. Bonham, A.M.E.I.C., (2) C. C. Richards, M.E.I.C.
Best net score 2nd 9 holes—(1) R. S. Stockton, M.E.I.C.
Hidden hole competition—R. S. Trowsdale, A.M.E.I.C.
Approaching (men)—E. N. Ridley, M.E.I.C.
Putting (men)—(1) R. C. Harris, M.E.I.C., (2) H. W. Tooker, A.M.E.I.C.
Approaching (ladies)—Mrs. H. W. Tooker.
Putting (ladies)—(1) Mrs. H. W. Tooker, (2) Mrs. G. H. Patrick.

Lethbridge Branch

G. Rowe, Jr.E.I.C., Branch News Editor.
E. A. Lawrence, S.E.I.C., Secretary-Treasurer.

Members and friends of the Lethbridge Branch gathered Tuesday evening, August 30th, for dinner at the Marquis hotel.

The dinner was complimentary to N. Marshall, M.E.I.C., immediate past-chairman of the Branch. Mr. Marshall was recently retired from the services of the Alberta Provincial government as provincial boiler inspector; and is taking up his residence at Kelowna, British Columbia.

Wm. Meldrum, A.M.E.I.C., occupied the chair with forty-six members and friends present. The chairman explained the special purpose of the meeting and also took the opportunity of introducing the new Branch Secretary, E. A. Lawrence, S.E.I.C. The usual musical programme was enjoyed.

Several speakers both in humorous and serious vein availed themselves of the opportunity to speak. All paid tribute to Mr. Marshall's high personal qualities and to his professional abilities. Many were the sincere wishes for his future health and happiness.

During the course of the evening Mr. Marshall was presented with a smoker's stand of mahogany and in rising to thank his many well wishers delighted his hearers with varied reminiscences of his early days at sea as a chief engineer.

The toast to the guest of the evening was proposed by J. B. deHart, M.E.I.C., and was heartily endorsed by all present. The meeting concluded with the singing of "For He's a Jolly Good Fellow" and the National Anthem.

BOOK REVIEWS

Unit Processes and Principles of Chemical Engineering

Edited by John C. Olsen. Van Nostrand, New York, 1932, cloth, 5½ x 8¾ in., 558 pp., figs., tables, $5.00 net.

Reviewed by PROFESSOR E. G. R. ARDAGH*

As the preface and the publisher's foreword make quite clear, the book has been written primarily for university students in chemical engineering. The editor, John C. Olsen, Professor of Chemical Engineering at The Polytechnic Institute, Brooklyn, New York, has himself written the Introduction and the chapters on II. Flow of Heat, VIII. Drying, and XIV. Materials of Construction. The remaining chapters have been written by a number of practising engineers, each an authority on the subject of his chapter.

The titles of these chapters are I. Heat and Power (Crosby Field), III. Evaporation (Alfred L. Webre), IV. Principles of Fractional Distillation (Theodore Baker), V. Steam Distillation (James W. Lawrie), VI. Dry Distillation and By-Product Recovery (F. W. Sperr, Jr.), VII. Filtration (Charles L. Bryden), IX. Electric Heating (Robert M. Keeney), X. Catalytic Processes (P. H. Emmett), XI. Absorption of Gases (Andrew M. Fairlie), XII. Electrolysis (L. D. Vorce), XIII. Separation of Solids and Liquids from Gases (Percy E. Landolt), XV. Costs and Financing (George A. Prochazke, Jr.), XVI. Factory Location (J. L. Warner). Table 1, Properties of Saturated Steam, and Table 2, Properties of Saturated Steam for Varying Amounts of Vacuum, constitute the Appendix. An index is also included.

It is, of course, a difficult task to draw the line sharply between chemical engineering and industrial chemistry. The editor avoids this difficulty by using well-known processes to illustrate certain chemical engineering principles. This method of presentation has some distinct advantages. The study of principles *per se* makes but dry reading. The examples of application intrigue the student's interest, improve his perspective and serve to associate ideas which help to fix each other indelibly in his memory.

"In the multitude of counsellors there is wisdom" is no doubt as true to-day as in the time of Solomon. But we must remember also that "too many cooks spoil the broth." In consequence, the book contains the invaluable experience of experts, each in his particular field, but lacks balance with respect to the proportion which industrial chemistry bears to strictly chemical engineering topics. In certain chapters the industrial completely dominates the engineering aspect. As an example, one might cite the chapter on Dry Distillation and By-product Recovery which would form an excellent contribution to a work on industrial chemistry. In the chapter on Electrolysis the reviewer considers that too much space for a book of this kind has been given to a description of electrolytic cells for caustic soda manufacture.

A chapter on Materials of Construction is indeed a welcome and much needed addition to a text on chemical engineering. The possibility of finding the ideal material to "fit the job" is increasing year by year as new materials of construction jostle one another for recognition and acceptance. This field is developing with such rapidity that to cover it adequately in a text for undergraduates is scarcely possible.

Much emphasis is wisely placed for the student's benefit upon the economics of chemical engineering. For the college student, however, a whole chapter on Factory Location, no matter how ably written, seems altogether out of proportion. This space might have been devoted to such topics as crushing and grinding, flow and transportation of fluids, diffusion and extraction, mixing and crystallization which have not been given a place anywhere in the book. For the practising chemical engineer, on the other hand, this chapter on Factory Location should prove exceptionally helpful.

The necessity for a good training in mathematics is pointed out in the preface, yet the calculus has not been permitted to poke its nose into the text with the exception of one example in the chapter on Drying. Students in chemical engineering everywhere are surely given some training in the calculus to-day. Possibly the editor had in mind students of other days who, as graduates of long standing, have, as Pat would put it, "forgotten more calculus than they ever knew."

There are, as might be expected, the usual number of typographical errors to be found in a first edition. Here and there, too, one finds a *lapsus calami*, for example, on p. 81, "aggravatingly tantalizing." In using the verb "to aggravate" as a synonym for "to irritate" one is guilty of a colloquialism. On p. 120, "Troutman" for Trouton on the diagram. On pp. 244 and 245, "phosphorous" for phosphorus.

To the editor dealing with numerous contributors falls the disagreeable task of harmonizing conflicting opinions on many minor matters such as spelling and abbreviations. In the chapter on Heat and Power we find "gage," while elsewhere throughout the book we find "gauge," except near the bottom of p. 74 where the typesetter has introduced "guage" to prove, no doubt, that "consistency is the bugbear of little minds." Then we have "aluminum." Dr. Vorce, however, prefers the English and continental form "aluminium." "B.Th.U." competes with "B.T.U's." for British Thermal Units, and "lb." with "lbs." for pounds. Since "lb." is the contraction for *libra*, the plural *librae* can scarcely parade as "lbs."

Throughout the entire book the method of presentation and the English are excellent. Only occasionally does one come upon faulty diction or the misuse of words.

The satisfaction expressed on p. 87 over the efficiency of his catchall was evidently thoroughly justified, but the reviewer considers its expression to be a little out of place in this book.

Comparatively few of the illustrations appear to have been made from drawings prepared especially for the book, and a number are not as clear as one could wish, for example those on pp. 104 and 338.

Despite these criticisms, however, the book is a distinct addition to the literature of a field which has expanded almost beyond recognition since Davis published his classic in the days when chemical engineering was still in swaddling clothes. It should find a useful place not only upon the student's table but also upon the bookshelf of the practising engineer.

*Professor of Applied Chemistry, University of Toronto, Toronto, Ont.

Artificial Earthing for Electrical Installations

By T. C. Gilbert. Ernest Benn, Ltd., London, 1932, cloth, 173 pp., illus., figs., tables, 9/- net.

Reviewed by W. P. DOBSON, M.E.I.C.*

This book is an argument for what the author terms "Artificial Earthing" or "Protective Switching," by which he means a system for isolating an electric circuit from its source of supply by the passage of a small leakage current to ground caused by a defect in insulation, or by the appearance of a small potential upon the neutral grounded wire of the system. The first portion of the book is devoted to a discussion of what is termed in Canada "dead grounding," emphasizing chiefly its disadvantages and hazards. He concludes that protection by grounding is absolutely impracticable except where public water supply or underground cables are available. This appears to be a strong statement and the conclusion unwarranted by the evidence, at least as presented in this country.

The remainder of the book is devoted to a description of "artificial earthing" as developed in Germany, which the author strongly advocates especially for rural installations. The essential feature of this protective system is a trip coil connected in a separate circuit to ground actuating the main switch. The system has been adapted for use in house service boxes, for the protection of appliances on branch circuits, for substation switches, and for the protection of motors, and according to the author offers a more complete and satisfactory system of protection for all emergencies than solid grounding, especially where the ground resistance is high. Its success is not contingent upon a low earth resistance.

While Mr. Gilbert's objections to "dead grounding" are in the main correct, his argument appears rather overdrawn and all of his conclusions should not be considered applicable to conditions at present existing in Canada. According to his statement there appears to be a widespread condemnation of solid earthing throughout Europe. In the United States and Canada solid earthing is practised almost universally by power companies both for high tension networks and for distribution systems. While its disadvantages are fully realized it has not been condemned as a protective measure.

With particular reference to distribution in urban areas where water distribution systems are available for grounding, there appears to be no necessity here for the schemes proposed by Mr. Gilbert. In rural areas, however, where it is found difficult to obtain low ground resistance the system proposed by him would no doubt have useful applications. It should be pointed out that the values of resistance given by him appear, in the main, to be much higher than those obtained in this country under similar conditions.

The adoption of this system in Canada would involve a revision of the Canadian Electrical Code. It would also involve a change in the design of switches and would require the running of an additional wire.

Mr. Gilbert has made a useful contribution to the industry by calling attention to the progress in Europe which has not been sufficiently broadcast to Canadian and American engineers.

*Chief Testing Engineer, Hydro-Electric Power Commission of Canada, Toronto, Ont.

Preliminary Notice

of Applications for Admission and for Transfer

September 19th, 1932

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, 1932.

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

MEEHAN—OWEN MICHAEL, of Ottawa, Ont., Born at Halifax, N.S., Oct. 26th, 1904; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1929; 1927 (May-Sept.), asst. to engr. on erection of Provincial Exhibition Bldgs., Halifax; 1928 (May-Sept.), student asst., Geol. Survey of Canada; 1929 (May-Nov.), temp. engr. on prelim. survey and investigation of proposed Halifax Airport site: engr. and inspr. of a sheet asphalt pavement, Halifax; 1929-30, engr. for McDonald Construction Co. on erection of Capital Theatre Bldg.; Aug. 1930 to date, hydrographer 1, Canadian Hydrographic Service, on actual field surveys and office work in connection with chart production.

References: F. R. Faulkner, A. F. Dyer, W. J. DeWolfe, F. Anderson, J. A. Macdonald, M. A. MacKinnon, C. A. Price.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

SPROULE—GORDON ST. GEORGE, of 39 Thornhill Ave., Westmount, Que., Born at Montreal, April 23rd, 1885; Educ., B.Sc. (Mining), 1908, M.Sc. (Metallurgy), 1909, McGill Univ.; 1904 (summer), Can. Niagara Power Co.; 1905-06, Ont. Hydro Commn.; 1907 (summer), Hall Mines Smelter, B.C.; 1908-10, demonstrator, McGill Univ.; 1910-15, inspr. and asst. engr. of tests, C.P.R.; 1915-16, engr. of tests, C.P.R.; 1916-18, asst. inspr. of steel, Imperial Ministry of Munitions, Dept. of Inspection, Canada; 1918-32, lecturer and asst. prof., and at present, associate professor of metallurgy, McGill University, Montreal. 1918 to date, also consultant, metallurgical engrg. (*S. 1904, Jr. 1912, A.M. 1920.*)

References: E. Brown, A. Stansfield, E. W. Stedman, W. McG. Gardner, C. E. Herd, W. G. H. Cam, E. S. Holloway, H. H. Vaughan.

FOR TRANSFER FROM THE CLASS OF JUNIOR

GELDARD—PERCY WALTER, of 93 Boon Ave., Toronto, Ont., Born at West Hartlepool, England, Nov. 29th, 1903; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1929; 1920 (Mar.-Nov.), chainman, C.N.R.; 1921-22, rodman, F. Barber & Co., Toronto; 1923-25, constrn. engr. on municipal improvements, Township of York; also 1926 (April-October); 1927-28 (Summers), engr. in charge of rock ballasting, C.N.R.; 1929-30, engrg. asst. and Sept. 1930 to date, supt., West District, Dept. of Distribution, Consumers' Gas Co , Toronto, Ont. (*Jr. 1928.*)

References: O. M. Falls, L. I. Stone, F. B. Goedike, C. R. Young, E. G. Hewson, R. E. Smythe, C. S. Coyne.

GERIN—MAURICE, of Montreal, Que., Born at Coaticook, Que., Jan. 17th, 1899; Educ., B.Sc., Univ. of Montreal, 1920. M.Sc. (Mech.), Mass. Inst. Tech., 1921; 1922 to date, sales engr., Canadian Fairbanks Morse Ltd., Montreal, Que. (*Jr. 1923.*)

References: A. Frigon, O. O. Lefebvre, W. S. Lea, A. Cousineau.

MACNAUGHTON—MORAY FRASER, of Montreal, Que., Born at Westmount, Que., April 8th, 1899; Educ., B.Sc., McGill Univ., 1922. M.Sc., Univ. of Mich., 1925; 1920-23, inspr. on staff of paving dept., and 1923-25, chief inspr., paving dept., Milton Hersey Co. Ltd.; 1925-29, supervising inspr., foundations and concrete structure, Montreal South Shore Bridge; 1929 to date, consltg. engr. on concrete, Milton Hersey Co. Ltd., and engr., Suburban Water Ltd., Montreal, Que. (*St. 1920, Jr. 1926.*)

References: P. L. Pratley, C. N. Monsarrat, C. A. Mullen, C. M. McKergow, P. B. Motley, G. R. MacLeod, R. E. Heartz, H. Hadley.

PREVOST—JOSEPH EDOUARD WILFRID, of Outremont, Que., Born at Montreal, July 24th, 1899; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1921; Summers: 1918, rodman and note recorder, Geol. Survey party; 1919, topogr., Quebec Streams Commn.; 1920, inspr. on foundation work for Belgo Canadian Paper Co., Shawinigan Falls; 1921-22, field engr., Montreal Water Board; 1922 (May-July), mapper on timber cruise, Wayagamack Pulp & Paper Co., at Flamand, Que.; 1922-23, traffic engr., Bell Telephone Co. of Canada; 1923-26, field engr., Atlas Construction Co.; 1926 (Feb.-May), cost engr. on rock excavation for Mr. C. Gagnon, Lake St. John; 1926-28, res. engr. in Valleyfield for Beaubien, Busfield & Co.; 1928-30, field engr., Atlas Construction Co.; 1930 to date, constrn. engr. for Damien Boileau Ltee & Ulric Boileau Ltee, on contract for new bldgs. of the University of Montreal. (*St. 1920, Jr. 1924.*)

References: E. Cormier, E. W. Wall, A. S. Dawes, C. H. Gordon, deG. Beaubien, J. L. Busfield, O. O. Lefebvre, A. Frigon, R. DeL. French, H. G. Hunter, C. J. Desbaillets, G. Claxton.

ROSS—JAMES HARGRAVE DRUMMOND, of 3035 Cedar Ave., Montreal, Que., Born at Dundas, Ont., April 2nd, 1897; Educ., B.Sc. (Chem.), McGill Univ., 1922; Summers: 1920, test work in hardwood distillation plant; 1921, operator in sodium acetate plant, Standard Chemical Co.; 1922, sampler and analyst, textile print works, Dominion Textile Co.; 1922-23, operator, sodium nitrate experimental plant, for Guggenheim Bros., Chile; For the past ten years the firm of Guggenheim Bros. have been introducing into Chile new methods for mining "caliche" and a new process for the extraction of sodium nitrate from this ore. Since return from experimental operating work in Chile, engaged in nitrate development as engr. and executive in the New York office of Guggenheim Bros. Mostly acting as asst. to the President and Vice-President on the following types of work: estimation of costs and earnings of nitrate plants, railway, etc., design of plants, purchase of materials and equipment for constrn. of plants and railway, assisting in negotiations in connection with the acquisition of companies, nitrate reserves, etc., handling al ldetails of executive control of operations under vice-president, etc. (*S. 1921, Jr. 1924.*)

References: G. H. Duggan, C. M. McKergow, J. B. Woodyatt, T. S. Morrisey, H. A. Crombie, A. S. Rutherford, J. F. Plow.

British Industries Fair

Canadian manufacturers and producers who expect to benefit by the greater British and Empire markets recently made available to them, will find in the British Industries Fair to be held from February 20th to March 3rd next, an excellent opportunity to place their goods before the buyers of the Empire as well as the purchasing public of Great Britain. This fair is to be held in two sections, at the Olympia, London, and at Castle Bromwich, Birmingham. The first section is devoted mainly to food products and the lighter industries, and the second to the heavy industries including machinery, building materials and home equipment. Canadian exhibitors at the fair are provided by the Department of Trade and Commerce, Ottawa, with the advantageous rates of $2.50 per square foot which covers rental of space, stand construction and maintenance, uniform decoration, lighting, cleaning and two-way transportation of the exhibits between Canada and the United Kingdom. By providing such a rate, the Department of Trade and Commerce state they are shouldering approximately half of the total expenses of transportation and exhibiting Canadian products.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Vacant

SALES ENGINEER, wanted by large Canadian Company. Must be university graduate in mechanical engineering, not over 30, and absolutely essential that he speak both French and English with equal facility and fluency. No other need apply. Some sales experience preferred. Applications to be considered must be in applicant's own handwriting, giving full particulars as to education, experience and references. Apply to Box No. 875-V.

Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

YOUNG ENGINEER, B.A., B.Sc., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C., Jr.A.S.C.E., age 28, married. Experience: construction, design, cost estimating on hydro-electric and storage work, also railway. Desires work in engineering, industrial or commercial fields. Available at once. Apply to Box No. 447-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. For three years on railway construction and as instrumentman, cost clerk and inspector on city improvements, and construction. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

ELECTRICAL ENGINEER, A.M.E.I.C., University graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, graduate of McGill University, B.Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CIVIL AND MECHANICAL ENGINEER, with twenty years experience in design, manufacture, sales and installation of pulp and paper, also mining machinery, seeks association with firm as sales engineer. Apply to Box No. 633-W.

CIVIL ENGINEER, A.M.E.I.C.; R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, B.Sc., '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

MECHANICAL ENGINEER, Jr.E.I.C., G.I. MECH.E. Ten years practical experience—design and construction—elevating, conveying and transporting machinery—contractor's stone and woodworking machinery. Recently mechanical engineer with pulp and paper company. Will develop and design machinery to suit individual requirements pending full time employment. Available immediately. Apply to Box No. 704-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

Situations Wanted

SALES ENGINEER, B.Sc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available at once. Located in Canada. Apply to Box No. 749-W.

CIVIL ENGINEER, M.A. (Cantab.), A.M.Inst. C.E., A.M.E.I.C. Age 27. Unmarried. Three years experience on hydro-electric construction, tunnels, dams, penstocks, etc., geodetic and general surveying. Three years experience on design of hydro-electric structures and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 751-W.

CIVIL ENGINEER, B.A.Sc., Toronto '26. Age 27. Single. Desires position, technical or non-technical, with an engineering, industrial, construction or business firm where the ability to learn and work will develop a future. Experience includes surveying, dredging, reinforced concrete detailing and four years structural steel detailing. Available immediately. Apply to Box No. 753-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate, '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box No. 770-W.

ELECTRICAL ENGINEER, Queen's Univ. '24, Jr.E.I.C., age 32, married. Experience includes, student Test Course, Can. Gen. Elec. Co., four years dial system telephone engineering with large manufacturing company. Available at once. Apply to Box No. 772-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

SALES REPRESENTATIVE. Electrical engineer with ten years experience in power field interested in representing established firm for electrical or mechanical product in Montreal territory. Excellent connections. Apply to Box No. 795-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C., with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments, in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C. B.Sc. (Queen's '32), age 21. Three summers surveying in Northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

AERONAUTICAL ENGINEER, B.Sc. (McGill), M.Sc. (Mass. Inst. Tech.). Canadian. Age 26, recent graduate. Capable of aeroplane design and stress analysis. Apply to Box No. 838-W.

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Temperature Survey of Power Cable Ducts

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 21st, 1932.

SUMMARY.—This paper deals with a survey conducted in London, Ont., to ascertain the temperature of certain portions of the underground cable system of the London Public Utility Commission, there being reason to suppose that the temperature of certain parts of the system was too high. The method and equipment adopted are described, as is also the cable system, and details of the observations and calculations are given from which can be determined the conductor temperature and its distribution, the maximum permissible load current and the thermal resistivity of the soil.

Introduction

The life of an underground power cable is dependent, among other things, upon its temperature, which, in turn, is dependent upon the electrical stress under which the cable is operating, the amount of current it is carrying, the number and arrangement of cables in the conduit, the temperature and thermal quality of the earth and materials of the conduit, etc. Temperature limitations are imposed because of the rapid deterioration caused either directly or indirectly by excessive heat. In the case of paper power cables, excessive temperatures may cause rapid deterioration of the paper insulation and, under cyclic changes in temperature, may cause the following changes in the structure of the cable:—

1. The lead sheath, having little elasticity and a smaller coefficient of expansion than the insulating compound, may be permanently stretched due to a rise in temperature. Any voids formed on cooling may be a source of electrical weakness.
2. The lead sheath having been stretched to a larger volume may permit improper redistribution of compound during cooling, especially in a cable installed on a slope.
3. Longitudinal expansion of the conductors may cause them to separate, and in non-shielded cable any voids formed between the conductors may permit ionization at these points and cause gradual deterioration of the insulation.
4. Longitudinal movement due to expansion and contraction of the cable may cause abrasion at the mouth of the duct.
5. Unequal longitudinal expansion of the copper and lead may, on cyclic changes of load, cause wrinkling or cracking of the lead sheath.

Object of the Survey

There was reason to think that the temperature of the 13,200-volt cables of certain portions of the feeder system of the London Public Utilities Commission was too high and it was decided to make a temperature survey of these portions.

The object of the survey was to obtain data from which could be determined:

1. The conductor temperature at one point throughout the day.
2. Distribution of conductor temperature and location of the hottest section of the line.
3. Maximum permissible load current.
4. Thermal resistivity of the soil.

This is, therefore, a description of a temperature survey of certain portions of the 13,200-volt feeder system of the Commission. This survey was made during the month of July, 1930.

Method and Equipment

The heat loss of the conductors must pass through the cable insulation, the lead sheath, the duct structure and the earth, to the atmosphere. This flow of heat produces a temperature gradient along this heat path, thus the temperature of the air in the duct will be somewhere between that of the conductor and that of the atmosphere. The temperature of the air in an occupied duct is difficult, if not impossible, to measure over the whole length of the duct. Also the sheath and duct surfaces are not at the same temperature and one is uncertain as to whether the temperature observed is that of the sheath, the duct wall or the air between them. It has been found however, that the temperature of an adjacent vacant duct may be used as a means of determining the cable temperature with greater certainty.

It was impracticable to measure the vacant duct temperature at all points along the duct at the same instant and, as the factors affecting it were varying continually, means had to be found whereby the vacant duct temperatures taken on different sections and at different times could be compared.

The general method was, therefore, to measure the temperature of the air in a vacant duct in the conduit and that of the earth some distance away from the conduit and from these and the load on the cables, the conductor temperature was calculated at one section and the vacant duct temperatures at other sections compared with that at this section.

The following are some of the types of apparatus that have been used in measuring duct temperatures:

- Maximum-reading mercury thermometers.
- Recording thermometers.
- Resistance coils in connection with a Wheatstone bridge.
- Single thermo-couple and potentiometer.
- Multiple thermo-couple cable and potentiometer.

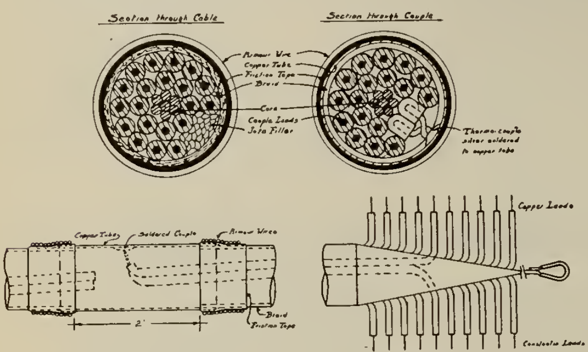

Fig. 1—Thermo-Couple Cable.

A multiple thermo-couple cable was chosen for reading the temperatures on account of the simplicity, robustness and accuracy of the equipment. The multiple-couple cable also has the advantage that the temperature at a number of points along the duct can be taken at one time, whereas a single couple must be drawn from point to point with a sufficient interval at each point to allow the temperature of the couple to reach that of the duct.

The operation of thermo-couples is based on the fact that, if two wires of suitable dissimilar metals are fused together and the junction heated, there will be a difference of potential at the opposite ends. Two causes contribute to the production of this difference of potential. An electro-motive force exists between two different metals placed in contact, the magnitude of which depends upon the temperature and upon the metals used. Another is developed between the hot and cold ends of the wire, if it is homogeneous, and which depends upon the metal and upon the differences in temperature of the ends. These two phenomena are known as the Peltier and Thomson effects, respectively. In general, the thermo-electric circuit consists of more than two metals, others being introduced by the instrument employed for measuring the potential difference. However, it can be shown that the insertion of other metals in the circuit has no effect if both ends of each of these metals are at the same temperature. Thus it is that the resistance wire of the instrument may be of different metal from the couple wires and also the couple may be made by welding or soldering.

Although any two dissimilar metals might be used for a thermo-couple, certain combinations are unsatisfactory because of the small differences of potential produced and also because of the fact that some combinations produce potential differences that first increase, then decrease, become zero and change sign as the temperature increases. Copper-constantin couples are generally considered satisfactory up to about 350 degrees C. Their reproducibility and constancy are sufficiently good, as well as their accuracy when no current is passing through the junction. The passage of current through the couple and leads produces two sources of error. One is due to the fact that there is an absorption or generation of heat at the junction of the two metals, the Peltier effect being reversible. The other is due to the potential drop in the leads. For these reasons a potentiometer was used in measuring the voltage of the couple, the latter being balanced against an opposing voltage from a battery. The multiple-couple cable and potentiometer thus provided an accurate and convenient method of measuring duct temperatures.

The cable consisted of a core around which were stranded ten pairs of No. 14 B & S rubber insulated couple wires over which was a weatherproof covering. The construction of the cable is shown in Fig. 1. The core was of hard drawn copper having an outside diameter of 0.192 inch. Ten couple wires were tinned annealed copper and the other ten constantin. They were all insulated with National Electrical Code standard rubber insulation for 600 volts, the insulation thickness being 3/64 inch. The copper and constantin couple wires were stranded around the core in two layers, the inner containing four copper and four constantin wires and the outer six copper and six constantin wires. With only twelve wires in the outer layer, a space was left which was filled with four ends of 150-pound jute. This jute was to facilitate the making of the couples in the cable and will be referred to later. The whole was covered with a rubber filled tape and a weatherproof braid. The outside diameter of the finished cable was approximately 1.06 inch and the length 500 feet.

The cable contained ten couples spaced 50 feet apart. In making the couples, the braid was removed for a few inches at the desired point and a copper and a constantin wire were cut and silver-soldered together to form the couple. The remainder of the two wires beyond each couple were left dead in the cable. In making the couples on the inner layer of wires, the jute in the outer layer of wires was removed at the desired point to make space for bringing the pair of wires to the surface. All couples were silver-soldered to a copper plate which was then rolled around the cable and soldered to form a tube. The purpose of this copper tube was to provide sufficient exposure area to the couple so as to reduce the effect of the transmission of heat away from the couple along the couple wires. Excessive transmission of heat away from the couple would cause the couple to indicate a lower temperature than that of the air

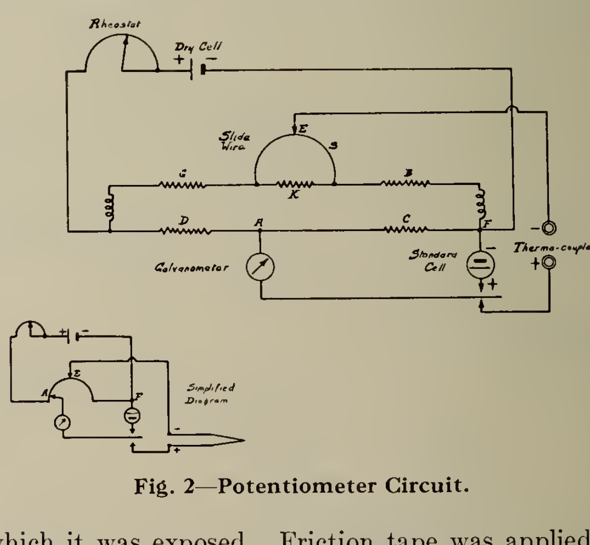

Fig. 2—Potentiometer Circuit.

to which it was exposed. Friction tape was applied over the ends of the copper tube to prevent the entrance of moisture into the cable. About ten turns of galvanized iron wire was applied over the friction tape to protect it from abrasion.

The end of the cable that was to be connected through to the potentiometer, was fanned out as shown in Fig. 1 and a thimble fitted to the core. Reinforcing wires were brought back from the thimble and braided around the cable after the manner of a cable grip. The other end of the cable was bound with friction tape and armoured with a few turns of iron wire.

The potentiometer circuit is shown in Fig. 2. It was scaled to read the temperature directly, the scale reading from 0 to 150 degrees C. It had automatic cold-junction compensation, thus the temperature was read directly from the scale regardless of the temperature of the cold junction of instrument.

In the operation of the system, the potential of the couple is balanced against the drop across a portion of the potentiometer resistance. Balance is indicated by a zero

Fig. 3—Assembled Cable, Box and Potentiometer.

reading of the galvanometer. A scale attached to the sliding contact of the potentiometer and calibrated directly in degrees indicates the temperature of the couple at the time of balance. An increase in the temperature of the cold junction would reduce the voltage of the couple and the resistance drop between A and E must be reduced but the position of E must be maintained so as to indicate the temperature of the hot junction. This may be done by moving A but in the instrument used here this is accomplished automatically by making C of a metal having zero temperature coefficient and D of a metal having a high coefficient. The resistance D is placed near the cold junction, thus an increase in the cold junction temperature causes an increase in the resistance of D. With proper adjustment of the resistances C and D the balance is therefore maintained without moving E, regardless of the cold junction temperature. The proper voltage is maintained across the potentiometer by replacing the couple by a standard cell and balancing by adjusting the battery rheostat.

The cable was connected to the potentiometer through a terminal box containing a ten-position switch. It was of wood and made in two halves hinged together. This box was fitted with two terminal strips each containing ten clips. The ten constantin wires were clipped on to one strip and the ten copper wires on to the other. Leads ran from the ten pairs of clips to the ten-position switch, by means of which any couple could be connected through to the potentiometer. A clamp held the cable firmly in place so that no strain was placed on the clips. The potentiometer was placed on the terminal box, its weight tending to prevent movement of the latter. The assembled cable, box and potentiometer are shown in Fig. 3.

The thermo-couple cable was drawn into the duct and the temperatures read directly on the potentiometer. The cable was then drawn from one duct to another until the length of conduit was surveyed.

The temperature of the earth was determined at various depths by means of a stick containing five thermo-couples which was placed in a hole in the earth. The hole was first made by driving into the earth an iron rod slightly larger than the earth stick. This rod was then replaced by the earth stick which was connected to the terminal box and potentiometer in the same manner as the cable.

The construction of the earth stick is shown in Fig. 4. It consisted of a wooden rod containing five flutes. A constantin and a copper wire, each rubber insulated, were placed in each flute. Each pair of wires was soldered together to form couples spaced one foot apart. The couples were soldered to copper sleeves in a manner similar to the couples in the cable. The bottom end of the stick was fitted with a brass tip and the wires at the other end of the stick were stranded around a rope core to form a cable. The free ends of the wires were fanned-out as in the thermo-couple cable so that they could be connected in the terminal box. The stick and cable were covered with friction tape except that the couple sleeves were left exposed.

Layout of the 13,200-Volt Cable System

The general layout of the conduit system is shown in Fig. 5. Power is received from the Hydro-Electric Power Commission of Ontario at a station on Giles street. From this station the power is transmitted at 13,200 volts over feeders to substations Nos. 2 and 4. The feeders are 13,200-volt, 3-conductor, paper insulated, lead covered power cables of No. 4/0 B & S, and 300,000 C.M. An overhead line runs from the Hydro-Electric Power Commission station on Giles street to substation No. 2 at the corner of Cabell and Kitchener streets and from substation No. 2 to substation No. 1 at the corner of Horton and Ridout streets but these overhead lines were not in use at that time. A ring runs from substations No. 1 to No. 2, No. 2 to No. 6, No. 6 to No. 8, No. 8 to No. 4 and No. 4 to No. 1. This ring consists of 13,200-volt, 3-conductor, paper insulated, lead covered power cables of No. 4/0 B & S and 250,000 C.M. There are two lines connecting substations No. 1 to No. 4 and also No. 4 to No. 8. In each case one line goes by way of Richmond street and the other by way of Talbot street, but the lines on Talbot street were not in use at that time.

The power is stepped down from 13,200 to 4,000, 2,300 and 575 volts for distribution around the city.

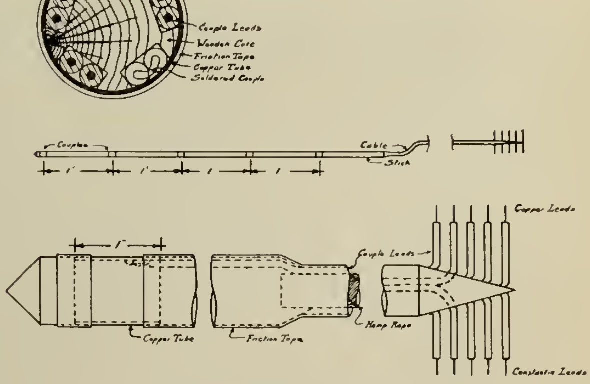

Fig. 4—Earth Stick.

The following sections of the system were surveyed:

1. One section from the Hydro-Electric Power Commission station along Giles, the north side of Hamilton, Chesley, Lovett and Kitchener streets to substation No. 2.
2. One section from King street along Richmond street to Queen street. This is part of the ring on each side of substation No. 4 and includes part of the feeder into substation No. 4 as well as some cables for distribution, street-lighting, etc.

3. The section from substation No. 4 along Carling and Talbot streets to Dundas street. This is part of the duplicated section of the ring between substations No. 4 and No. 1 but which was not in use at that time. It includes some cables for distribution, street-lighting, etc., and a steam main runs parallel to portions of this section.

The soil throughout the portion of the system studied was a mixture of sand with a small amount of gravel. West of about Colborne street there was some clay mixed with the sand and gravel. The conduits on Hamilton road were laid for most of their length under the boulevard between the curb and the sidewalk. This boulevard was, for the most part, covered with short grass.

A cross-section of the cable running from the Hydro-Electric Power Commission station to substation No. 2 is shown in Fig. 6 and the following are some of the details of the cable:

Number of conductors	3
Size of conductors	No. 4/0 B & S
Shape of conductors	Sector
Kind of insulation	Impregnated paper
Thickness of conductor insulation	.18 inch
Thickness of belt insulation	.18 inch
Outside diameter of lead sheath	2.3 inches

Detailed Procedure

The first section of conduit tested was between manholes "B" and "C," along Lovett street between Kitchener and Chesley; a cross-section of which is shown in Fig. 6. This was called the reference section, with which others in this line could be compared. The ducts were of fibre embedded in concrete. This conduit contained four ducts arranged horizontally, three of which were each occupied by a No. 4/0 B & S, 13,200-volt, 3-conductor, paper power cable. There was also a similar armoured cable buried directly in the earth across the street. Two of these cables were known as feeder No. 457 and the other two as feeder No. 458. All four cables were in parallel and carried approximately equal loads. One of the centre ducts was vacant and the thermo-couple cable was drawn into this duct and allowed to remain there for a period of forty-one hours. The earth stick was inserted in the earth at a point about 25 feet north of manhole "C" at the Chesley street end. The earth at this point was covered with grass. The bottom couple was 4 feet below the surface and the topmost couple was half in the earth and half in the grass. Temperature readings were taken periodically on both the cable and the stick. The observations of the vacant duct temperatures are shown in Fig. 7 and of the earth in Figs. 8 and 9. A water main ran parallel to the duct about 4 feet to the south. Observations of load current per conductor are also shown in Fig. 7.

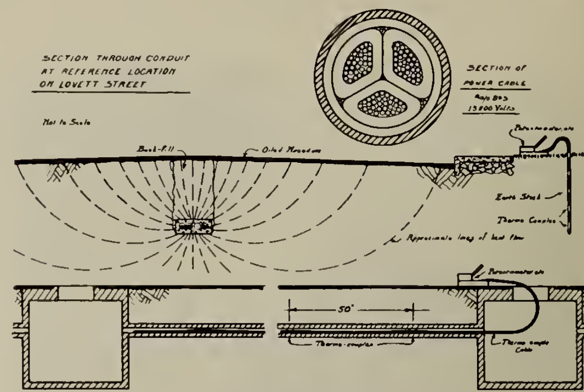

Fig. 6

The entire line from No. 2 substation to the Hydro-Electric Power Commission station was surveyed. The conduit was of the same construction and the cables arranged in the same manner as the reference section. A cross-section of this line at Hamilton road is shown in Fig. 10. All three cables were No. 4/0 B & S, 13,200-volt, 3-conductor, power cables. The thermo-couple cable was drawn into the vacant duct between each pair of manholes and allowed to remain there until the temperature of the couples became constant, when they were assumed to be at

Fig. 5—13,200-volt System, Public Utilities Commission, London, Ont.

the same temperature as the air surrounding them. The manholes were lettered from "A" to "T," starting at the manhole outside substation No. 2.

The temperature observations were taken throughout the length of the line on various days and at various times of the day. These are shown in Fig. 11. The load current in the cables from the Hydro-Electric Power Commission station to substation No. 2 is shown in Fig. 12 for July 1930.

A portion of the conduit along Richmond street from King to Queen streets was surveyed and is shown in Fig. 13. This section is in the downtown district and includes cable of the ring on both sides of substation No. 4 and a portion of the feeder from the Hydro-Electric Power Commission station to substation No. 4 as well as some cables for distribution, street-lighting, etc. Both portions of the ring running out of substation No. 4 were 250,000 C.M., 13,200-volt, 3-conductor, paper power cable and known as feeder

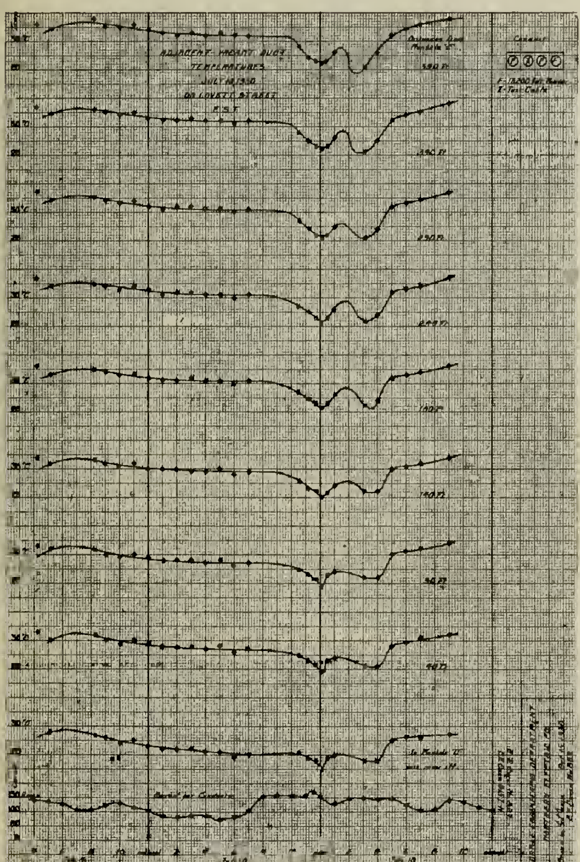

Fig. 7

No. 514. A primary of 350,000 C.M., 4,000-volt, 3-conductor, paper power cable passed through the whole length of this conduit, and was known as No. 241. Other secondary power cables No. 5e, No. 1, No. 3, No. 6 and No. 12 passed through portions of the section tested. Other cables carrying a negligible current were in this section, including cables for street-lighting, traffic signals, grounds, service, police alarm and telegraph. The test cable was drawn into a vacant duct at the manhole at the corner of Richmond and King streets and was drawn through and pulled out at Queen street. Temperature readings taken throughout this section of conduit are shown in Fig. 13.

Portions of the conduit from substation No. 4 along Carling and Talbot streets to Dundas street were surveyed to determine the effect of a steam main near-by. The layout of this section, the location of the steam main and cross-sections of the conduit are shown in Fig. 14. The manholes were lettered "A," "B," and "C," "A" being at Carling street. This section is in the downtown district and includes a portion of the ring between substations No. 1 and No. 4 as well as some cables for distribution, traffic signals, etc. The portion, of the ring was No. 4 B & S, 13,200-volts, 3-conductor paper power cable and known as No. 514-B. Secondaries Se. No. 17, No. 18, No. 19 and No. 20 also passed through portions of this section, as well as a number of cables for street-lighting, police-alarm, etc. The test cable was drawn into a vacant duct along Carling street. At

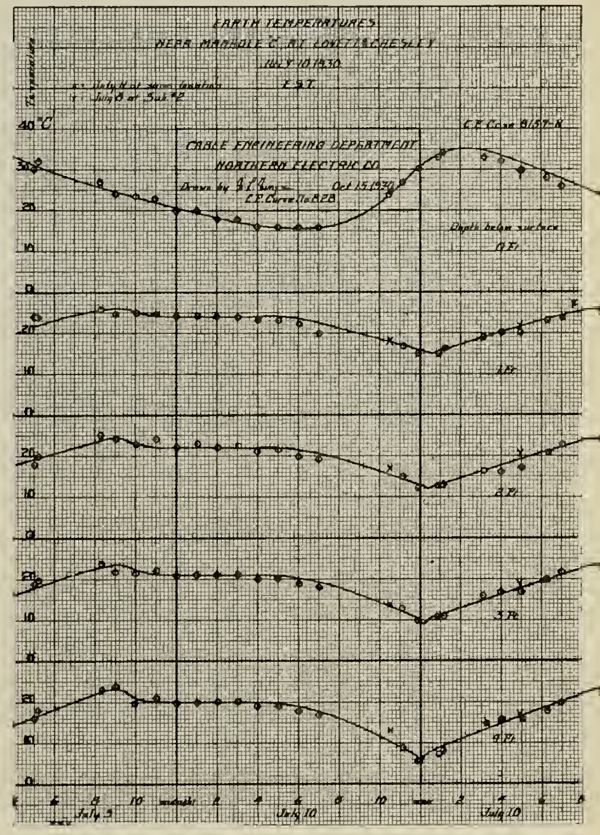

Fig. 8

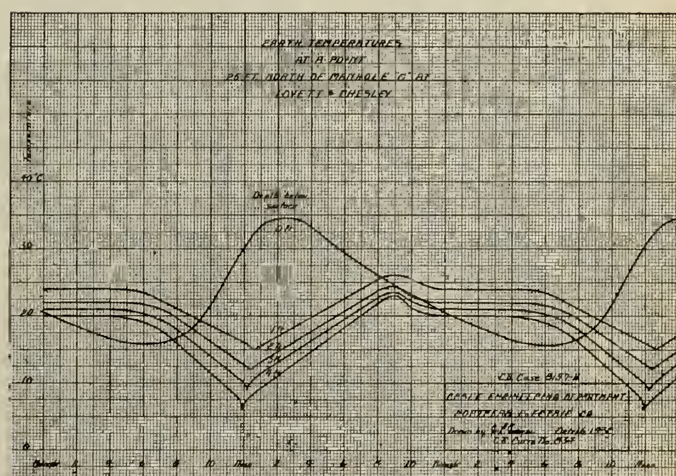

Fig. 9

each manhole a single exploring couple was pushed into a vacant duct in each direction and temperature of the manholes were also observed. The temperature readings taken throughout this section of conduit are shown in Fig. 14 and those taken in the manholes are shown in Table 1. It was found, upon enquiry, that the steam in the main was maintained at a pressure of 8 pounds per square inch at all times.

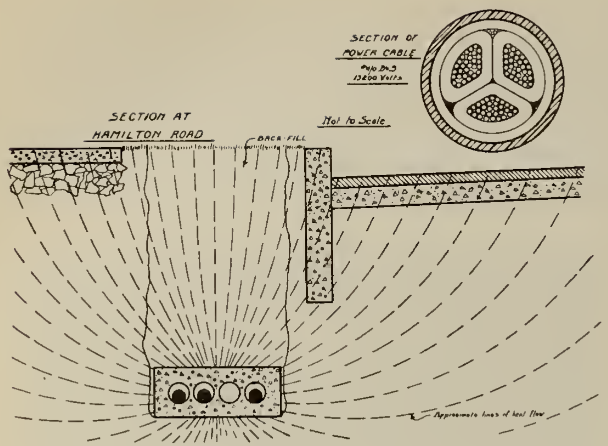

Fig. 10

TABLE 1

TEMPERATURES OF MANHOLES ON TALBOT STREET

Time	*Height above floor*	*Temp.* Degrees C.	*Conditions*
Wednesday, July 30th, 1930—M.H. "A" at Carling			
8.49 a.m.	0 feet	21.5	Before removal of cover.
8.51	2.5	21.5	"
8.52	at roof of M.H.	21.5	"
Tuesday, July 29th, 1930—M.H. "B" North side of Dundas			
10.50 a.m.	.3 feet	33	After removal of cover.
11.30	1 foot below roof of M.H.	33	"
11.50	.1	34	"
11.55	.5 feet below roof of M.H.	35	"
2.15 p.m.	0	37	"
Wednesday, July 30th, 1930—M.H. "B"			
8.38 a.m.	0	32.5	Before removal of cover.
8.41	.3	34	"
8.43	.1 foot below cover	33.5	"
Tuesday, July 29th, 1930—M.H. "C" South side of Dundas			
3.02 p.m.	0	41	After removal of cover.
4.03	0	37	"
4.05	.5 feet below roof of M.H.	38	"
Wednesday, July 30th, 1930—M.H. "C"			
8.26 a.m.	0	35.5	Before removal of cover.
8.29	2.5	36	"
8.32	at roof of M.H.	36	"

DEVELOPMENT OF RESULTS OF SURVEY

Having obtained the temperature of the vacant ducts throughout the portion of the system under consideration, it remained to develop these data so that they would give a clearer picture of the thermal conditions of the feeder to substation No. 2. These data, in brief, consisted of the following:

(1) Load current and earth and vacant duct temperatures at what was called the reference duct on Lovett street, over an extended period of time.
(2) Vacant duct temperatures at different locations, the temperature of no two being taken at the same time.
(3) Hourly load current throughout the period of testing.

VACANT DUCT TEMPERATURE

The first problem that presented itself was to relate the load current and the earth temperature to the vacant duct temperature. It was assumed that the temperature in the vacant duct was made up of two portions, one that was related to the earth temperature and another that was related to the heat loss in the conductors. Obviously it requires time for a change in the temperature of the conductor to make itself felt in the adjacent vacant duct. Also the thermal condition of the earth some distance away may not be the same as that of the earth over the conduit, as the latter is back-fill and the surface conditions may be different. In the case of the reference duct, the point where the earth temperatures were observed was covered with grass whereas the duct was in the centre of the street, the surface being oiled macadam. The grass shaded the earth somewhat and would be expected to keep the earth temperature lower than where it was exposed to the direct rays of the sun.

The square of the current per conductor, which is proportional to the heat flow from the cables, was multiplied by a constant and plotted with a time lag. The earth temperature 4 feet down near the reference duct was also plotted after having been given a percentage increase. It was found that when the square of the current was multiplied by 0.0005 and given a time lag of two hours and the increase in the earth temperature was 25 per cent, the

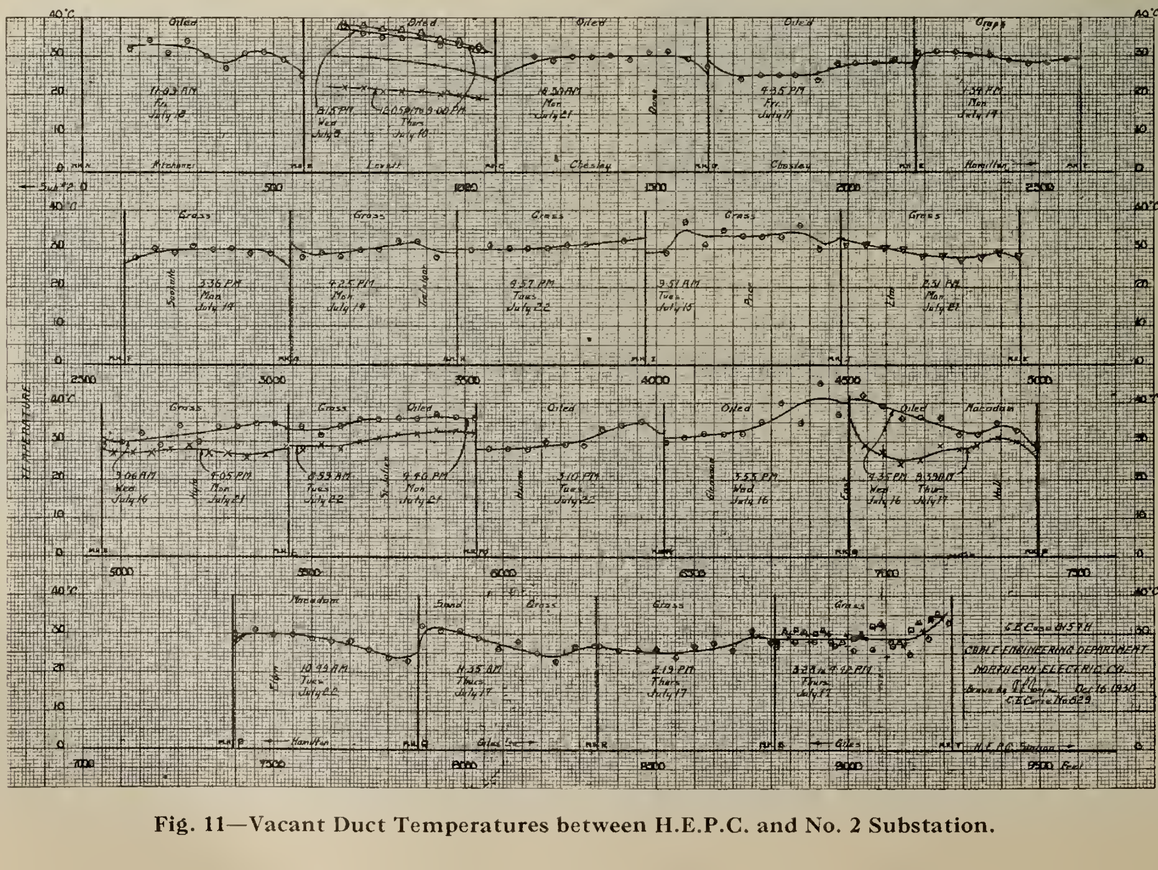

Fig. 11—Vacant Duct Temperatures between H.E.P.C. and No. 2 Substation.

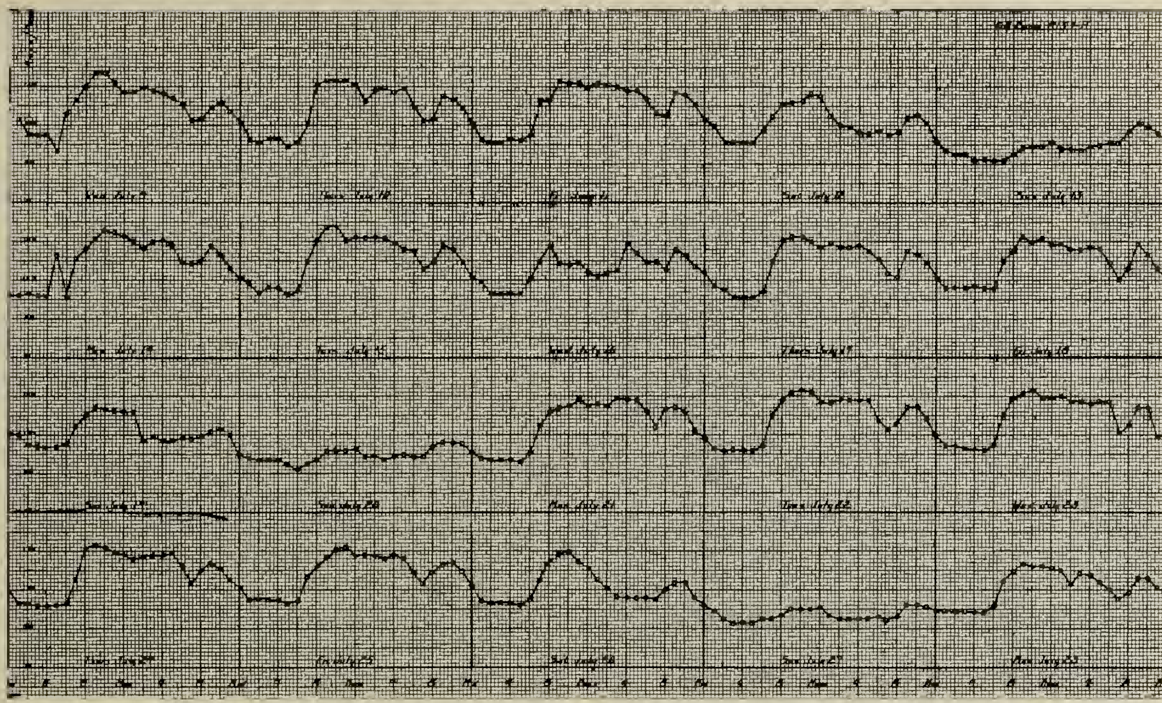

Fig. 12—Load Current from H.E.P.C. Station to Substation No. 2.

sum of these two curves coincided approximately with that of the vacant duct temperature. These three curves and that of the load current are shown in Fig. 15. This relationship is very important in the present problem and will be referred to later. It might be pointed out here that this relationship applies in this particular case. The various constants will probably be different with different duct arrangements, soil and surface conditions, etc.

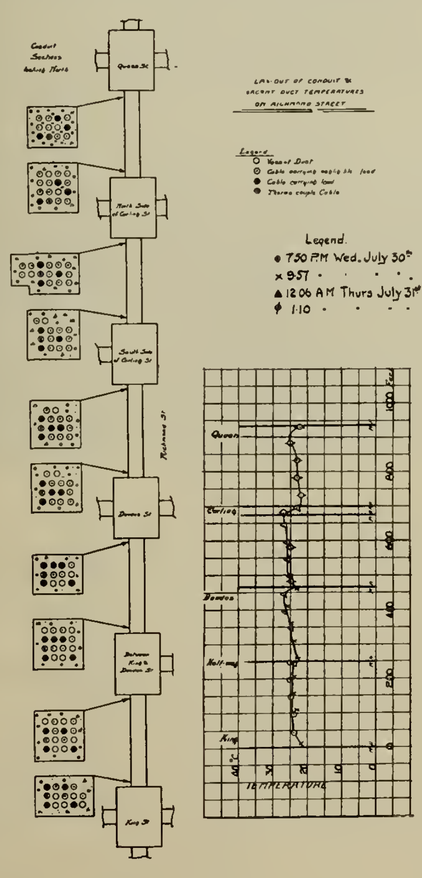

Fig. 13

Conductor Temperature Throughout the Day

In determining the conductor temperature in the reference section of conduit throughout the twenty-four hours, the change in conductor temperature was obtained by determining the conductor temperature rise during each hour, assuming the conditions during that hour to be constant and equal to the average. This hourly temperature rise was obtained by the use of an hourly attainment factor which is an exponential function of the thermal resistance between the duct wall and the conductor, and of the effective specific heat or thermal storage capacity of the cable.

The temperature of the conductor at the end of any one hour period is given by

$$T_h = T_d + T_o + T_1$$

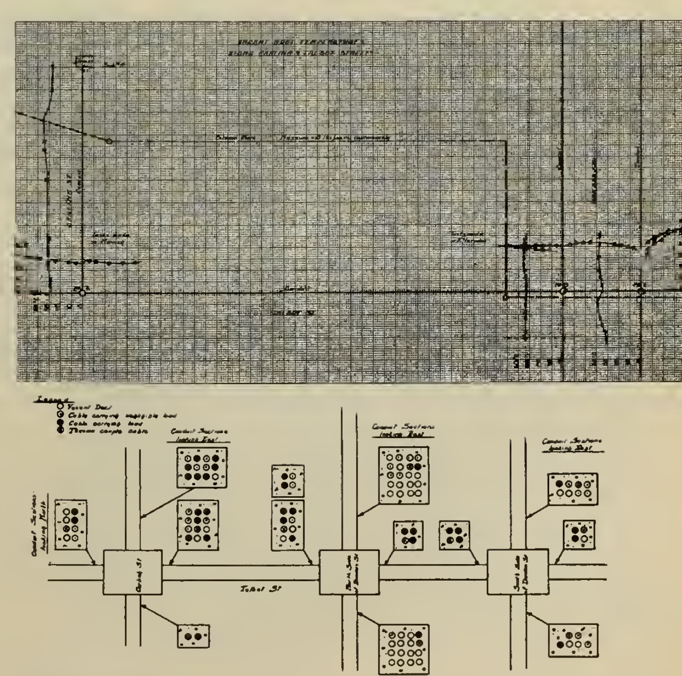

Fig. 14

where T_d = temperature in the adjacent vacant duct

T_o = temperature of the conductor above the vacant duct at the beginning of the hour

T_1 = temperature rise of the conductor during the hour and is given by

$$T_1 = A\,(T_m - T_o)$$

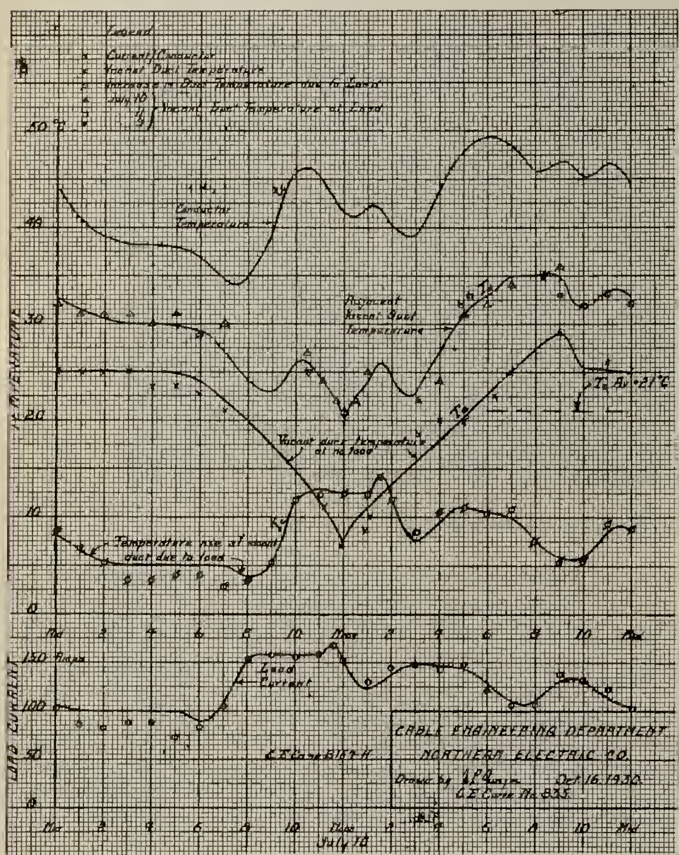

Fig. 15—Conductor, Duct and Earth Temperatures and Load Current on Lovett street.

where A = an hourly attainment factor

T_m = the ultimate temperature rise of the conductor above the temperature, T_d, of the adjacent vacant duct for constant conditions.

The ultimate temperature rise, T_m, of the conductor above that, T_d, of the adjacent vacant duct for constant conditions is given by

$$T_m = WR_v$$

where W = the loss in the three conductors

R_v = thermal resistance between the conductor and the adjacent vacant duct.

The loss in the three conductors per foot of cable is given by

$$W = 10.6\,nI^2\,(1 + at_r)/A_c$$

where n = number of conductors = 3

a = temperature coefficient of resistance = .00393/degree C.

A_c = conductor area in circular mils. = 211,600 C.M.

t_r = conductor temperature rise above 20 degrees C.

I = current per conductor,

therefore

$$W = 10.6 \times 3\,I^2\,(1 + .00393\,t_r)/211{,}600 \text{ watts/ft.}$$

The thermal resistance R_v to the flow of heat from the conductor to the adjacent vacant duct may be divided into the following three parts:

r_1 between the conductors and the lead sheath

r_2 between the lead sheath and the wall of the duct

r_d between the occupied duct and the adjacent vacant duct.

Thus $$R_v = r_1 + r_2 + r_d.$$

The thermal resistance to the flow of heat from the conductor to the sheath can be obtained by the equation derived in Appendix No. 1, that is,

$$r_1 = .0052\,rG/n \text{ thermal ohms/foot}$$

where r = thermal resistivity of the cable insulation

G = a geometric factor depending on the dimension of the cable and is given in Fig. 21 as a relation of the conductor insulation thickness, T, and of the belt insulation thickness, t

n = number of conductors in the cable.

The thermal resistance of the sheath surface is given by the equation derived in Appendix No. 2, that is,

$$r_2 = .0041\,E/D \text{ thermal ohms/foot}$$

where E = effective thermal resistivity of the sheath surface

D = diameter of the lead sheath.

The following are some of the dimensions of the cable which were used in the above formulae:

Diameter of the equivalent round conductor...	0.528 inch
Thickness of conductor insulation.............	0.18 inch
Thickness of belt insulation....................	0.18 inch
Outside diameter of lead sheath...............	2.3 inch

Thus $$t/T = 1.0 \text{ and } \frac{t+T}{d} = \frac{.36}{.528} = .683$$

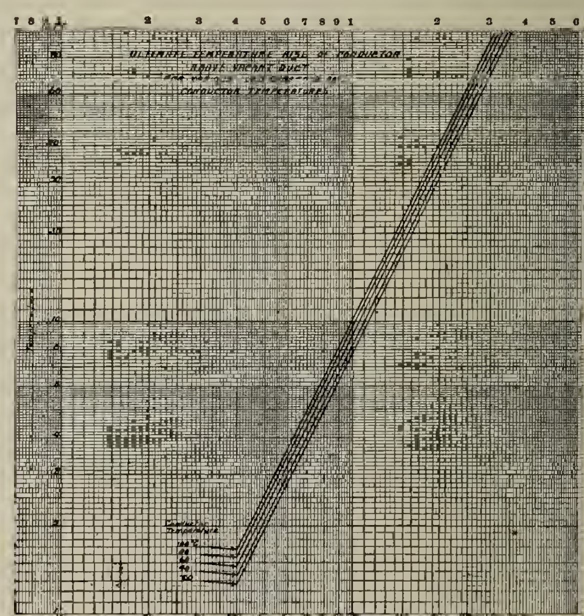

Fig. 16

The value of G from Fig. 21 = 1.72 for round conductors and for sector conductors 90 per cent of 1.72, that is, 1.55.

Therefore

$$r_1 = .0052 \times 870 \times 1.55/3 = 2.34 \text{ thermal ohms/foot}$$

and

$$r_2 = .0041 \times 1150/2.3 = 2.05$$

and

$$r_d = .75 \text{ according to Kirke}$$

Therefore the thermal resistance between conductors and vacant duct is

$$R_v = 2.34 + 2.05 + .75 = 5.14 \text{ thermal ohms/foot}$$

and

$$T_m = 5.14 \times 10.6 \times 3\,I^2\,(1 + .00393\,t_r)/211600$$

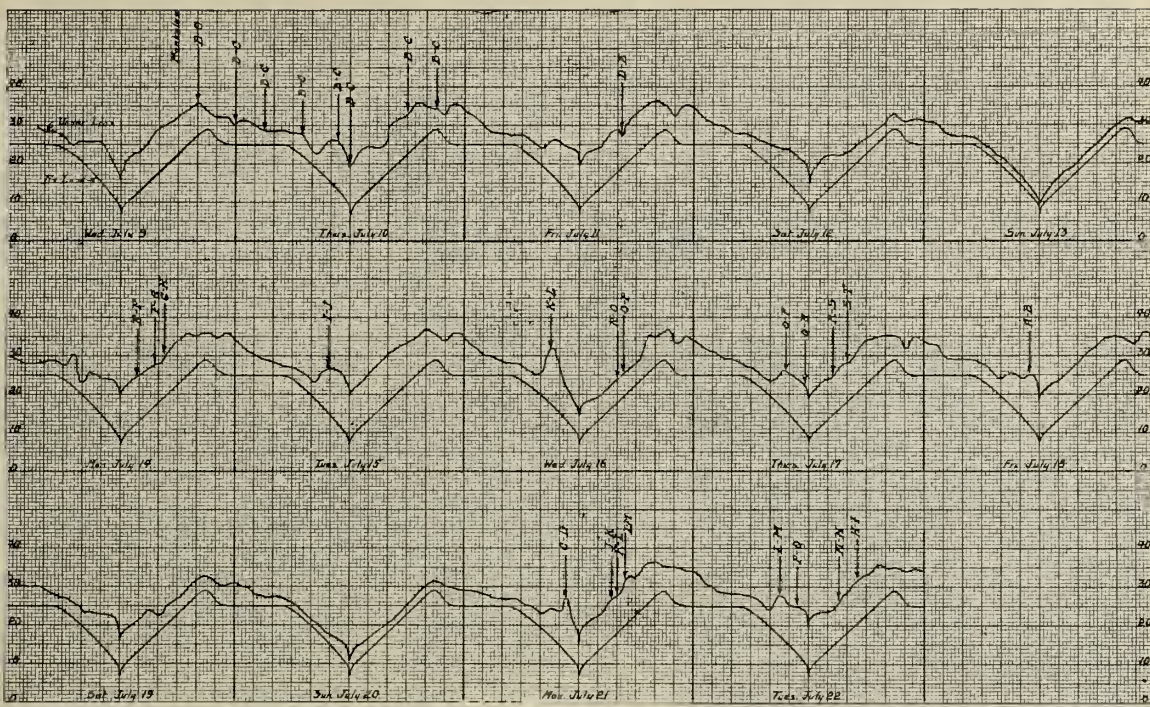

Fig. 17—Vacant Duct Temperatures at Reference Location on Lovett street.

Values of conductor temperature rise, T_m, are shown in Fig. 16 for various values of current and conductor temperature. Given a value of duct temperature, T_d, the ultimate conductor temperature for constant conditions can be obtained directly from this curve.

It has been shown in Appendix No. 3 that the hourly attainment factor A or the proportion of the ultimate temperature rise of the conductor during an hour under changed conditions of heat generation, is given by

$$A = 1 - e^{-1/HS}$$

where H = thermal resistance between the conductor and the thermally unaffected portion of the structure

S = effective thermal storage capacity of the cable per degree rise.

In calculating the value of H, it has been assumed that during the hour, the temperature of the duct structure does not change. The error caused by this assumption is small and on the side of safety. Therefore

$$H = r_1 + r_2 = 2.34 + 2.05 = 4.39 \text{ thermal ohms/foot}$$

The thermal storage S has been taken as being equal to the thermal storage of each component part of the line multiplied by its fractional temperature rise above the wall of the occupied duct, that is,

$$S = S_1 + S_2 + S_3 + S_4$$

where S_1 = thermal storage capacity of conductor multiplied by its temperature rise

S_2 = thermal storage capacity of paper multiplied by its temperature rise

S_3 = thermal storage capacity of insulating compound multiplied by its temperature rise

S_4 = thermal storage capacity of lead sheath multiplied by its temperature rise.

The thermal storage of each component is equal to its weight multiplied by its thermal capacity.

The weight of the

conductor	= 1.960 pounds per foot of cable
paper	= .648 " " "
insulating compound	= .467 " " "
lead sheath	= 3.340 " " "

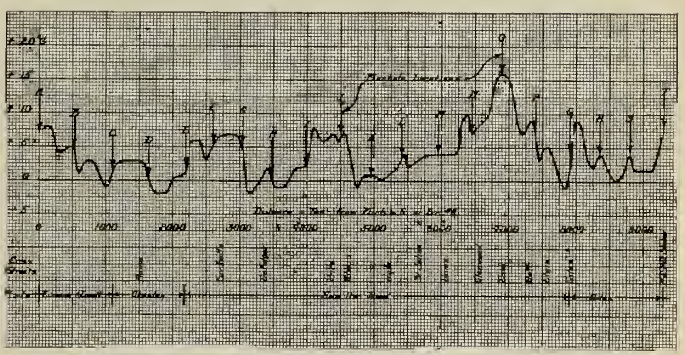

Fig. 18—Temperature of Vacant Duct Above and Below the Reference Point on Lovett street.

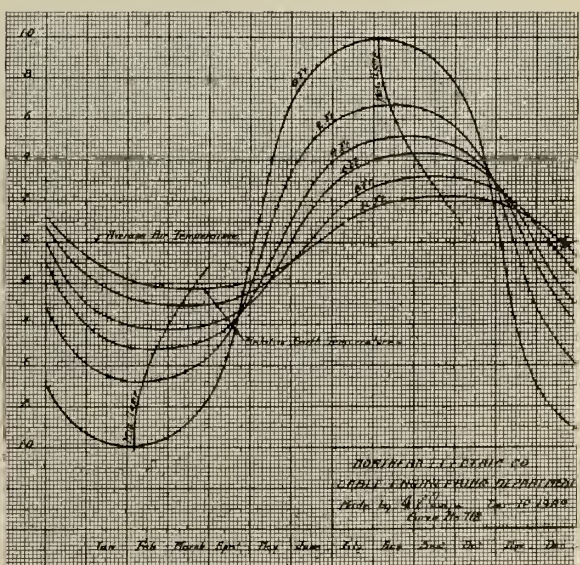

Fig. 19—Relative Earth Temperature as Compared with Average Air Temperature.

The following values have been given by Kirke.

The thermal capacity of

copper	= .048	watt hour per pound per degree C.
paper	= .137	" " "
insulating compound	= .237	" " "
lead	= .016	" " "

The fractional rise of the conductor above the wall of the occupied duct = 1.000

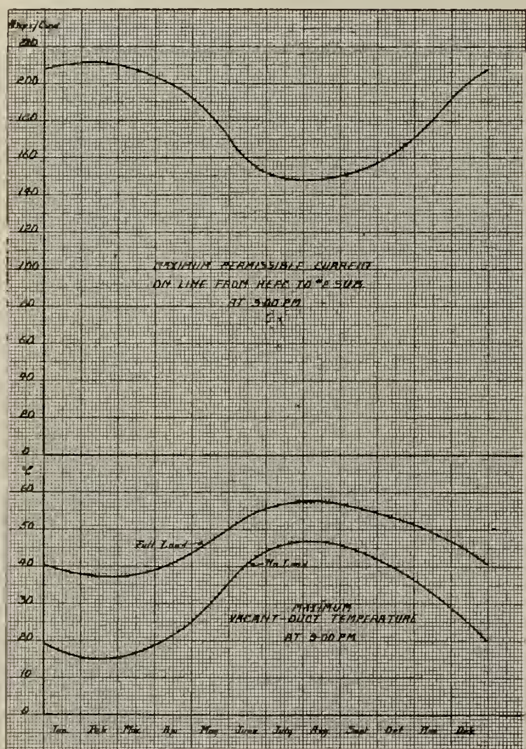

Fig. 20

The fractional rise of the insulation above the wall of the occupied duct

$= (.5\, r_1 + r_2)/H = (1.17 + 2.05)/4.39 = .735$

The fractional rise of the sheath above the wall of the duct $= r_2/H = 2.05/4.39 = .466$

Therefore the component storage factors are

for conductor $= S_1 = 1.96 \times .048 \times 1.000 = .094$

for paper $= S_2 = .648 \times .137 \times .735 = .065$

for compound $= S_3 = .467 \times .237 \times .735 = .080$

for lead $= S_4 = 3.34 \times .016 \times .466 = .024$

Thermal storage factor S for the cable $= .263$

The hourly attainment factor is

$$A = 1 - e^{-1/4.39 \times .263} = .58$$

therefore, $T_1 = .58\, (T_m - T_o)$

In calculating the conductor temperature, T_h, at the end of any hour, the vacant duct temperature, T_d, is obtained from Fig. 15, the temperature rise, T_o, of the conductor above the vacant duct temperature is that at the end of the previous hour and the temperature rise T_1 of the conductor during the hour is obtained as shown above for the load current shown in Fig. 15.

Table 2 shows the values used in these calculations. The conductor temperatures throughout the twenty-four hours are shown in Fig. 15.

Location of the Hottest Section of the Line

In determining the approximate location of the hottest section of the run, it was assumed that the portion of the vacant duct temperature, T_c, at the reference location due to the load, during July could be obtained from the load current with a two-hour time lag as described above. It was also assumed that the earth temperature, T_e, at this point would also be the same as on July 10, as it was uniformly sunny, the air temperatures were approximately the same and there was no rain. The temperatures obtained by adding the value of T_c, due to load, to the no load vacant duct temperatures T_e, in Fig. 15, are shown in Fig. 17. These values are the temperatures of the vacant reference duct on Lovett street during July.

The dates of the various temperature observations on the run to No. 2 substation are also shown in Fig. 17. In Fig. 18 is shown the difference between the vacant duct

Table 2—Conductor Temperature at the Reference Location on July 10

Time	Av. Current Fig. 15	Av. T_d Fig. 15	T_m Fig. 16	T_o	$T_m - T_o$	$T_1 = A\,(T_m + T_o)$	$T_o + T_1 = T_t$	T_d Fig. 15	Cond. Temp. $= T_t + T_d$
		degrees C.	degrees C.	degrees C.	degrees C.	degrees C.	degrees C.	degrees C.	degrees C.
Mid.-1 a.m.	101	32	8.4	0	8.4	4.9	4.9		
1–2	100	31	8.2	4.9	3.3	1.9	6.8		
2–3	100	30	8.2	6.8	1.4	.8	7.2		
3–4	100	30	8.2	7.2	1.0	.6	7.8		
4–5	100	30	8.2	7.8	.4	.2	8.0	29.8	37.8
5–6	95	29	7.4	8.0	– .6	– .3	7.7	29.2	36.9
6–7	95	28.5	7.4	7.7	– .3	– .2	7.5	27	34.5
7–8	125	26	13.0	7.5	5.5	3.2	10.7	24	34.7
8–9	155	23	20.0	10.7	9.3	5.4	16.1	23	39.1
9–10	160	24.5	21.5	16.1	5.4	3.1	19.2	26	45.2
10–11	160	26	21.5	19.2	2.3	1.3	20.5	24.5	45.0
11–Noon	165	22.5	22.5	20.5	2.0	1.2	21.7	19.5	41.2
Noon–1 p.m.	140	22.5	16.0	21.7	– 5.7	– 3.3	18.4	24	42.4
1–2	128	25.5	13.5	18.4	– 4.9	– 2.8	15.6	25	40.6
2–3	145	23	17.0	15.6	1.4	.8	16.4	23	39.4
3–4	147	25	17.5	16.4	1.1	.6	17.0	27	44.0
4–5	143	29	17.0	17.0	0.0	0.0	17.0	31	48.0
5–6	137	32.5	16.0	17.0	– 1.0	– .6	16.4	33	49.4
6–7	117	34	11.7	16.4	– 4.7	– 2.7	13.7	35	48.7
7–8	108	35	9.4	13.7	– 4.3	– 2.5	11.2	35	46.2
8–9	120	35.5	12.2	11.2	1.0	.6	11.8	35	46.8
9–10	133	33.5	15.0	11.8	3.2	1.9	13.7	31.5	45.2
10–11	123	32.5	12.7	13.7	– 1.0	– .6	13.3	33.5	46.8
11–Mid.	109	33.5	9.9	13.3	– 3.4	– 2.0	11.3	33	44.3
Mid.–1 a.m.	101	32	8.2	11.3	– 3.1	– 1.8	9.5	31.5	41.0
1–2	100	31	8.2	9.5	– 1.3	– .8	8.7	30.5	39.2
2–3	100	30	8.2	8.7	– .5	– .3	8.4	30	38.4
3–4	100	30	8.2	8.4	– .2	– .1	8.3	30	38.3
4–5	100	30	8.2	8.3	– .1	– .1	8.2	29.7	37.9

temperatures on the run to No. 2 substation as shown in Fig. 11; and the vacant duct temperatures on Lovett street at the same time as shown in Fig. 17. Thus Fig. 18 shows the difference between the vacant duct temperature at any point on the run and that of the vacant duct on Lovett street and therefore the difference in the conductor temperatures at these points. Inspection will show that the hottest section of the line is in the vicinity of manhole "O" at East street.

Maximum Permissible Load Current

The hot section around manhole "O" on the line from the Hydro-Electric Power Commission station to No. 2 substation is about 16 degrees C. above the reference point between manholes "B" and "C." This condition might be due to the nature of the surface of the earth, or to a higher thermal resistivity of the soil. The soil throughout this run was sand and gravel and the surface was the same as at the reference section, indicating that the moisture content was about the same. The increased temperature was therefore probably not due to increased thermal resistivity of the soil. Also there were no extraneous sources of heat such as steam mains, etc. It was therefore assumed that this increased temperature was caused by increased heat absorption from the sun, probably due to increased exposure. The effect of this assumed increased heat absorption was to increase the temperature of the earth by about 16 degrees C. at 4 feet deep.

The hottest point on the line being around manhole "O," the maximum current that this line can carry was limited by the thermal conditions at this point. In calculating the maximum permissible current, a chart was used showing the variation of temperature at the surface of the earth and at various depths as a proportion of the maximum variation of the surface temperature for the year. This chart is based on certain data published by the National Electric Light Association and is shown in Fig. 19. Taking the maximum value of the average daily air temperature throughout the year as 29 degrees C. and the minimum as − 12 degrees C., the yearly average would be 8.5 degrees C. and the maximum variation from this average would be 20.5 degrees C. The average daily temperature of the earth away from the duct but at the depth of the duct, i.e. 4 feet, can be taken normally as 8.5 degrees C. plus or minus the proportion of the maximum variation shown by the "4 foot" curve on Fig. 19, that is,

$$8.5 + (20.5 \times P_4)$$

where P_4 = the proportion shown by the "4 foot" curve at any month. This should be increased 25 per cent to give the vacant duct temperature at the reference location and at no load. To this must be added or subtracted the variation, u, from the daily average no-load vacant-duct temperature for any time of the day. This variation is a maximum in July and a minimum, probably nearly zero, in January.

For the location near manhole "O," must be added 16 degrees C., from Fig. 18. Thus the vacant duct temperature, T_e, near manhole "O" at no load becomes

$$T_e = 1.25\,(8.5 + 20.5\,P_4) + u + 16$$

The temperature, rise, T_c, of the vacant duct due to load can be taken as

$$T_c = 0.0005\,I^2$$

The conductor resistance is equal to $10.6\,(1 + at_r)/A_c$ and the temperature rise, T_m, of the conductor above the vacant duct is given by

$$T_m = 41\,I^2R_v/A_c$$

The conductor temperature, T_c, is therefore given by

$$t_c = T_e + T_c + T_m = 77 \text{ degrees C. maximum}$$

$$= 1.25\,(8.5+20.5\,P_4)+u+16+.0005\,I^2+41\,I^2\,R_v/A_c = 77$$

$$I^2\,(.0005+41\,R_v/A_c) = 77-1.25\,(8.5+20.5\,P_4)-u-16$$

For this line $R_v = 5.14, \quad A_c = 211{,}600$

$$\text{therefore } I^2 = \frac{61 - 1.25\,(8.5 + 20.5\,P_4) - u}{.0005 + (41 \times 5.14/211{,}600)}$$

$$I = \sqrt{\frac{50.4 - 25.6\,P_4 - u}{.0014}}$$

for the cable of this run.

For early August, P_4 taken from Fig. 19 is .50 and at 9.00 p.m. u, taken from Fig. 15, is 8 degrees C. for July but in August would probably be more nearly 5/6 of this, that is 6.5 degrees, and at this time the maximum permissible current would be approximately.

$$I = \sqrt{\frac{50.4 - 25.6 \times 50 - 6.5}{.0014}} = \sqrt{22100} = 149 \text{ amperes}$$

Fig. 20 shows the maximum permissible load currents for this line between the Hydro-Electric Power Commission and No. 2 substations as obtained by the above method. The values are for load periods of about two hours and for shorter periods the loads could be somewhat greater due to the thermal storage capacity of the system.

Thermal Resistivity of the Soil

Obviously the true thermal resistivity of the soil can only be obtained when all the factors affecting it have become constant. An inspection of Fig. 15 will show that the load with and without time lag, the earth temperature, and the vacant duct temperature, are all practically constant between 2.00 and 5.00 a.m. Therefore, the data obtained during this period were used in calculating the

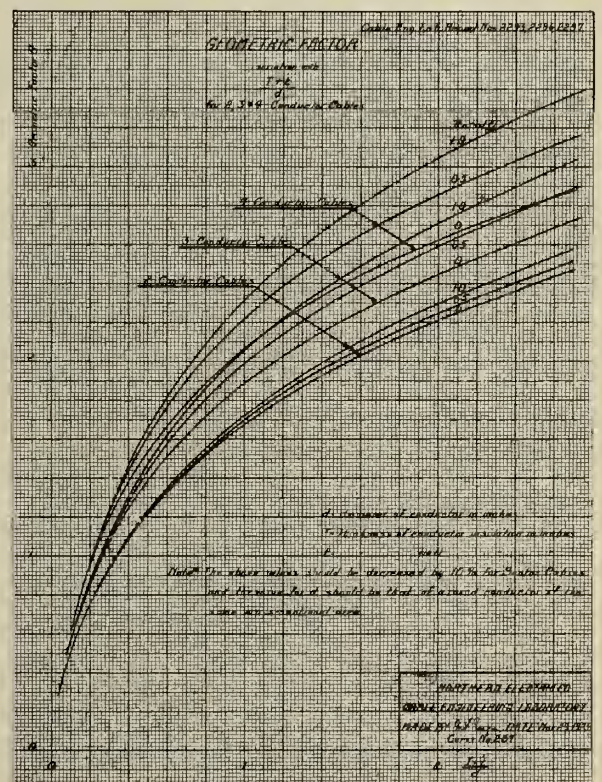

Fig. 21

thermal resistivity of the soil. The equation for the calculation of the thermal resistivity of the earth is shown in Appendix No. 5 to be

$$m = \frac{(A_cT_r/11.5\,nI^2) - (r_1+r_2)}{.008\,N\log\frac{4\,L}{l}} \text{ degrees C./watt/cm. cube}$$

Where A_c = conductor area = 211,600 cm.
T_r = temperature rise of conductor above ambient.
n = number of conductors in cable = 3.
I = current per conductor.
r_1 = thermal resistance of cable insulation = 2.34.
r_2 = thermal resistance of cable sheath surface = 2.05.
N = Number of cables in conduit = 3.
L = depth of centre of conduit = 48 inches.
l = geometric mean of axes of duct group $= \sqrt{4 \times 18} = 8.5$ inches.

Taking the current from Fig. 15 at 5.00 a.m. as 100 amperes and the conductor temperature as 38 degrees C. and the ambient as the average earth temperature between 0 and 4 feet from Fig. 9, that is 20 degrees C., we have

$$T_r = 38 - 20 = 18 \text{ degrees C.}$$

Therefore the thermal resistivity is

$$m = \frac{(211600 \times 18/11.5 \times 3 \times 10000) - (2.34 + 2.05)}{.008 \times 3 \log (4 \times 48/8.5)}$$

= 205 degrees C./watt/cm.

Discussion and Conclusions

Although the temperature at the surface of the earth reaches its maximum about two p.m., the temperatures a few feet below the earth's surface do not reach their maxima until six or seven hours later. The minimum surface temperature occurs about six a.m. and about the same relation holds between these minimum temperatures. This is an advantage where the peak load occurs in the late morning but a disadvantage when the peak occurs in the evening.

It seems that the vacant duct temperature can be calculated from the earth temperature and the heat loss in the surrounding cables. The temperature of the vacant duct at no load may be consistently higher or lower than the earth temperature due to conditions of backfill, etc. The increase in the vacant duct temperature due to load lags behind the load and quite probably the relation between the load and this temperature varies considerably with different arrangements of cables and different conductor resistances although in this case the lag was two hours and the rise equal to $0.0005 I^2$. Both the effects of the backfill, etc., and the relation between load and vacant duct temperature for various arrangements, could be determined experimentally, when conductor temperatures could be calculated at any point of any known load cycle for other installations.

The chart showing the distribution of temperature in the earth throughout the year is of a general nature. Such a chart should be prepared for the particular locality of the cable system, and the effect of surface and soil conditions studied to determine their effect on the distribution of soil temperature. This would improve the accuracy of the vacant duct temperature calculations for the no load condition. The variation of earth temperatures throughout the day should also be studied under both summer and winter conditions. Lacking both of these more precise charts, assumptions had to be made accordingly, although the error caused thereby is not thought to be very great.

No calculations were attempted on Richmond, Talbot or Carling street ducts as the feeder and ring loads were low and secondary loads were unknown. The Richmond and Carling street duct temperatures were not high but at the intersection of Talbot and Carling streets, the vacant duct temperatures were rather high due to the proximity of a steam main.

The thermal resistivity of the soil (205 degrees C./watt/cm. cube), is higher than that which has been considered more nearly the average.

Acknowledgment

The writer wishes to acknowledge the assistance of the Public Utilities Commission of London in making this survey of their system and for their permission to use the data obtained.

Symbols

A = Attainment factor.
A_c = Conductor area.
A_s = Area of sheath surface.
a = Temperature coefficient of resistance.
b = Inside radius of annulus.
c = Outside radius of annulus.
D = Outside diameter of sheath.
d = Diameter of conductor, diameter of duct.
E = Thermal resistivity of sheath surface.
e = Base of natural logarithms = 2.72.
F = Function of cable dimensions.
G = Geometric factor of cable.
H = Thermal resistance of cable insulation and sheath surface.
I = Conductor current.
L = Depth of centre of conduit.
l = Geometric mean of axes of duct group in conduit.
m = Thermal resistivity of earth.
N = Number of loaded cables in conduit.
n = Number of conductors in cable.
R = Thermal resistance of heat conductor.
R_a = Thermal resistance of annulus.
R_v = Thermal resistance between conductor and adjacent vacant duct.
R_t = Thermal resistance between conductor and atmosphere or ambient medium.
r = Thermal resistivity.
r_a = Thermal resistance of annulus.
r_c = conductor resistance.
r_d = Thermal resistance between occupied and adjacent vacant duct.
r_1 = Thermal resistance between conductor and sheath.
r_2 = Thermal resistance between sheath and duct wall.
r_3 = Thermal resistance between duct wall and atmosphere or ambient medium.
S = Thermal storage capacity.
T = Difference in temperature along a thermal conductor, conductor insulation thickness.
T_c = Temperature rise of vacant duct due to load current.
T_d = Vacant duct temperature.
T_e = Vacant duct temperature at no load.
T_m = Temperature rise of conductor above adjacent vacant duct—ultimate.
T_o = Temperature rise of conductor above adjacent vacant duct—at beginning of the hour.
T_r = Temperature rise of conductor above atmosphere or ambient medium.
T_1 = Temperature rise of conductor during 1 hour.
t = Thickness of belt insulation.
t_c = temperature of conductor.
t_h = Temperature of conductor at end of 1 hour.
t_r = Temperature rise of conductor above 20 degrees C.
t_{t_1} = Temperature rise of conductor after any time t_1.
t_1 = Time.
t' = Time constant.
V = Voltage.
v = Radius of annulus.

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APPENDIX NO. 1

The equation giving the thermal resistance of cable insulation may be developed in the following manner.

The thermal resistance or resistance to the flow of heat, was calculated after the manner of calculating the electrical resistance of conductors. According to Ohm's Law, the ratio of the electro-motive force to the current in a conductor is constant, that is,

$$\frac{e}{I} = \text{a constant for any one conductor}$$

where e = difference in voltage or electro-motive force along the conductor,
I = current in the conductor.

This ratio is known as the resistance of the conductor.

The factors in the flow of heat follow a similar law known as "Ohm's law for heat," that is,

$$\frac{T}{W} = \text{a constant, } R\text{, for any one heat conductor.}$$

where T = difference in temperature along the conductor.
W = flow of heat through the conductor.
R = thermal resistance of the conductor.

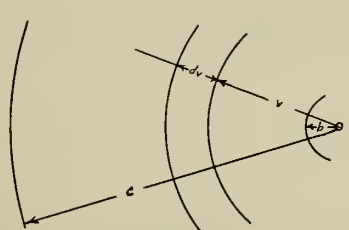

Fig. 22

T is usually expressed in degrees Centigrade, W in watts and R in thermal ohms. The thermal resistivity of a material is the thermal resistance of a cube having unit sides and will be expressed as degrees C./watt/cm. cube.

If we consider an elementary annulus as in Fig. 22 the thermal resistance to the flow of heat across the annulus is given by

$$R_a = \frac{r\,dv}{2\,\pi v}$$

where r = thermal resistivity.

Integrating this from the inner radius, b, to the outer, c, we have for the thermal resistance of a single conductor cable

$$r_1 = \int_b^c \frac{r\,dv}{2\,\pi v}$$

$$= \frac{r}{2\pi} \log_e \frac{b}{c}$$

In multiple conductor cables having round conductors this equation is sometimes used in the form

$$r_1 = \frac{r}{2\,\pi n} \log_e F \ldots\ldots\ldots\ldots\ldots (1)$$

where n = the number of conductors.
F = a function of the dimensions of the cable.

Simmons gives the expression $\log_e F$ as a quantity G and shows the values of G for multiple conductor cable as a function of

$$\frac{T+t}{d} \text{ and } \frac{t}{T}$$

where T = thickness of conductor insulation
t = thickness of belt insulation
d = diameter of conductor.

Equation (1) therefore becomes

$$r_1 = \frac{r}{2\,\pi n}\, G$$

and the thermal resistance per foot of cable is

$$r_1 = \frac{rG}{2\,\pi n \times 12 \times 2.54}$$

$$= \frac{.0052\,rG}{n} \text{ thermal ohms}$$

Values of G are shown in Fig. 21 and are based on formulae developed by Mie and experiments made by Atkinson with certain corrections made by Simmons and shown in the paper of the latter. For sector conductors the diameter of the round conductor should be used and the corresponding value of G decreased 10 per cent.

The values of thermal resistivity, r, that have been obtained by various experimenters are shown in the following table:—

Table 3

Values of Thermal Resistivity of Paper Power Cable Insulation

	Maximum Degrees C./watt/cm.³	Minimum Degrees C./watt/cm.³
Melsom and Booth....	980	745
Atkinson and Fisher...	1,000	869
Powell...............	1,230	877
Symons and Walker...	705	489
Melsom and Fawssett..	1,330	505

In what follows the value 870 will be used.

APPENDIX NO. 2

The equation for the thermal resistance of the cable sheath surface is obtained in the following manner.

Heat is dissipated from the sheath by radiation, convection and conduction to the inside surface of the duct. The resistance to this dissipation has been found by several investigators to be practically proportional to the area of the area of the cable sheath. Thus the thermal resistance between the cable sheath and the duct wall may be given by

$$r_2 = \frac{E}{A_s} \text{ thermal ohms}$$

where E = effective thermal resistivity of the sheath surface in degrees C./watt/sq. cm.
A_s = area of sheath/foot

or $r_2 = 0.0041\ E/D$ thermal ohms/foot of cable

where D = diameter of sheath in inches.

The values of E determined by various experimenters are shown in the following table.

Table 4

Values of Effective Thermal Resistivity of Sheath Surface

	Maximum Degrees C./watt/cm.²	Minimum Degrees C./watt/cm.²
Melsom and Booth....	1,140	645
Atkinson and Fisher...	1,200	1,040
Powell...............	1,110	910
Dushman............	1,230	910
Melsom and Fawssett.	1,820	860

The value 1,150 will be used here.

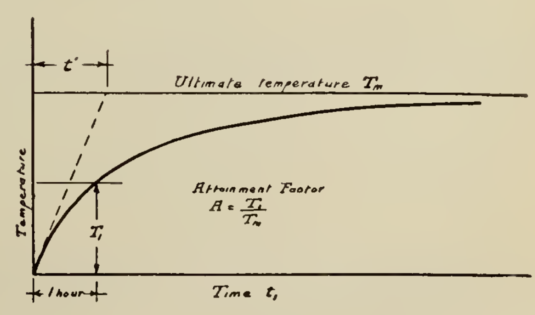

Fig. 23—Transient Temperature of Cable under Changed Rate of Heating.

APPENDIX NO. 3

The following is a brief resumé of Kirke's method of determining conductor temperatures under variable load conditions.

When the heat loss in the conductor is constant, the increase in the temperature of the conductor, according to Kirke, follows closely the exponential law

$$T_{t1} = T_m (1 - e^{-t_1/t'})$$

as shown in Fig. 23 and

where T_{t1} = temperature rise of conductor at any time t_1

T_m = ultimate rise of conductor

t' = time constant

The time constant is the time to reach the ultimate temperature assuming all heat loss to be stored, or to reach 63 per cent of the ultimate temperature rise with constant heat loss ($.63 = 1 - 1/e$).

The hourly attainment factor is taken as the ratio of the conductor rise after one hour, to the ultimate rise, the conditions being constant, and is given by

$$A = \frac{T_1}{T_m} = 1 - e^{-1/t'}$$

The time constant, t', is equal to HS, therefore,

$$A = 1 - e^{-1/HS}$$

where H = thermal resistance between the conductor and the thermally unaffected portion of the duct structure, that is, the duct wall,

$= r_1 + r_2$

S = effective thermal storage capacity of the cable per degree rise.

APPENDIX NO. 4

The following is a derivation of the equation for the thermal resistance between the conduit and the surface of the earth.

It has been shown in Appendix No. 1 that the thermal resistance between the two concentric cylinders is given by

$$R = \frac{m}{2\pi}\log_e\frac{r_1}{r_2}$$

where m = thermal resistivity. Therefore the difference in the temperature between these cylinders is

$$t_{12} = WR = \frac{Wm}{2\pi}\log_e\frac{r_1}{r_2}$$

Superposing the fields from A'_1 and A'_2 in Fig. 24, the temperature difference between H_2 and P due to the radial heat flow from A'_1 is

$$t_{p1} = \frac{Wm}{2\pi}\log_e\frac{x_1}{a}$$

Similarly, the temperature difference between H_2 and P due to the radial heat flow from A'_2 is

$$t_{p2} = \frac{Wm}{2\pi}\log_e\frac{x_2}{b}$$

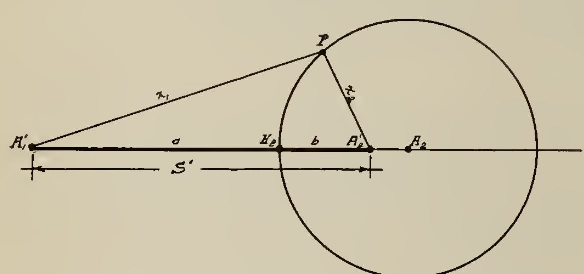

Fig. 24

The temperature difference between H_2 and P due to the resultant field is then

$$t_p = t_{p1} + t_{p2} = \frac{Wm}{2\pi}\left(\log_e\frac{x_1}{a} - \log_e\frac{x_2}{b}\right)$$

If the two points are on the same isothermal surface the temperature difference between them is zero, therefore

$$\log_e\frac{x_1}{a} = \log_e\frac{x_2}{b}$$

$$\frac{x_1}{a} = \frac{x_2}{b}$$

$$\frac{x_1}{x_2} = \frac{a}{b} = \text{constant}$$

if H_2 is fixed, that is for any one isothermal surface.

These isothermal surfaces are cylinders whose sections are circles which surround the infinitely small heat sources at $A'_1A'_2$. These circles have centres on the line $A'_1A'_2$ but are not concentric with the heat sources.

Green's theorem states that if any equipotential surface be kept at its original potential, the flux within it may be removed without any change in the external field. This is analogous to isothermal surfaces and lines of heat flow.

The circles in Fig. 25 represent isothermal cylinders surrounding centres of heat flux A'_1 and A'_2. The cylinders

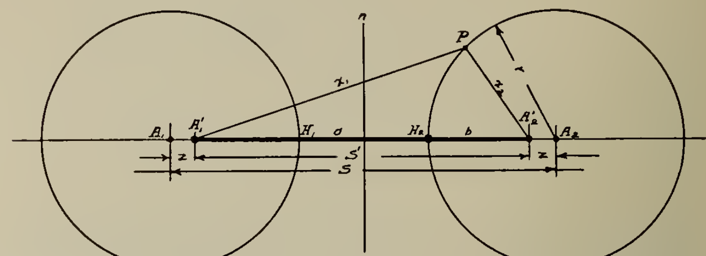

Fig. 25

have a radius r and a spacing between centres of S. The distance, z, between the centre of the isothermal cylinder and the centre of heat flux is found in the following manner.

$$a = A'_1H_2 = S - r - z$$

$$b = A'_2H_2 = r - z$$

$$z = \frac{b^2}{a - b} = \frac{r^2 - 2rz + z^2}{S - r - z - r + z} = \frac{r^2 - 2rz + z^2}{S - 2r}$$

$$zS = r^2 + z^2$$

$$z^2 - Sz + r^2 = 0$$

$$z = \frac{S \pm \sqrt{S^2 - 4r^2}}{2}$$

The negative sign is taken for the radical as, obviously, z cannot be greater than $S/2$.

$$a = S - r - z$$

$$= \frac{2S - 2r - S + \sqrt{S^2 - 4r^2}}{2}$$

$$= \frac{S - 2r + \sqrt{S^2 - 4r^2}}{2}$$

$$b = r - z$$

$$= \frac{2r - S + \sqrt{S^2 - 4r^2}}{2}$$

$$\frac{a}{b} = \frac{S - 2r + \sqrt{S^2 - 4r^2}}{2r - S + \sqrt{S^2 - 4r^2}}$$

Multiply and divide by $2r - S - \sqrt{S^2 - 4r^2}$

$$\frac{a}{b} = \frac{S - 2r + \sqrt{S^2 - 4r^2}}{2r - S + \sqrt{S^2 - 4r^2}} \times \frac{2r - S - \sqrt{S^2 - 4r^2}}{2r - S - \sqrt{S^2 - 4r^2}}$$

$$= \frac{-2S^2 - 4rS + 2(S - 2r)\sqrt{S^2 - 4r^2}}{4r^2 - 4rS + 4r^2}$$

$$= \frac{(2r - S)(S + \sqrt{S^2 - 4r^2}}{2r(2r - S)} = \frac{S}{2r} + \sqrt{\left(\frac{S}{2r}\right)^2 - 1} \quad ..(2)$$

Let t_n represent temperature difference between the circle H_2 and the neutral plane N and let R be the corresponding thermal resistance to the neutral plane per centimetre of axial length. The temperature difference due to A'_1 is

$$t_{n1} = \frac{Wm}{2\pi}\log_e\frac{x_1}{S'/2}$$

Due to A'_2

$$t_{n2} = \frac{-Wm}{2\pi}\log_e \frac{x_2}{S'/2}$$

Therefore $$t_n = t_{n1} + t_{n2} = \frac{Wm}{2\pi}\left(\log_e \frac{x_1}{S'/2} - \log_e \frac{x_2}{S'/2}\right)$$

$$= \frac{Wm}{2\pi}\log_e \frac{x_1}{x_2}$$

and $R = t_n/W = \frac{m}{2\pi}\log_e \frac{x_1}{x_2} = \frac{m}{2\pi}\log_e \frac{a}{b}$

Substituting from (2)

$$R = \frac{m}{2\pi}\log_e\left(\frac{S}{2r} + \sqrt{\left(\frac{S}{2r}\right)^2 - 1}\right) \text{ thermal ohms/cm.}$$

$$\text{or } r_3 = \frac{m \log_e\left(\frac{2L}{d} + \sqrt{\left(\frac{2L}{d}\right)^2 - 1}\right)}{2\pi} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where L = distance between centre of the cylinder and the neutral plane = $S/2$

m = thermal resistivity of the intervening material in degrees C./watt/cm. cube

d = diameter of cylinder = $2r$

In the case where L is large compared with d

$$\sqrt{\left(\frac{2L}{d}\right)^2 - 1} \text{ nearly equals } \frac{2L}{d}$$

and $$r_3 \frac{m \log_e \frac{4L}{d}}{2\pi} \text{ approximately} \ldots . (4)$$

In the limiting case where $2L$ is equal to d

$$\sqrt{\left(\frac{2L}{d}\right)^2 - 1} = 0$$

and $$r_3 = \frac{m \log_e \frac{2L}{d}}{2\pi} \text{ exactly.}$$

In practice, $2L$ is usually greater than d and, therefore, the numerator under the logarithm should be somewhere between $2L$ and $4L$.

The concrete of the conduit is in the portion of the heat path where it has the most effect and although it has a lower thermal resistance than most soils, it is considered here as having the same thermal characteristics as the earth. Also the back-fill may contain more or less water than the surrounding earth depending on whether the conduit is lightly or heavily loaded and its thermal characteristics may therefore be different from the surrounding earth. Owing to the uncertainty produced by these considerations as regards formula (3), it has been thought that the approximate formula (4) could be used, especially as it tends to give a high rather than a low value of r_3, which is on the side of safety.

It has generally been considered that the surface of the earth is the equivalent of the neutral plane in the above arrangement and that the earth and conduit can be considered as the equivalent of the system on one side of the neutral plane. But it is known that the earth's surface is not exactly an isothermal plane when considered in connection with the dissipation of heat from underground structures, as such structures as steam mains can, under favourable conditions, be traced in winter by the line where the snow has been melted away due to their heat. This tends to reduce the value of r_3 and it has been shown by German investigators and by Melsom and Fawsett that formula (4) gives results that are about 50 per cent high. The factor .67 has, therefore, been introduced to make the formula agree better with experimental results of these investigators. Thus formula (4) becomes

$$r_3 = \frac{.67\, m \log_e \frac{4L}{d}}{2\pi} \text{ thermal ohms/cm.}$$

$$= .008\, m \log \frac{4L}{d} \text{ thermal ohms/foot} \ldots\ldots (5)$$

where d = diameter of the duct in the conduit.

If, however, there is more than one duct in the conduit, d is taken as the geometrical mean, l, of the axes of the group. Also r_3 is the thermal resistance to the flow of heat from any one cable and formula (5) therefore becomes

$$r_3 = .008\, mN \log \frac{4L}{l} \text{ thermal ohms/foot}$$

where N = number of loaded cables assuming all to be similar and similarly loaded.

APPENDIX NO. 5

The equation for the calculation of the thermal resistivity of the earth was derived in the following manner:

The method used was based on that of Simmons. It is generally assumed that the heat loss of the conductors is transmitted to the atmosphere. Thus the heat path, R_t, may be divided into the following three portions,

r_1 = the cable insulation.
r_2 = the sheath surface, etc.
r_3 = the surrounding earth.

Thus $R_t = r_1 + r_2 + r_3$

The calculation of r_1 and r_2 has previously been shown in Appendices Nos. 1 and 2.

An approximate formula for the calculation of r_3 has been derived in Appendix No. 4. This formula is

$$r_3 = .008\, mN \log \frac{4L}{l} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

It has been shown that the heat loss is given by

$$W = T_r/R_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where T_r = temperature of conductor above the atmosphere or ambient medium.

R_t = Thermal resistance between the conductor and the atmosphere or ambient medium.

and $W = I^2 r_c n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$

where I = current per conductor

r_c = resistance per foot of conductor

n = number of conductors per cable.

Also $r_c = 11.5/A_c$ for stranded cable with 38 degrees C. rise $\ldots\ldots\ldots\ldots (9)$

where A_c = conductor area in circular mils.

Therefore from equations (7), (8) and (9) we have

$$\frac{I^2\, 11.5\, n}{A_c} = \frac{T_r}{R_t}$$

$$R_t = \frac{A_c T_r}{I^2 11.5\, n} = r_1 + r_2 + r_3$$

or $$r_3 = \frac{A_c T_r}{I^2 11.5\, n} - (r_1 + r_2)$$

and substituting (6) for r_3 we have the thermal resistivity as

$$m = \frac{(A_c T_r/11.5\, nI^2) - (r_1 + r_2)}{.008\, N \log \frac{4L}{l}} \text{ degrees C./watt/cm. cube}$$

The Seaboard Power Plant, Glace Bay, N.S.

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SUMMARY.—This paper describes a steam-electric plant of 7,500 kv.-a. capacity, recently completed and designed to burn in pulverized form either refuse or unsaleable coal or coal of better quality. It is located on tidewater near Glace Bay, N.S. A number of problems which have arisen during the operation of the plant are discussed, particularly in connection with water supply, load fluctuation and the nature of the fuel; the results of a boiler test are given.

Four inter-connected steam-electric power plants are operated by the Dominion Steel and Coal Corporation to supply electrical energy for its steel mills and coal mines in the Sydney-Glace Bay area in Nova Scotia. The latest and most modern of these is the Seaboard plant, which was designed and constructed during the nine months prior to June, 1930. Its principal equipment consists of one 7,500 kv.-a. turbo generator and two 922 h.p., 450-pound pressure, pulverized coal fired boilers. It is the purpose of this paper to discuss the mechanical, rather than the electrical, aspects of this power station.

The optimum of reliability and efficiency, with a minimum of capital outlay, was the aim in designing this plant to handle heavy intermittent loads with refuse and unsaleable coals. It was also desired to secure good operating characteristics when using merchantable coals from any or all mines in the district. Further, it was planned to be operated as a base load plant insofar as this was economically possible.

The Seaboard power plant, housed in a substantial brick and steel structure and arranged for future extensions, is located near its load centre on the shore of a salt-water bay about three miles south of the town of Glace Bay and closely adjacent to several coal mines—the nearest colliery (Dominion No. 24) being about 1,500 feet distant. The bay provides an abundance of cool condensing water, and has a moderate tide of less than three feet, so that the pumping cost of condensing water is at a minimum. Also the plant site is some distance from any centre of population, which might be annoyed by the products of combustion.

Splint Coal

In the process of coal preparation at each colliery, all sizes over ¾ inch are hand picked, i.e., the stone or slate is picked out and put into a refuse car; and the "splint" which contains mostly coal, but some shale, bone or other impurities, is put into the splint car. This so-called splint may, or may not, be a true splint as defined by mining engineers—but it is unattractive and not merchantable even though some of it may have high heat value, moderate ash and excellent burning qualities. From the mines in the Emery seam, however, there is a true splint, high in ash and containing bands of shale, or bone, and adhesions of roof stone. This Emery splint, when used in hand-fired or stoker fired boilers, considerably reduces the steaming capacity—but in pulverized form is quite satisfactory for boiler furnaces of conventional design.

The varying ash content of Emery splint depends not only on conditions of mining, but also on the judgment (or want of judgment) of the picker-boys; pure rock,

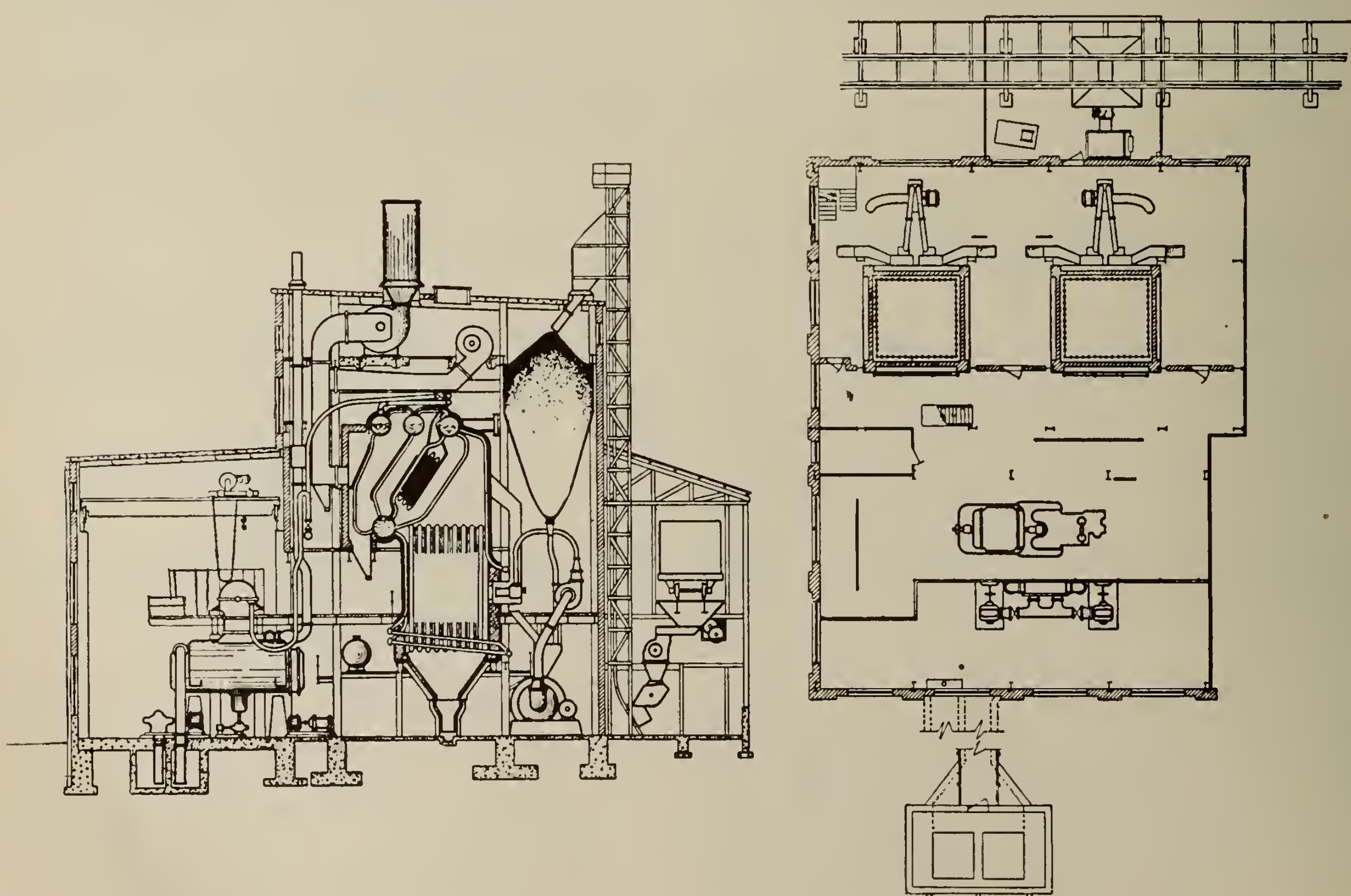

Fig. 1—General Arrangement of Plant.

coupling-links, pit timber and track spikes occasionally find their way into the splint car instead of the stone car. In order, therefore, to prepare economically splints and other refuse coals of varying ash and moisture content for boiler use at Seaboard, it was decided to use unit type ball-mill pulverizers arranged for mill drying. A fairly high ash sample of Emery splint used as a basis for calculations and design, as well as for grinding tests, had the following proximate analysis:—

Fixed Carbon	45.33 per cent
Moisture	4.00 " "
Volatile	27.50 " "
Ash	23.17 " "
Total	100.00
Heat value	11,000 B.t.u. per pound
Sulphur	1.32 per cent

Coal Handling

Fuel, at Seaboard, is received in railway cars on a trestle adjacent to the boiler room, and from the cars the coal is dropped into a track hopper to a plate feeder, and thence to an American No. 18 ring roll crusher, where the coal is reduced to one inch and smaller. Crushed coal, at the rate of 30 to 40 tons per hour, is elevated to the coal storage bunker, above the firing aisle of boiler room, by a Link-Belt vertical automatic motor-driven skip hoist. The 150-ton capacity coal storage bunker is of the parabolic suspended type, with concrete lined steel plate shell.

One 7-foot diameter by 36-inch Hardinge conical ball mill, complete with 125-h.p. motor drive, feeder, automatic capacity control device and 30-h.p., 1,200-r.p.m. motor-driven exhauster is arranged to supply pulverized coal to the two burners of each boiler (Fig. 2). Each mill has a rated capacity of 12,000 pounds per hour of 75 per cent through 200-mesh Emery splint, containing 6 per cent moisture—when the mill is supplied with air at 350 degrees F. These mills have proved very reliable, economical and satisfactory, although it required some time for the operators to learn how best to handle them.

Boilers

The two boilers are of the Babcock and Wilcox Stirling type, each designed for 90,000 pounds of steam per hour at 450 pounds working pressure, and equipped with two horizontal Couch type 27-inch diameter burners. The heating surface of each boiler is 9,219 square feet and the furnace volume 5,800 cubic feet, the furnaces being equipped with "Combustion" fin tube water walls and slag screens, with a total area 1,610 square feet. Solid fire brick walls are used for that portion of the side wall located above the water wall—also for that portion of the front wall extending below a horizontal line located slightly above the burners. The ash hopper below the water screen is of the refractory lined ventilated cast iron type, as designed by Allen-Sherman-Hoff. In the first pass of each boiler are placed Elesco bare-tube superheaters of the five loop type. Diamond soot blowers are provided. The interior surfaces of boilers and water walls are coated with Apexior paint. Copes feed water regulators and Craig damper regulators are installed. Secondary air control by Bailey meters is satisfactory. Normally, only one boiler is in operation.

Air Preheater and Fans

Air for combustion and for mill coal drying is provided through "Combustion" vertical counter-flow plate type preheaters, each having 5,000 square feet heating surface. The elements are of electrically welded No. 12 gauge copperoid steel, 3 feet wide and 16 feet long, with one inch gas spaces and ¾-inch air spaces. Each preheater is designed to handle 110,000 pounds of air per hour with 139,500 pounds of flue gas at a pressure of 0.48 inches water gauge and draught loss of 3.2 inches. The observed air rise is 300 degrees F.; the flue gas temperature drop 140 degrees F. from approximately 560 degrees F. to 410 degrees F. (February 3rd, 1932).

The temperatures of the superheated steam, the flue gases leaving the boiler and the air leaving the preheater, of course, all increase as excess combustion air is supplied.

Each boiler is equipped with one motor-driven forced draught and one motor-driven induced draught fan. The induced draught fans have dual motor drive for two operating speeds.

Fig. 2—Hardinge Ball Mill.

The forced draught fans are double inlet with ring oiled bearings; to deliver 35,000 c.f.m. of 100 degrees F. air at 8.5 inches static pressure at 1,175 r.p.m.

The induced draught fans are double inlet with ring-oiled water-cooled bearings to handle 70,000 c.f.m. of 530 degrees F. flue gas at 6 inches static pressure and 874 r.p.m.—or, 27,200 cubic feet of 450 degrees F. flue gas at 2.4 inches static pressure and 490 r.p.m.

Turbo Generator

One 7,500-kv.-a., 3,600-r.p.m., 6,600-volt, 3-phase, 60-cycle turbo generator, built by Brown Boveri of Baden, Switzerland, is installed. The turbine is of the combined impulse-reaction type, with one two-stage compound impulse wheel and 22 reaction stages, designed for 400 pounds gauge and maximum steam flow of 94,000 pounds per hour, 650 degrees F. steam at throttle—exhausting at one inch mercury absolute, steam rate 10.32 pounds per kw.-h. at 6,000 kw. and .80 power factor—or 10.75 pounds at 7,500 kw. unity power factor. Two bleed points are provided:—

To extract 16,000 pounds per hour at 118 pounds absolute.
To extract 10,000 pounds per hour at 12 pounds absolute.

The impulse blading is nickel steel; the reaction blading partly brass and partly stainless steel. Speed regulation 2 per cent above or below normal.

The generator is 6,000 kw. at .80 power factor star connected for 6,600 volts. The end shaft exciter is 125 volts—33 kw. for 264 amperes normal field current. The generator efficiency is specified as 95.6 per cent at 6,000 and 96.6 per cent at 7,500 kw. Insulation tests were 1,500 volts for the field and 14,200 volts for the armature. Six temperature detectors of the resistance type are provided.

Two oil-coolers are installed, one cooled by the condensate—the other (spare) by sea water.

A well designed reinforced concrete foundation and framed structure of rolled steel members supports the turbo generator and condenser, independent of, and free from, the building and the building foundations.

Auxilary Equipment

A totally enclosed generator-air-cooler is provided using the hot well condensate as a cooling liquid. This two-pass surface air-cooler contains 2,940 square feet of ⅝-inch outside diameter Admiralty mixture U-Fin tubes, and is designed to transfer 956,000 B.t.u. per hour from 89,000 pounds of heated air. A steam connection is made to the air side of cooler for use in case of fire in generator winding.

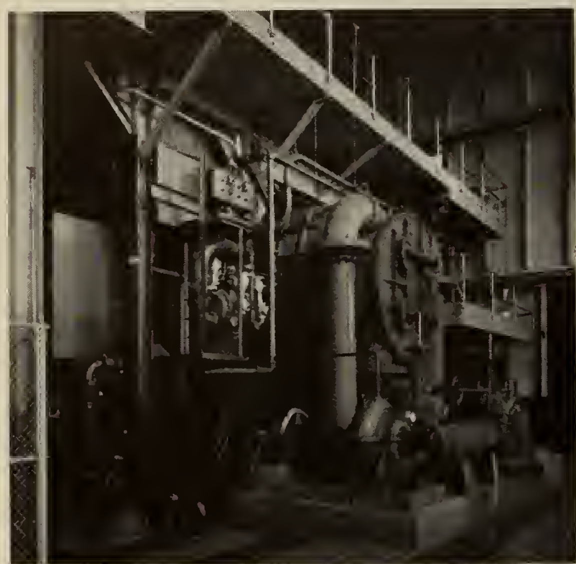

Fig. 3—Auxiliary Equipment.

Through a cast iron connecting piece, a Foster-Wheeler surface condenser is rigidly bolted to the turbine exhaust flange. The condenser is supported by springs. The water boxes of the condenser are divided into two sections, so that one half of the tubes may be available for cleaning while the other half are working. Two water passes are arranged through 9,150 square feet of one-inch diameter by 18 feet long No. 18 b.W.g Admiralty condenser tubes. The complete condensing equipment includes combined hot-well and condensate reheater, 2 feet 6 inches diameter by 3 feet deep; an external air cooler with 150 square feet of cooling surface; two twin-element two-stage steam-jet air pumps, each complete with after-condensers; two 180 Imp.g.p.m. motor-driven centrifugal hot well pumps, and two 600 r.p.m., 4,750 Imp.g.p.m. motor-driven salt water circulating water pumps. In order to permit unrestrained vertical movement of the condenser shell, there are flexible connections of special design in both circulating water inlet pipes and both vertical siphonic discharge pipes. One hot-well pump and one steam jet air pump is spare, but both circulating water pumps are operated when the sea water temperature exceeds 55 degrees F.

Since all station auxiliaries are motor driven, the boiler feed water is heated by steam bled from the turbine at two points as shown by the boiler feed water diagram (Fig. 4). From this it will be seen that all condensate from the hot-well is delivered by the hot-well pump at 40 pounds discharge pressure through the turbo generator oil-cooler; then progressively through the generator air-cooler, the after-condenser of the steam-jet air pump, No. 1 feed water heater, and then to the suction of boiler feed pump. In addition to the hot-well condensate heated as above outlined, the boiler feed pump also delivers to the boiler, through No. 2 heater, the condensate from the evaporator, No. 1 heater and No. 2 heater (Fig. 5). Except for leakage and make-up, the feed water and steam flow is a closed system. Approximately 25 per cent of the total steam is bled and the remainder is exhausted to the surface condenser—the proportion depending on vacuum, superheat, etc. Steam bled at about 115 pounds absolute is about 15 per cent of total steam. Steam bled at 12 pounds absolute is about 10 per cent of total steam.

Both feed heaters are Griscom-Russell, Style T, floating head, four pass vertical, condenser type.

	No. 1	No. 2
Maximum working pressure of water, pounds	125	500
Maximum working pressure of steam, pounds	Vacuum	125
Normal flow of water, pounds per hour	72,600	96,000
Inlet water, temperature degrees F	80	197
Outlet water, temperature degrees F	196	334
Steam condensed, pounds per hour	6,800	14,400
Entering steam pressure pounds absolute	12	118
Entering steam pressure, B.t.u. per pound	1,110	1,243
Drains flashed, pounds per hour	21,200	......
Drains flashed, temperature degrees F	339	......
Maximum water flow, pounds per hour	100,000	100,000
Pressure drop at maximum flow, pounds per square inch	5	4.2
Square feet heat transfer surface	360	276

For heater No. 1 there is a heater-drainer and a motor-driven centrifugal drain pump (also a spare heater drain pump) to handle 19 to 47 g.p.m. at 90 pounds absolute discharge pressure.

The temperatures and pressures shown on boiler feedwater diagram were observed on February 3rd, 1932, when the average load was about 7,000 kw. and these indicate that heater specifications closely meet operating conditions.

The boiler feed pumps are of the following types:

Two—100-h.p. motor driven, Weir, 10-stage, 1,750-r.p.m., 200-g.p.m., 525-pound discharge.

One—5,200 r.p.m. steam turbine driven, Weir, two-stage, 200-g.p.m., 525-pound discharge head.

The above steam-driven emergency feed-pump is the only steam-driven auxiliary in the plant and is very seldom used.

Of the total water evaporated by the boilers, there are losses in the system varying from 1½ to 2½ per cent.

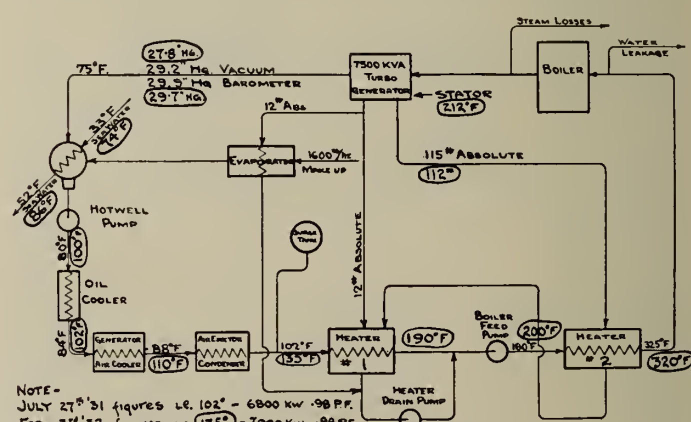

Fig. 4—Boiler Feedwater Diagram.

These losses are made up by distilled fresh water supplied by a steam heated evaporator. The evaporator is a Griscom-Russell horizontal low-pressure single-effect, submerged, Bentube, scale-shedding type with 54.2 square feet of heating surface and 17.1 square feet disengaging surface to produce 3,000 pounds per hour of vapour at 3 inches of mercury absolute when supplied with sufficient steam at 12 pounds absolute. Normally, this evaporator is operated about twenty-two hours daily at reduced capacity. No perceptible scale has thus far formed on the tubes. There is a reducing valve and pipe connection for 30 pounds steam to be used for cracking scale from the tubes.

A 14,000-gallon capacity surge tank for distilled water supply is located on the fan floor and floats on the feed water line entering low pressure heater.

The amount of steam extracted from the turbine is controlled by hand operated valves at each of the two bleed-points and these valves are regulated to limit the flow to

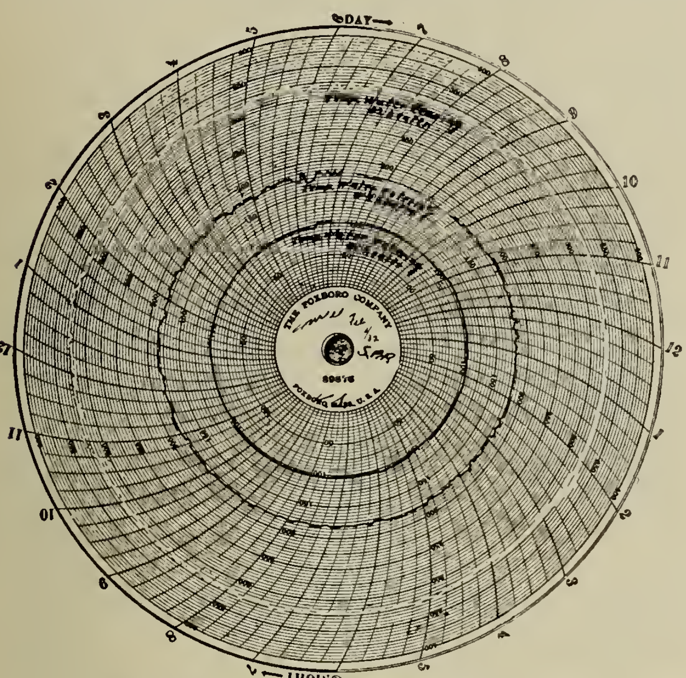

Fig. 5—Temperature Chart for Feed-water.

produce the desired temperatures in the feed water heaters. Pressure ranges at the two turbine bleeder points are 5 pounds to 12 pounds absolute and 47 pounds to 118 pounds absolute. Both steam and water lines to the extraction feed water heaters are equipped with automatic valves designed to shut off the supply to either heater in case of tube failure; check-valves on the heater discharges prevent reverse water flow.

Cooling Water

A reinforced concrete tunnel for intake cooling water extends from a line under the power house floor level to an intake-well and screen house located about 200 feet distant in the salt water bay at a point where there is about 7 feet of water at low tide. From the power house, a discharge tunnel parallels the intake tunnel to a point about 100 feet from the screen house where it empties into the bay. Beneath the power house floor these two tunnels are connected by a 5-foot by 5-foot sluice gate arranged for hand operation in order to temper excessively cold or slushy intake water with warmer discharge water. The level of ordinary high tide is about two feet below floor level, so that pumping head is at a minimum. Intake and discharge tunnels are designed to handle cooling water for 25,000 kv.-a. generating capacity and the screen house is designed for two travelling water screens, only one of which is installed. It might be interesting to note that this one travelling water screen was installed after several months of operation with three tiers of stationary screens. It was found that seaweed and small fish sometimes clogged the stationary screens faster than it was possible to clean and change them. The Link-Belt Company's travelling water screen has given splendid satisfaction. There has been no trouble with needle-ice or slush in the intake water, neither has the warm discharge tunnel water appreciably reduced the condenser efficiency by short circuiting to the intake well. However, condensing water inlet temperature changes correspond with tide reversal, as might be expected. On February 3rd, 1932, the circulating water leaving the condenser was at a temperature of approximately 52 degrees F.. the exhaust steam entering condenser at 75 degrees F. and the water in the hot well at 80 degrees F.

Operating Force

The normal operating force consists of eighteen men, divided into three shifts of eight hours. On all shifts there is an operating and switchboard engineer, also an assistant, one fireman and one ball mill operator. In addition to these there are on the day shift, two coal and ash men, one electrician and mechanic, one clerk and one superintendent.

Besides regular operating duties, these men attend to ordinary maintenance and minor plant improvements.

Plant Loads

Production schedules at the coal mines and steel mills greatly influence the character of the load. During the 7 a.m. to 3 p.m. shift of a normal working day, sudden heavy demands of numerous induction motor driven hoists (up to 1,500 h.p. each) must be met. A glance at the steam flow chart for February 3rd (Fig. 6) will illustrate this point. These charts also show between midnight and 7 a.m. of February 4th the effect of an intermittent load from a billet mill. These irregularly frequent and short peak demands, or swings, make it practically impossible for the firemen to keep constant steam pressure by regulating the coal feed and combustion air to burners always in correct proportions; but, by practice and with the guidance

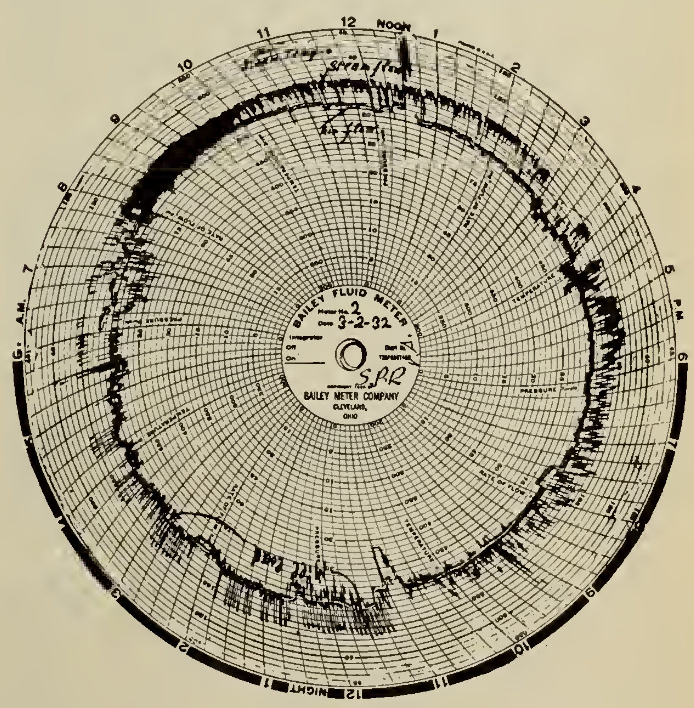

Fig. 6—Steam Flow Chart.

of the Bailey boiler meters and draught gauges, a remarkably good combustion condition is maintained as is evidenced by the usually good appearance of stack gases. In addition to the Bailey meter board the fireman is guided by an indicating generator watt-meter, indicating ammeters for forced-draught and induced-draught fans; gauges showing steam and feed water pressures; recording charts showing boiler water level, preheater temperatures; and a thermometer showing exhauster air temperature.

Operating Problems

Unusually wet coal or refuse coal containing much snow and ice reduces the capacity of pulverizers to such an extent that, in a few instances, it has been necessary to operate two boilers. Some home-made improvements which the operating staff have added to the mill drying facilities have materially improved the mill capacity for handling wet coal. Occasional doses of splint coal, extremely high in ash content (mostly shale or rock), have caused combustion difficulties.

During the first few months of operation, there was some trouble with coke in the burner and an erratic form of flame. This condition resulted largely from a constant slagging of the fire brick adjacent to the burner nose. Then a water-cooled annular ring (similar to a blast furnace tuyere) was installed flush with inside brick-work and around burner-nose, with the result that there is no trouble from coke on burner tip, no slagging of fire brick around burner and a constant flame form, which more uniformly distributes furnace heat and improves superheat in steam. With this improvement to the burner, there is but little slagging of ash on water walls or boiler tubes and, with Emery splint or low fusing ash coal, it now seems possible to operate the boiler furnace constantly for, say, six months with a heat release of 20,000 B.t.u. per cubic foot of furnace volume.

At present, one boiler is operated from three to six weeks without blowdown, then cooled, emptied and examined inside. There has been a little internal boiler corrosion due to high concentration resulting from a very short period when condenser tube leakage existed. Also a very little internal boiler corrosion has resulted from too high an oxygen content in feed water. In order to eliminate oxygen trouble the heater drains are now passed through a deaerating heater and thence to the feed-pump. Also a small amount of chemical treatment maintains the feed-water alkalinity at about 150 parts per million to give a P.H. value over nine.

It is the aim to improve the operation so that six months' continuous boiler operation may be expected. Soot blowers are used once every eight-hour shift. Also every eight hours, a sample of hot-well water is tested for salt water leakage. Each day, a sample of water from the boiler mud drums is tested for concentration of salts, also oxygen. The operators are fully aware of the accelerated chemical activity at the pressure and temperature under which these boilers operate.

It has been the practice to shut down completely for eight hours about once every four months in order to thoroughly test, clean and repair the main condenser. During Easter holidays, it is customary to make an internal examination of the turbine and to undertake any heavy plant repairs.

Although the turbine oil is continually filtered, it is completely drained off and renewed annually.

The exhauster fan blades require renewal after handling about 10,000 tons of coal, but this fan may require balancing once or twice during its useful life.

No accurate records have been kept to show the consumption of grinding balls in pulverizers, but the usage is close to ½ pound per ton of coal.

The constant wear on the blades and scroll lining of induced-draught fans handling flue gases from pulverized coal furnaces is always a source of expense; the higher ash fuels cause greater wear but, with frequent repairs, this need not be an operating hazard. At Seaboard, a new fan rotor can be safely operated for about six weeks, after which repairs by welding are essential every three to four weeks. Stellited fan blades have been used, as well as blades half-soled with various kinds of steel. A more costly and slower speed fan, built of heavier material, would last longer, but a complete spare induced-draught fan (with drive), cross-connected to both boilers seems to be a promising solution for this problem.

Superheat

The turbine is designed to handle steam at a maximum of 700 degrees F., or about 250 degrees F. superheat—but it is rated on the basis of 650 degrees F. steam at the throttle. Superheaters are designed to produce 650 degrees F. steam. It has been found that coals having a low fusing ash, when burned in the Seaboard boilers, slag the front rows of the boiler tubes and water walls to an extent which somewhat reduces the heat absorption of the furnace, thus allowing high temperature gases to sweep the superheater tubes, produce high superheat and leave the boiler at a somewhat higher temperature than would result from coals with higher fusing ash. But the Emery splint, which is largely used, has a comparatively high fusing ash which slags the furnace walls very little; thus the water walls and front rows of boiler tubes are relatively clean and absorb much of the radiant heat of combustion and furnace gases, and these gases reach superheater tubes at a temperature often too low to produce 650 degrees F. steam; also these gases reach the air preheater at too low a temperature to give high preheat to air for combustion. A little excess combustion air will increase the weight and volume of furnace gases to an extent which will permit the superheaters to produce 650 degrees F. steam and this greater usage of combustion air from the preheater maintains a relatively moderate stack temperature. Thus, the evils of low CO_2 in furnace gases are offset by the advantages of increased steam temperature—and operating results at this plant indicate that moderate excess air does not perceptibly increase fuel usage, but does accelerate the wear on the induced-draught fan.

It is unquestionably more difficult to maintain a stable flame from high-ash pulverized coal in a furnace with four water-cooled walls than in a refractory lined furnace. Several "puffs" occurred at Seaboard before the firemen learned to maintain a stable flame; and it is only by constant diligence that they are successful in this regard.

Boiler Test

During the course of regular plant operation in August 1931, the Nova Scotia Fuel Advisory Board conducted a boiler test at Seaboard, with results as follows:—

Fuel	
Volatile (dry basis)	31.35 per cent
Fixed carbon (dry basis)	51.22 " "
Ash (dry basis)	17.43 " "
	100.00
Moisture (as fired)	5.83 per cent
B.t.u. per pound (as fired)	11,833
Fineness through 200 mesh	97 per cent
Gas Analysis at Boiler Outlet	
CO_2	11.8
O_2	7.2
CO	0.0
N_2	81.0
Steam pressure at superheater outlet	406.0
Draught in furnace	.05
Draught at boiler outlet	1.8
Temperatures, degrees F.	
Steam temperature	637
Superheat	187
Air surrounding boiler	77.4
Air entering heater	77.4
Air leaving heater	377.0
Air for combustion	309.0
Furnace temperature	2,379.0
Gas leaving boiler	590.0
Gas leaving air heater	455.0
Feed water	314.0
Temperature of fuel	151.0

Hourly Quantities

Duration of test	8 hours
Fuel as fired per hour	9,907 pounds
Fuel per burner per hour	4,954 pounds
Actual water per hour	93,120 pounds
Factor of evaporation	1.074
Equivalent evaporation	100,011 pounds
Combustible in ash	4.03 per cent
Actual evaporation per pound of fuel as fired (dry)	9.78
Equivalent evaporation per pound of fuel (as fired)	10.10
Equivalent evaporation per pound of fuel (dry)	10.50
Equivalent evaporation per square foot heating surface per hour	10.86
Units of evaporation absorbed per square foot of boiler heating surface	10.55
Percent rating	259
Efficiency of boiler, furnace superheater and air heater	82.9

Heat Balance

Heat per pound of coal (dry)	100 per cent
Heat absorbed by water and steam	82.9 per cent
Heat loss combustible in ash	0.2 per cent
Heat loss due to theoretical dry gases	7.2 per cent
Heat loss due to moisture and water from combustion of hydrogen	4.8 per cent
Heat loss due to excess air	3.4 per cent
Unaccounted for	1.5 per cent
Efficiency of air heater	58.5 per cent

Owing to the difficulty of obtaining a fair sample of pulverized coal, the above figure on fineness through 200 mesh seems questionable. Although the above efficiency of 82.9 per cent is not bad, the operation has since been improved, so that average twenty-four hour efficiency now ranges higher than above test.

Results

In the table given at the foot of the page are shown the gross and net kilowatt-hour outputs, also fuel usage at Seaboard by months for 1931—also for January, 1932, and for February 3rd, 1932.

About 86½ per cent of the fuel used in 1931 was Emery splint, having a heat value ranging from about 11,000 to 12,500 B.t.u. per pound as fired. No careful check has been made on the over-all thermal efficiency of the plant, but close to 19,000 B.t.u. per net kilowatt-hour is apparently the 1931 average. For a steady load of 6,000 kw., about 18,000 B.t.u. per net kilowatt-hour is indicated; but, with fluctuating load carried and variable heat value of fuel used, the annual results indicate good commercial efficiency.

A record of outages at the plant for the year 1931 shows that the total amounted to only one hundred and eighty-eight and a quarter hours which gives an availability factor of 97.85 per cent. The principal shutdowns were arranged for week-ends or idle days at the collieries.

Electrical Equipment and Transmission System

The bus system is double and is arranged in a metal-clad switching structure using 800-ampere solenoid-operated oil circuit breakers. Disconnecting switches are provided

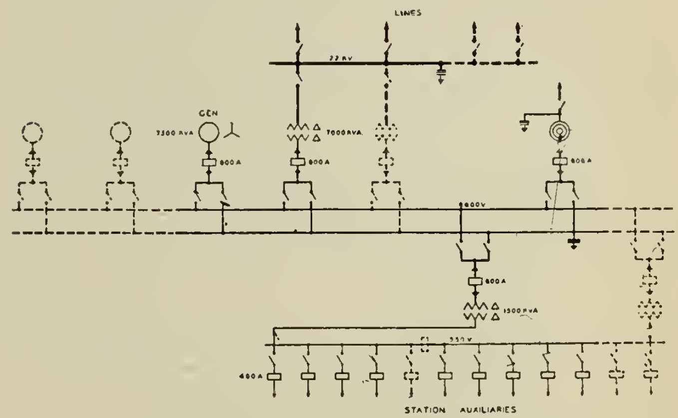

Fig. 7—Single Line Diagram Electrical Circuits.

for bus selection. The oil circuit breakers are of the removable type, having bushings with disconnecting contacts. All instrument transformers and the 6,600-volt bus lightning arrester are mounted inside the switching structure.

One 7,000 kv.-a. 6,600/22,000-volt delta-delta connected transformer bank located in the outdoor switchyard is fed from the 6,600-volt bus system. This transformer in turn feeds the 22,000-volt busses through a 3-pole gang operated air break disconnecting switch. Two outgoing transmission lines tie to the 22,000-volt busses. These lines may be disconnected by 3-pole gang operated disconnecting switches. The transmission voltage can be raised in future to 38,000 volts by connecting the transformer delta-star. The principal electric equipment and circuits are shown diagrammatically in Fig. 7.

1931	A Generator Output kw.-h.	B Consumed by Auxiliaries kw.-h.	C Net Station Output kw.-h.	D Boiler Coal Pounds	D/A Pounds Coal per kw.-h. Gross	D/C Pounds Coal per kw.-h. Net	B/A Per cent Gross to Auxiliaries	Capacity Factor Basis 7,000 kw.
January	4,178,000	306,480	3,871,520	6,481,340	1.55	1.67	7.35	.80
February	3,250,200	273,630	2,976,570	5,264,929	1.62	1.77	8.40	.69
March	4,322,300	328,970	3,933,330	6,202,230	1.44	1.55	7.60	.83
April	3,811,800	279,200	3,532,600	5,445,309	1.43	1.54	7.33	.76
May	4,333,100	334,620	3,998,480	6,187,465	1.43	1.54	7.74	.83
June	4,213,600	331,380	3,882,220	6,017,870	1.43	1.55	7.85	.83
July	4,465,000	342,900	4,122,100	6,419,000	1.44	1.56	7.67	.85
August	4,722,000	342,250	4,379,750	6,718,135	1.43	1.53	7.25	.90
September	4,440,400	331,190	4,109,210	6,160,550	1.39	1.50	7.45	.88
October	4,658,600	339,360	4,319,240	6,448,498	1.38	1.50	7.27	.88
November	4,270,300	302,500	3,967,800	5,897,078	1.38	1.49	7.10	.85
December	4,460,900	309,270	4,151,630	6,075,675	1.36	1.46	6.92	.86
Total and Average	51,126,200	3,821,750	47,304,450	73,318,079	1.43	1.55	7.5	.835
1932								
January	4,267,600	307,450	3,960,150	6,016,879	1.41	1.52	7.2	.82
February 3rd	158,700	10,540	148,160	227,013	1.43	1.53	6.7	.945

Total coal shown above for 1931 is 94,681 pounds less than amount charged against the plant. During January and February, 1931, some boiler coal was not weighed but estimated.

Also above generator outputs and net kw.-h. outputs, as taken from integrator readings for ten and a half months of 1931, are probably low—as a careful check of distribution meters has quite clearly proved.

All bus supports and switches are insulated for 73,000 volts to take care of the unfavourable climatic conditions. Aluminum conductors are used for the busses and connections. The outdoor structure is designed to provide room for one additional transformer bank and outdoor oil circuit breakers, including the necessary disconnecting switches and instrument transformers for protecting transformer banks and transmission lines.

One 6,600-volt feeder line connects nearby collieries to the 6,600-volt system. This circuit is protected by three

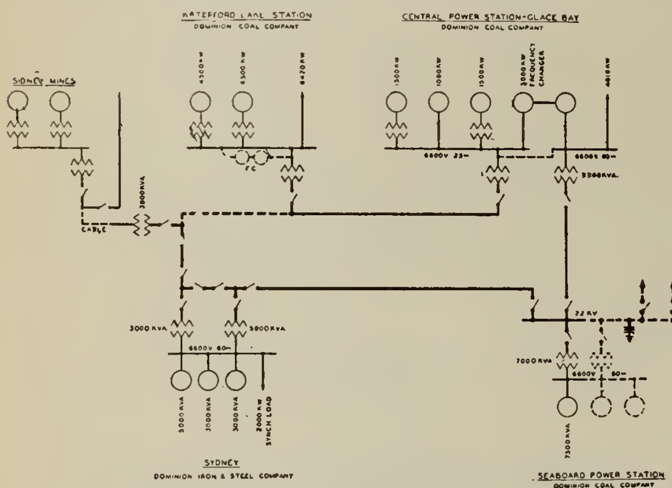

Fig. 8—System Diagram.

single-phase oil-immersed reactors of 7 per cent reactance and a lightning arrester.

The control of the 6,600-volt switchgear is arranged on an eight-panel switchboard which is located on the operating floor above the structure so as to provide the shortest possible connections. Differential protection is employed for the generator. A voltage regulator in connection with a current-limiting regulator adds to the stability of the system and provides further short circuit protection. The excitation system at present consists of a 33-kw., 125-volt shaft-exciter controlled by the voltage and current limiting regulators. The load indicating equipment consists of a totalizing transmitter operating a recording graphic receiver and a boiler room indicator. Individual watthour meters are provided for generator as well as feeders. Ground faults in the 6,600-volt system will be indicated by a triplex ground voltmeter.

The main transformer has overload protection at present, but will be supplied with differential protection when outdoor oil circuit breakers are installed. Overload protection is also used for the station transformer and 6,600-volt feeder. A bell alarm system is used in connection with differential and overload relays.

One 1,500-kv.-a., 6,600/550-volt station transformer furnishes power for the station auxiliaries. The auxiliaries are controlled from a 13-panel auxiliary switchboard on the rear of which manually-operated 2,500-volt, 400-ampere trip free oil circuit breakers are mounted. One panel of this switchboard takes care of the D.C. distribution and controls a 2-kw. motor generator charging set for the 125-volt Exide battery. The charging set is protected by a single-pole circuit breaker with reverse current protection mounted on the same panel. It is intended to make two separate bus systems of the 550-volt distribution when the second station transformer is added. For this purpose, a bus tie panel and two panels for the incoming power are provided. Each circuit is protected by overload relays and ground detector lamps are connected to the 550-volt busses.

All motors for station auxiliaries are of the squirrel cage, line start induction type and are equipped with either ball or roller bearings. Push button operated line starters with thermal overload relays are installed for individual motor control. Arc quenchers are used in line starters and safety switches. The auxiliary motors are so distributed on the 550-volt bus system that operation of the plant can be maintained if failure develops in one section of the busses.

A 25-kv.-a. lighting transformer furnishes power for all lighting. An emergency lighting system, supplied from the station battery, will function automatically in case of voltage failure on the main system.

Conclusion

From the above operating data, it is apparent that the manufacturers of Seaboard equipment have supplied rugged and reliable units. Also, it is evident that the fairly consistent and gradually improving results are due not only to a high capacity factor, but also to the loyal, energetic and enterprising efforts of the operating staff.

Industrial Engineering

William Snaith,
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Paper presented before the Toronto Branch of The Engineering Institute of Canada, November 13th, 1930.

SUMMARY.—The comprehensive nature of the services rendered by the industrial engineer is indicated in this paper which discusses the duties of such an officer in a hypothetical case. Emphasis is laid on the need for thorough study, resulting in effective production control and the preparation of a budget for the whole business. Reference is made to the work of F. W. Taylor and his contributions to the science of management.

Industrial engineering is the formulated science of management. It is a new applied science. An industrial engineer is more than an efficiency expert, though his chief aim is efficiency. His job is both analytic and synthetic. He has to do with machinery, materials, methods, management, men, markets and money.

Most industrial engineers were trained in one or other of the older branches of engineering. The civil engineer, who has analyzed stresses and strains in a static structure, becomes an industrial engineer who has to analyze the elements of an industrial enterprise to eliminate unnecessary stresses and strains. The mechanical engineer, called in to design the machinery or consult in laying out a process, remains as the industrial engineer who keeps it all operating efficiently. The field of industrial engineering overlaps the other branches just as they overlap one another and other fields of human activity. In fact there are no definite dividing lines in the entire field of engineering.

In an industrial enterprise the civil engineer lays out the site, puts up the building and provides water, sewers and similar services. Mechanical engineers design and supply the machinery. The electrical engineer puts in light and power and the chemical engineer makes his contribution. The plant is ready.

The management decided on the size and type of building, after consultation with an architect and engineer. The management selected the mechanical and other equipment, also from experience and after consultation with mechanical, electrical and chemical engineers. Now, when the time comes to start the plant running the industrial engineer is called in. It would have been better still if he had come in to the picture at the very beginning, but in an average case this starting point is fairly representative. He starts in with plenty of problems on his hands, which might have been easier if he had started earlier; the later his entry the more difficult they become. As soon as he does arrive he becomes the right hand of the management.

The first thing to do is to study the product. What is it; what is it for, and can it be sold at a profit? It may happen that the answers to these questions may not be altogether satisfactory and that changes in design should be made before getting into production. It may be impossibly difficult to sell the product after it is made. In this case the engineer must switch to something else, or quit.

As an illustration of the imperative need of such study, a case may be cited in which a headstrong president and general manager of a subsidiary drew the parent company into an investment of $125,000 for a plant to handle a new process. The industrial engineer was convinced that the product required exhaustive study and that the estimate for the plant was absurdly low, but he was over-ruled. The final cost of the plant was over three times the original estimate; after running for two years the parent company wrote off a quarter of a million dollars. And in the meantime the market for the product shrank 60 per cent.

In any case it is important to know that the product will render useful service and that a profit can be made in making it. If there is one thing against which there should be a law, it is the concern which does not render service enough to make profits, and yet uses labour, of which there is usually not too great a supply, and capital, which is always difficult to get. There ought to be such a law and there is — an inexorable economic law. It takes its time in operating but it never fails to inflict punishment on the guilty.

Although much thought may have been given to machinery and methods, improvement is always possible, so it is not surprising if the industrial engineer sets time-study men to work to see that labour is not being wasted. Well-paid labour can buy more goods. Such labour must, of course, not be misapplied or its effort used in needless motions. Because time-study always increases production it has at times aroused antagonism as a grinding down of the labourer. The truth is that the first application of time-study practically amounted to a study of fatigue also. Thousands of time-studies have resulted in the worker performing no more real labour, but certainly directing his efforts in a much better way.

As an example, in making small wooden cases of the better grade, there are thousands of small pieces of wood to handle. Time-study showed that nearly 90 per cent of all productive time was handling time; sawing, drilling, etc., was done very fast. Quite a lot of the handling time was devoted to stacking the small parts in orderly piles on the machine and then transferring the piles to a truck and tidying them up again. A miniature hod, such as the bricklayers use, was introduced, the wooden pieces arranged themselves in the hod, the hod was transferred to the truck. Aesthetic sensibilities were satisfied as to orderly arrangement and the production nearly doubled without anyone working any harder.

It would be manifestly unfair, even if it were not practically impossible, to ask for increased output without increasing wages. Very few will now deny this, but the earliest industrial engineers had to wage the battle of their lives for this principle. If Taylor showed a lack of knowledge of psychology when he spoke of the "ox type" of workman, he must be credited with a capacity for accurate appraisal of human nature when he called an employer a "hog" who tried to evade his promises in the way of wage increases. Bonus plans of wage payment exist in wide diversity and there is much significance in the fact that they are particularly popular in the most prosperous branches of industry. It is outside the province of this paper to discuss them at length. A good bonus plan is a most effective mechanism of management. It also affords an illustration of the fact that all mechanisms must be fitted to the work in hand. There can be no ready-made system.

Having conserved labour by studying to use it as economically as possible, the use of materials must be studied. A suitable system of handling and issuing stores is laid out and order quantities and balances of stores are established so that the flow of material into the plant corresponds to the outflow of finished goods. The emphasis is on keeping the inventory low. Great strides have been made in hand-to-mouth buying. It is said that the inventory of one of the automobile companies is sometimes a negative quantity — the parts have been built into cars and sold before the invoices are received from the makers. No stores are kept in the plant of Grigsby-Grunow. The parts are received in the morning and shipped in completed radios in the afternoon.

All material is bought to specification and tested to see that the requirements have been fulfilled. Labour must not be wasted on inferior parts nor may such parts get to customers. It is sought to eliminate waste by not wasting rather than by salvaging something which has been partly spoiled.

Labour and material having been studied, they are brought together by production control. Operation times have been studied, and next the operations on each part are scheduled, and the tools required are listed. The most far-reaching step in the organization of industry was taken when management undertook to know the details of the best way of doing the work—to know far more than the man on the job could ever be expected to know, that is, the science of it. The first industrial engineer found a complete lack of accord as to this best way. Each man had his own ideas. Operation study and time study revealed which was best. Generally it was a compromise, part from one man's practice and parts from others'. And most of the time changes in the tools were indicated which would still further speed things up. This assumption by the engineer of the task of codifying practice in doing work which hitherto had been left to the workers in the various trades, must rank with the greatest of inventions. It, alone, would establish the fame of Frederick W. Taylor and yet it is only one of the contributions of that remarkable man.

The second step in production control is the despatching of the work—distributing it to the various machines and departments so that as far as possible all machines are busy all the time. This problem can vary from a very simple matter to one of amazing complexity. Full utilization of all facilities is a difficult goal to strive for. Despatching is often a fine art. If there are many parts involved it is essential that they be made or purchased in time to reach the sub-assemblies so that these will arrive at the final assembly neither too early nor too late. When all available floor space is being utilized it is almost as serious to have it cluttered up with sub-assemblies before they can be used, as it would be to have them arrive too late.

The railroad engineer will observe that routing, scheduling and despatching have been borrowed from his practice and applied to something very different. Industrial engineering has borrowed precedent and practice from all the other branches.

As a result of the industrial engineer's efforts, the product is now being turned out systematically and efficiently. Machinery, materials, methods and men have been dealt with. Now another factor—money—is introduced, and the question arises how much is being spent on the product. The industrial engineer has to study accounting, as F. W. Taylor did, to evolve a system of cost accounting, which he must carry beyond the ordinary function of accounting. He incorporates the feature of control, and instead of his records showing that part A-12 cost 13c. more this week than last, they tell him that a group of parts, of which A-12 is one, are costing 25 per cent more than standard. Before he can get around to investigate, his system has brought the same figures to the attention of the foreman of the department responsible, who has at once taken steps to correct the condition. He may need help in solving the problem, but this will be welcomed as co-operation instead of critical fault finding.

A cost system is of small value (if it even has any value) when it is only history. It must be prophecy to be really valuable. It must project itself into the future and point out whether the budget will be exceeded or not.

The engineer has now applied the principles of study, investigation and synthesis to problem after problem, with good results. He may have slipped a little by gathering information at times in too great detail. He may have complicated matters with a few forms too many, but he was not slow in weeding them out. And he probably got something out of all of them.

Other problems now arise and there is some hesitation about turning him loose on them. The goods must be sold and the business must be financed. The engineer is not a salesman, nor is he a financier. He is asked for suggestions. After due consideration he presents a market analysis and a budget, coupled with an analysis of the business from the standpoint of profits. In this excursion into the sales department the engineer has done analytical work which would have been very distasteful to any of the selling force. A good salesman is rarely analytical. The market analysis will not sell goods—the salesmen are still needed; but it very considerably economizes their efforts. Selling potentialities have been measured and it is evident that in some territories only a fraction of the possible business is being obtained. In another case possibly more than our share is secured. Can the skill of this salesman be transferred like that of the men in the shop a few years ago? This can be done, and is done. The engineer has not sold anything, but he has increased sales.

Thus the budget can be approached with hope. The engineer has tackled one problem after another and the solutions have been eminently satisfactory. The whole industrial system is so new and it was so easy to go off on the wrong tack that many additional difficulties have appeared. F. W. Taylor showed that a bonus system which increased wages first increased output at a much greater rate. These higher wages were held so close to the organs of vision of many manufacturers in the early days that they could not see the lower costs, of which they were the direct cause. And it was many years before it was realized that industry's biggest customer was Mr. Wage-earner and that in proportion as his wages are adequate the markets for goods are expanded. There is much significance in the fact that human values have received more attention from the engineers than from all others connected with the management of industry. It is not necessary to recall what the earliest factories were like, but it should be noted that the new ones are pleasant places to work in and that the lighting, heating and ventilation are as good as can be provided. Safety has become one of our greatest cares and was the first meeting ground of labour and management.

With this background, the preparation of the budget for the whole business has been entrusted to the industrial engineer. The line of reasoning he follows runs thus:

This being a budget for the whole business, it will include everybody and everything. So far materials and men have been specified and scheduled. Now the same must be done with money. A service is being rendered, and a profit should be earned. The directors think that in their particular line this should be, say, 15 per cent on the capital. This must therefore be earmarked, or set aside. From experience it is known that capital should be turned over so many times in the year and it is also known approximately what sales can be expected during the year—but perhaps there is doubt about this. In these days it is being proved that goods cannot be forced on people who think they cannot find the money to pay for them. Nevertheless some sales volume must be assumed, because there must be some starting point. The assumed sales volume decides what money will be received. So the sales department and the management go into conference and come out with a prophecy of sales to the extent of 80 per cent of the manufacturing capacity, or say $800,000. Suppose the capital and turnover to be such that profit should be 10 per cent or $80,000, so that finance must be based on the remainder, or $720,000. Material and labour will take $500,000 and selling and administration $220,000. Considering where this $220,000 will be spent it is found that a great many items are fixed regardless of whether sales are greater or less than anticipated. Other items can be cut if volume is reduced and probably must be increased if production goes up very much. Overhead is being discussed, not labour and material, which of course vary nearly directly with production. The items in the overhead which are variable are the ones which can and must be controlled.

Objective — 15 Per Cent Profit on Capital
Manufacturing Capacity — $1,000,000

	I	II	III
Sales	$800,000	$700,000	$700,000
Per cent of mfg. capacity	80	70	70
Per cent desired profit on sales	10	11	11
Desired profit on sales	$ 80,000	$ 77,000	$ 77,000
Gross cost	$720,000	$623,000	$623,000
Material and labour	$500,000	$440,000	$420,000
Selling and administration	$220,000	$183,000	$203,000

Note that total desired profit is $77,000 instead of $80,000 because with less sales the working capital required is less and there is a chance of making a financial profit with the money which it is unnecessary to use in the business.

What happens if, instead of sales amounting to $800,000, it is found after a couple of months that the estimates have been too optimistic and that in all probability the sales will only be $700,000 this year? The situation is not desperate, but it calls for courageous action. Expenses must be cut to fit the reduction. Instead of eight salesmen, seven must do. Shorter hours must be worked or some of the men laid off. All items of overhead which are not fixed must be reduced in proportion to the lowered volume of sales. It is still intended to earn 15 per cent on capital. It is not essential to this discussion to estimate what that capital amounts to. To keep in round figures, assume that a profit of 11 per cent on sales must be earned, or $77,000. This leaves $623,000 to handle production. Labour and material would normally take about $440,000 and leave $183,000 for overhead. It may be possible to work to these figures but probably it will be better to compromise. An intensive study may justify budgeting labour and material at $20,000 less, allowing $203,000 for overhead, which is $17,000 less than it was before. All this $17,000 must be whittled from the variable items in the overhead. If sales next year are $900,000 the process will be reversed.

Perhaps some one will point out that it is one thing to say that the overhead must be reduced by $17,000 and quite another thing to do it. This is quite true. It takes courage to manage to a budget. The sales dollar has 100 cents—no more and no less. If 10 or 11 cents is the proper service charge, financing must be done on the 90 or 89 cents that remain. If this seems arbitrary it is the dollar itself which is arbitrary. The $17,000 must be saved. A few jobs will be cut out and the work spread among those who are left. Expense accounts will be pruned. Advertising will be scrutinized. Shipping expense will be studied. When all the people in the business are set the problem of saving that $17,000, they will save it and probably a few thousand more. The Ford Motor Company saved $75,000,000, or something like that, in one year when they made up their minds they had to; and no one would have called them anything but efficient before they started to save it.

Taking leave of the industrial engineer whose work has just been discussed, the case of another may be followed. He also has had an interesting time. The success of the first engineer was observed by a competing firm, so they engaged a good man themselves. They were not natural leaders, but they knew all that their competitors were doing and when they saw something that seemed to produce results they copied it. Also they worshipped the great god Speed. Their engineer was accordingly instructed to postpone analysis and study of the product and manufacturing methods and get busy on speeding up production. Production control was started ahead of time-study and control of stores. A budget based on past experience only was started. Forms closely following the first engineer's practice were put into use. As fast as he could this second engineer tried to build his foundation under the superstructure he was being forced to erect. But time was against him and the cost system did not show savings sufficient to justify the additional outlay. The company got another engineer, and put on more speed to make up for the time they blamed the other man for losing, and had another failure. This convinced them that industrial engineering was "bunk" and they do not hesitate to advertise their conviction of the fact.

There can be other causes of failure quite beyond the control of the engineer. Some concerns are honeycombed with politics. Others are hidebound with prejudices. Open antagonism is not hard to combat, but apathy and indifference can chill the heart. Because engineers direct and use the forces of nature (and to these the industrial engineer in particular adds human nature), there arises a popular idea which endows them with supernatural powers as pocket editions of the Creator.

A number of mechanisms of management have been mentioned. All of them are valuable and important. None of them is indispensable and the decision as to which should be used depends on many factors, not the least of which is the psychology of human nature. What is one man's meat may be another man's poison. Conveyors contribute greatly to the success of Henry Ford. A manager of a woodworking plant less than two hundred miles from Detroit was so impressed with them that he put a conveyor system in his own plant. Now he did not know that thousands on thousands of time studies were made by Ford engineers to secure the very evident co-ordination he admired. He made no time-studies. If he had he would have found that such co-ordination might have been possible if his plant were ten or twenty times as large as it was. When the conveyors were scrapped and the equipment properly located his costs were reduced 60 per cent. He swears by industrial engineering. This is not an extreme case. The author knows of a stores control system which annually cost more than the total value of the stores it controlled. There was nothing wrong with the system. It was properly designed and it functioned perfectly, only there should have been fifty or a hundred times as much stores to look after.

It is not always true that the easiest way to reduce costs is to increase production. Too many have acted on this belief and given us the problem of over-production and a sales problem with only a very disagreeable and discouraging solution. An industrial engineering firm cites the instance of a firm making one hundred and eighty-eight articles a day; the product was the cheapest in its field and no profits had been earned during the life of the business, although sales ran close to $1,000,000 annually. Production was cut from one hundred and eighty-eight to one hundred and thirty-seven per day; quality and design were improved; a budget and piece rates helped in the work; sales rose to $1,300,000. The merchandise became the highest grade and highest priced in its field and the profits were 11½ per cent on the sale, equivalent to 145 per cent on the investment.

It is impossible to discuss the industrial engineer without bringing in the name of Frederick W. Taylor. His philosophy, his classical study of the art of cutting metals, and his invention of high speed steel are all well known. He stated a few simple principles. In his own time they were hailed or derided, adopted or bitterly fought. The world has moved on. Such is the vitality of the underlying principles he stated, that in spite of the increased tempo in industry they are still fundamental, and their validity and applicability have increased rather than lessened. The unorthodox, visionary and impractical ideas of this unbalanced theorist, as some of his generation labelled him, are the basis of present orthodoxy. Taylor stated his principles thus:

1. Develop a science for each element of a man's work which replaces rule of thumb methods.
2. Scientifically select, train, teach and develop the workman; whereas in the past he chose his own work and trained himself as best he could.
3. Heartily co-operate with the men to insure all work being done in accordance with the science which has been developed.
4. There should be equal division of work and responsibility between management and men. Each does work for which it is best fitted.

It will be noted at once that the keynote is scientific investigation. It is an attitude of mind which is demanded and not the following of a system. Each and every job is a problem. Analyze the situation, measure the facts, experiment with the basis thus obtained and finally discover, prove and apply the law.

It was this new attitude, this fresh angle of approach to the problem of industrial control, which constituted Taylor's great contribution to the art and science of management. While his achievements in material and methods were so considerable that men still speak of the "Taylor System," he would have been the first to object to the term. It was not high-speed steel, the care of belting, mnemonic classification, or functional foremanship which were his great gifts to the world, but the suggestion of that "mental revolution" which he so often emphasized as necessary to the application of his methods.

Scientific management has been a predominant power in the operation of the industrial system. It has tremendously reduced costs and increased output. In 1912 the American railroads were told that they could save $1,000,000 a day by scientific management. The present actual saving is nearly twice that sum.

One man used to build six tires by hand per day. Today with a helper and two machines his output is one hundred and twenty tires per day.

Automatic freight car handling on one railroad displaced four hundred men.

Seven men cast as much pig-iron as sixty used to do.

It used to take one man eight hours to make four hundred and fifty bricks. Today a machine will make forty thousand per hour.

One man can now set type simultaneously on almost any number of linotype machines scattered over the country.

To match the progress in the printing industry a new process outside the industry reproduces any letter press work at a fraction of the cost of printing.

The list could be stretched indefinitely, but all are familiar with these manifestations of mechanical progress.

Industrial engineering has affected employment both ways—it has abolished many jobs entirely and it has created many others. To mitigate the hardships which occur it has suggested a dismissal wage to be paid to the man whose skill is no longer required.

Perhaps mankind has never been called on to digest so much progress in so brief a time as in the past few decades. The inequality of the present distribution of this progress has been numerically expressed by Mr. T. T. Reid, in terms of work per person, as follows:—

China	1.
British India	1.25
Russia	2.5
Italy	2.75
Japan	3.5
Poland	6.
Holland	7.
France	8.25
Czechoslovakia	9.5
Germany	12.
Belgium	16.
Great Britain	18.
Canada	20.
United States	30.

Here is a glimpse of the international aspect of the problem. What will happen when the backward nations begin to reach the higher standards is likely to cause more discussion in future generations than tariffs have in this. The engineer will be required to turn economist.

Potential markets in China for goods made in Canada offer attractive possibilities, but it is not necessary to look so far afield for problems to solve. Unemployment is with us always. It cannot be hoped to eliminate entirely over-production or under-consumption. Styles and changes in styles make and mar business; materials vary in quality from good to bad; human behaviour is influenced by obscure as well as obvious motives. Industrial engineering, scientific management, rationalization, call it what you will, has made an excellent beginning. It starts with a sound, logical, scientific foundation on which to build, with the humble attitude of the scientist in the face of an array of facts, knowing that they must be governed by some law. Some progress has been made in matters of cheaper and better production. The struggle is with distribution and merchandising and glimpses of financing and credit are seen still further ahead. A lot more F. W. Taylors are needed, or maybe the discernment to recognize those we have is required.

The opportunities of the industrial engineer to contribute to the success of the manufacturers and business men of Canada and the world in general are measured only by their willingness to permit the application of his specialized knowledge to their problems.

The Waterborne Trade of Toronto Harbour

Brig.-General J. G. Langton,

General Manager and Secretary, The Toronto Harbour Commissioners, Toronto, Ont.

Paper presented before the Toronto Branch of The Engineering Institute of Canada, February 25th, 1932.

SUMMARY.—The author gives statistics regarding the development and growth of traffic in Toronto harbour, and notes particularly the effect of the Welland Ship canal when opened in 1931 to 18-foot navigation.

Possibly no greater change has ever taken place in the city of Toronto than is to be seen in the transformation of its waterfront.

Ashbridge's bay and marsh have been reclaimed; the old pierhead line has been moved half a mile south of the old shore line; the old rickety wooden piers with 10 and 12 feet of water have been replaced by permanent concrete wharves with from 16 feet to 27 feet depth of water. The ownership and control of the waterfront has passed from the railway companies and private individuals to the Toronto Harbour Commissioners who with the city of Toronto now own and control over 99 per cent of the entire waterfront.

Two modern industrial areas have been created from marsh property and lands covered by water which were non-revenue producing in 1915.

These areas have direct access to rail and water transportation and are served by about 25 miles of Commissioners' railway tracks, there is free interswitching with all railways present and future entering Toronto.

The total length of berthing space approximates 40,000 lineal feet. Transit shed floor space amounts to 177,500 square feet, dry storage floor space to 750,000 square feet, cold storage warehouse space 2,500,000 cubic feet, elevator capacity 2,750,000 bushels.

Seventy-three establishments have already located on harbour properties and have invested approximately $36,000,000 in land, buildings and equipment.

The rapid development of the harbour industrial areas is clearly indicated by the assessed value of the occupied harbour properties, which increased from $1,976,804 in 1912 to $19,920,746 in 1931.

The total advances made by the city, under its guarantee, from 1912 to 1931, inclusive, amounted to $4,114,657. The taxes received from harbour properties during the same period amounted to $3,920,127, a difference of $194,530.

The taxes on the assessment of $19,920,746, due in 1932, based on the rate of 33.9 mils, will add $675,315 to the taxes already received by the city.

The net taxes paid by the Toronto Harbour Commissioners from 1912 to 1931 inclusive, and the estimated taxes for 1932 are as follows:

Year	General	Locals	Total
1912 to 1928	$ 65,971.92	$248,261.46	$314,233.38
1929	7,116.30	100,678.15	107,794.45
1930	8,741.36	107,062.09	115,803.45
1931	16,197.07	166,140.78	182,337.85
1932	14,400.00	205,600.00	220,000.00
Total	$112,426.65	$827,742.48	$940,169.13

The Toronto Harbour Commissioners, for the benefit of the city at large, have dedicated as public highways streets much wider than 66-feet which width would have been quite sufficient to meet the requirements of adjoining properties.

The excess acreage of these wide streets over streets 66-feet wide is as follows: Western district, 2.137 acres; Central district, 11.492 acres; Eastern district, 26.124 acres; total, 39.753 acres; and having a value of approximately $1,849,000.

The port of Toronto, as it is known to-day, is practically a new creation. The waterfront industrial areas combined with improved harbour facilities and the perfect co-ordination of rail, water and highway transportation have brought about an enormous increase in the waterborne trade of Toronto Harbour.

The realization of the magnitude of this increase can only be arrived at by a comparison of the returns for a period of years under the old regime with the gains which have been achieved since 1910 under management of the present harbour commission.

During the fifteen year period from 1896 to 1910, inclusive, the average annual waterborne trade of Toronto harbour was 237,244 tons.

After the appointment of the new commissioners, notwithstanding the lack of facilities and the numerous delays consequent upon the commissioners' construction programme, steamboat owners and shippers gave tangible expression of their confidence in the new management by increasing their shipments. During their first ten years of office the average annual waterborne trade of the harbour increased to 334,299 tons; and during the next five-year period the average annual waterborne trade increased to 355,440 tons.

By 1925 the harbour was beginning to benefit from the improvements and facilities already completed, and the next five-year period, from 1926 to 1930 inclusive, was marked by an annual increase of 25 per cent while the shipments for 1930 reached the total of 1,292,864 tons and the average annual waterborne trade amounted to 820,127 tons.

In the history of marine trade of Toronto, the year 1931 will stand out as one of special importance by reason of the opening of the new Welland Ship canal which moved the foot of the Great Lakes navigation from Lake Erie to Lake Ontario and enabled the large upper lakes vessels to reach Toronto harbour. Month by month the waterborne trade showed an increase of 60 per cent over the corresponding months of 1930 and at the close of navigation on 17th December, 1931, had reached the grand total of 2,122,066 tons, an increase over 1930 of 829,202 tons or more than 64 per cent.

It is an acknowledged fact that the year 1931 has been about the worst year on record for steamship companies who have had half their fleets tied up during the whole season of navigation, so there can be no doubt that the opening of the Welland Ship canal is responsible for the enormous increase in the waterborne trade of Toronto harbour, but it must be remembered that, during the season of 1931, the draught of vessels passing through the Welland Ship canal was restricted to 18-feet. It is expected, however, that when the canal will be opened to its full depth of 25 feet it will permit heavier loading, and possibly result in a far greater increase in the tonnage of waterborne freight.

The new bascule bridge over the ship channel at the foot of Cherry street was opened by His Worship Mayor W. J. Stewart on June 29th, 1931, as a result of which industrial lands, having a dock frontage of 3,330 feet out of a total dock frontage of 6,800 feet on the south side of the ship channel, hitherto inaccessible, were occupied by coal companies. Properties were also acquired by other companies and, despite the decreased activity in other branches of trade and commerce, the total value of the lands leased and sold during the year 1931 was $650,000 in excess of the value of the lands disposed of during 1930.

The additional area made available by the opening of the new bridge was largely responsible for the enormous increase in the shipments of waterborne coal this year which totalled 560,347 tons as compared with 225,992 tons in 1930.

The following is a comparative statement of the waterborne trade of Toronto harbour in tons of 2,000 pounds for the years 1928, 1929, 1930 and 1931:—

Item	1928	1929	1930	1931
Merchandise	225,331	249,533	275,380	299,864
Cement	none	none	31,549	77,259
Oils	201,055	275,870	449,219	653,679
Coal	150,099	191,299	225,992	560,347
Sand	70,998	106,752	166,953	260,655
Grain	74,446	105,288	124,014	250,940
Sundries	22,890	30,492	19,757	19,322
Total	744,819	959,234	1,292,864	2,122,066

An analysis of the above totals discloses the interesting fact that the tonnage of 1931 is more than double that of 1929 and nearly three times the tonnage of 1928—and that the increase, 829,202 tons, of 1931 over 1930 is considerably greater than the total tonnage of 1928.

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Looking for a Remedy

Not very long ago it seemed as if the development of our material resources offered boundless opportunities to the scientific worker and the engineer, for at that time the economic changes due to our technological progress had only just begun to force themselves on our attention. Science and engineering have become an integral part of our everyday life, and of late it has seemed to inquirers that some of the material blessings which they have given us may perhaps prove to have been too dearly bought. Possibly, they think, certain economic hindrances to our social welfare may be the results of the industrial progress of which we were so proud. This view is daily receiving wider acceptance.

In his presidential address this year to the British Association for the Advancement of Science, Sir Alfred Ewing said, "In the present day thinkers' attitude towards what is called mechanical progress we are conscious of a changed spirit. Admiration is tempered by criticism; complacency has given way to doubt; doubt is passing into alarm. There is a sense of perplexity and frustration, as in one who has gone a long way and finds he has taken the wrong turning. To go back is impossible; how shall he proceed? Where will he find himself if he follows this path or that? . . . . More and more does mechanical production take the place of human effort, not only in manufactures, but in all our tasks, even the primitive task of tilling the ground. So man finds this, that while he is enriched with a multitude of possessions and possibilities beyond his dreams, he is in great measure deprived of one inestimable blessing, the necessity of toil. We invent the machinery of mass production, and for the sake of cheapening the unit we develop output on a gigantic scale..... And the world finds itself glutted with competitive commodities, produced in a quantity too great to be absorbed, though every nation strives to secure at least a home market by erecting tariff walls." This is a dismal picture, and the speaker confessed that, like many other people, he was unable to suggest a remedy.

At the same meeting a somewhat similar note of alarm was sounded by the president of Section G, a well known electrical engineer; but he was able to see a brighter prospect, and outlined a definite proposal to permit a committee of engineers to try their hands at state control and organization. Professor Miles Walker in fact suggested that a beginning might be made with a comparatively small unit like France or one of the United States. He thought that by an experiment of this kind it might be ascertained whether in this way an adequate standard of life could be maintained; labour troubles abolished; financial difficulties done away with, and a state of unrest replaced by a comforting feeling of security. Apart from the difficulty of persuading the inhabitants of France or any other state to try such an experiment, the idea seems too good to be true, and it must be confessed that in the case of the one country where, as we understand, all the affairs of life are regulated by committees, the results have not yet aroused a general desire to follow the Russian plan, even though in that country industry, transportation, commerce, and agriculture are all controlled by a single authority.

The change in industrial and business conditions which has occurred during the past three years has been so violent in the United States, that the industrial world there has received a much ruder shock than has been the case in Europe, where economic troubles, though perhaps of equal severity, have not been so entirely unexpected. Thus it is natural that American engineers should be among the first to search for some guiding light, and should be actively inquiring as to the underlying causes of our industrial difficulties. It seems quite proper that such inquiry should be made by engineers, for we have for some time been telling ourselves (and the public) that our engineering training gives us special qualifications for such an investigation, and for drawing commonsense and useful conclusions from its results. The problem is being attacked from several angles in the United States, but marked interest attaches to an inquiry which is being conducted by a committee appointed in 1931 by American Engineering Council, a deliberative body on which more than twenty national, state and local engineering societies are represented, and which has as its object "to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions." The special task of the committee in question is to "study the relation between consumption, production and distribution in the United States." It has a widely representative membership, and its conclusions deserve most careful study, particularly in Canada, where industrial conditions so closely resemble those in the United States. The committee has already presented a progress report* from which an idea can be formed as to its methods and point of view.

As the chairman of the committee, Mr. R. E. Flanders, has explained in a recent article,† the instability of our present industrial system cannot be assigned to any one cause. In fact the report indicates that there are many factors which tend to raise the peaks and lower the valleys of the curve of business activity. For example, technological unemployment; wasteful manufacture and distribution; speculation; instalment buying; post-war deflation; mass psychology; all these are shown to be contributory causes. The committee is continuing its work by studying certain measures or policies which give prospects of beneficial results. Its progress report, however, rejects the

*Electrical Engineering, June 1932, pp. 373-378.
†Mechanical Engineering, September 1932, pp. 605-612.

possibility of any general economic control of the type which was found so effective during the World War. Then there was in each country one objective, the winning of the war. Credit resources were unlimited, and there was only one purchaser, the government. The emergency mechanism that served then would not function as a permanent organization serving millions of consumers and millions of producers. No single remedial measure seems adequate in the present crisis or likely to insure "a standard of living that is high, broadly distributed, and free from severe fluctuations."

Among the policies which are being considered as worthy of further detailed study, are the following:—

Long term budgeting, by national, state, municipal and business organizations. This would have a stabilizing effect on taxation, borrowing, retirement of borrowing, and programmes for public works and extension of industrial plants.

Centralization of public works control, which is not at present effective in the United States.

Stabilization of the great industry of agriculture, which has no inherent self-protection.

A more scientific method of investment, drawing surplus funds into profitable industry. The search for proper investment opportunities might be carried on more effectively and with greater reliance on technical advice than has hitherto been displayed by many financial organizations.

Development of trade associations, involving the pooling and publication of basic information relating to their industries.

Limitation of hours of labour, a measure which is considered essential by many authorities, but which can only be effective if carried out on an industry-wide basis.

It will be noted that in the general terms of its report the American committee differs fundamentally from Professor Walker and other advocates of experiments involving drastic changes in our whole industrial and governmental organization. To quote again from the committee's report, "Arbitrary control of modern industry and commerce in all their ramifications, complexities, and details, clearly is beyond the power of human beings; influences now at work must continue to govern its details. In particular, the profit motive and the active force of competition must be retained in such effective operation as will give society the benefit of the continuous improvement in methods and lowering of costs which they are capable of giving, but they must be restrained in their destructive and unsocial manifestations."

Thus the committee does not consider as practical any schemes in which the motives of profit and competition are replaced by reliance on an unselfish desire to benefit one's fellow men. Such schemes have been tried in all ages and in many countries, and have failed by reason of the inherent imperfections of human nature. Systems of industrial control based on appeals to patriotism, highly developed nationalism, or other forms of mass enthusiasm, are also doubtful remedies, leading, as they have done, to the development of dictatorial powers and a limitation of individual liberty which is distasteful to any people accustomed to democratic institutions.

The whole problem is of supreme importance to us now. In the words of the American committee, "There is no human problem which compares with it in difficulty, magnitude or hopefulness." Their way to a solution is by painstaking analysis of the underlying causes, followed by careful planning to put in action the various measures which seem best adapted to remove those causes. The study of this problem is particularly the duty of the engineer, but it should receive the attention of all intelligent and public-spirited people. This is necessary, because success in the application of a remedial policy in the case of any one of the many causes of the present instability will require the co-operation of many individuals, all of whom must be adequately informed on the subject, must be in agreement as to the remedy proposed, and must be prepared to assist in putting it into effect.

List of Nominees for Officers

Extract from By-laws

Section 68.—Not later than the seventh day of November, the Secretary shall mail to each corporate member of The Institute the list of nominees for officers, as prepared by the Nominating Committee and the Council.

Additional nominations for the list of nominees for officers signed by ten or more corporate members and accompanied by written acceptances of those nominated, if received by the Secretary on or before the first day of December, shall be accepted by the Council and shall be placed on the officers' ballot. The words "Special Nomination" shall be printed conspicuously near such names, and the names of the members making such nominations shall be printed on some part of the officers' ballot.

Section 74.—Notices shall be deemed to have been mailed to members as prescribed by the By-laws if such notices are printed in The Journal of The Institute and mailed by the dates prescribed in the By-laws.

Nominations

The report of the Nominating Committee was presented to and approved by Council at the meeting held on October 18th, 1932. The following is a list of nominees for officers as prepared by the Nominating Committee and now published for the information of all corporate members as provided by Sections 68 and 74 of the By-laws.

List of Nominees for Officers for 1933 as proposed by the Nominating Committee

President:	O. O. Lefebvre, M.E.I.C.	Montreal.
Vice-Presidents:		
*Zone "A"	R. S. L. Wilson, M.E.I.C.	Edmonton.
*Zone "C"	E. Brown, M.E.I.C.	Montreal.
	P. B. Motley, M.E.I.C.	Montreal.
Councillors:		
‡Halifax Branch	A. F. Dyer, A.M.E.I.C.	Halifax.
	W. A. Winfield, M.E.I.C.	Halifax.
‡Saint John Branch	A. F. Baird, M.E.I.C.	Fredericton.
	W. J. Johnston, A.M.E.I.C.	Saint John.
‡Saguenay Branch	D. A. Evans, M.E.I.C.	Dolbeau.
	C. N. Shanly, M.E.I.C.	Riverbend.
‡St. Maurice Valley Branch	B. Grandmont, A.M.E.I.C.	Three Rivers.
††Montreal Branch	J. L. Busfield, M.E.I.C.	Montreal.
	A. Duperron, M.E.I.C.	Montreal.
	P. E. Jarman, A.M.E.I.C.	Montreal.
	J. A. McCrory, M.E.I.C.	Montreal.
‡Ottawa Branch	G. J. Desbarats, M.E.I.C.	Ottawa.
‡Kingston Branch	L. F. Goodwin, M.E.I.C.	Kingston.
†Toronto Branch	C. S. L. Hertzberg, M.E.I.C.	Toronto.
‡London Branch	J. A. Vance, A.M.E.I.C.	Woodstock.
‡Border Cities Branch	O. Rolfson, A.M.E.I.C.	Windsor.
‡Lakehead Branch	G. H. Burbidge, M.E.I.C.	Port Arthur.
‡Saskatchewan Branch	D. A. R. McCannel, M.E.I.C.	Regina.
‡Edmonton Branch	J. Garrett, A.M.E.I.C.	Edmonton.
	H. J. MacLeod, M.E.I.C.	Edmonton.
‡Vancouver Branch	A. S. Wootton, M.E.I.C.	Vancouver.

*One Vice-President to be elected for two years.
‡One councillor to be elected for two years.
†One Councillor to be elected for three years.
††Two Councillors to be elected for three years each.

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, October 18th, 1932, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and four other members of Council present.

The report of the Nominating Committee, containing the list of nominees for officers for 1933, was received and approved.

The tentative programme for the Annual General and General Professional Meeting of The Institute to be held in Ottawa on February 7th and 8th, 1933, as submitted by the Managing Committee of the Ottawa Branch, was approved.

The chairman of a committee appointed by Council to study the recommendations of the Council of the Association of Professional Engineers of British Columbia with regard to the necessary qualifications of engineers in the Dominion Civil Service reported that in the opinion of the committee The Engineering Institute of Canada should endorse the recommendations submitted with one slight amendment. This was approved.

Ten members were placed on the Life Membership List; thirty-three members were placed on the Suspended List for one year; twelve reinstatements were effected, and a number of special cases were considered.

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

Elections		*Transfers*	
Assoc. Members	3	Junior to Assoc. Member	5
Affiliate	1	Student to Assoc. Member	1
Students admitted	4	Student to Junior	2

The Council rose at ten thirty-five p.m.

Junior Section—Montreal Branch

In the list of the fall meetings of the Montreal Branch of The Engineering Institute of Canada, the programme of the Junior Section is worthy of attention.

This section, which replaces the former Student Section of the Branch, was organized last spring by some of the younger members, and held its first two meetings at that time. It has been formed in an endeavour to maintain the interest of Students and Juniors in the activities of The Institute and to encourage them to take a more prominent part in the discussions on technical papers.

During the summer, some fifty of the larger engineering firms in the city were approached by members of the committee of this section, and have expressed their willingness to assist its work by encouraging their junior engineers to take part in its activities.

It should be mentioned that although primarily designed to interest members of The Engineering Institute, senior university students and other young engineers are encouraged to attend and will be welcome at the meetings.

Over fifty were present at the first meeting of the season, which was held on October 19th, and at which two papers were presented, one in French and one in English. It is intended to hold these sessions fortnightly throughout the year, two short papers being presented at each, of which a considerable number will be in French. Several debates on timely subjects will also take place, with the purpose of affording younger members practice in public speaking and discussion.

OBITUARIES

Louis Euclide Côté, M.E.I.C.

His many friends will deplore the death at Ottawa on September 26th, 1932, of Louis Euclide Côté, M.E.I.C., following a prolonged illness.

Mr. Côté was born at St. Hyacinthe, Que., on January 13th, 1875, and graduated in civil engineering from the Ecole Polytechnique, Montreal, in 1900, with the degree of B.A.Sc.

In 1901-1902 Mr. Côté was with the Phoenix Bridge and Iron Works, engaged on designing structural steel work, and later was assistant on railway location and construction at Frank, Alta. In 1904 he joined the staff of the Department of Marine and Fisheries as technical officer. In 1910 Mr. Côté was appointed chief draughtsman, and in 1922 became assistant chief engineer. Some seven years ago he succeeded the late B. H. Fraser as chief engineer, and became well-known for his constructive suggestions to the various harbour commissions throughout the Dominion, being largely responsible for the establishment of the present system of lights, radio direction stations and other aids to navigation on the St. Lawrence river. He was also closely associated with the development of the harbour of Montreal and the extension of the facilities at that port. Few civil servants enjoyed more widespread esteem than Mr. Côté during his thirty years' service in the Department of Marine.

Mr. Côté was a member of The Institute of long-standing, having joined as a Student on March 16th, 1899, transferred to Associate Membership on May 14th, 1908, and become a full Member on March 27th, 1923.

Henry Robertson Lordly, M.E.I.C.

In the death of Lieut.-Colonel Henry Robertson Lordly, M.E.I.C., which occurred at Montreal on October 4th, 1932, The Institute loses a member of very long standing.

Lieut.-Colonel H. R. LORDLY, M.E.I.C.

Lieut.-Colonel Lordly was born at Saint John, N.B., on December 12th, 1868, and received his early education at the Saint John Grammar School. In September 1889 he entered the College of Civil Engineering of Cornell University, graduating in 1893 with the degree of C.E.

From January to June 1894 he was in the chief engineer's office of the Canadian Pacific Railway Company, Montreal, returning in July of the same year to Saint John where he remained until 1897, taking up private consulting work and acting as lighting expert and general manager for the Auer Light Company. From 1897 to 1899 Colonel Lordly was located at Charlottetown, P.E.I., in connection with the gas distribution system. In 1900 he made a series of tests on anti-friction bearings, the report on which received the Fuertes Gold Medal, presented yearly by Cornell University. In 1901 Colonel Lordly entered the Dominion Government service as engineer to the Department of Railways and Canals at Montreal, and in April 1902 became engineer in charge of construction on the Lachine canal. Later he entered private practice as a consulting engineer.

Colonel Lordly had extensive military experience, having served in three branches of the Canadian Militia. He joined the 62nd Fusiliers at Saint John as a bugler in 1885, received his commission as a lieutenant in the Charlottetown Engineers in 1898, and transferred to the Corps of Guides in Montreal in 1904, later commanding that unit of the 4th Division. He went overseas with the 5th Pioneer Battalion of the Canadian Expeditionary Force with which he served until demobilization in 1919.

Colonel Lordly joined The Institute (then the Canadian Society of Civil Engineers) as a Student on March 10th, 1890, transferring to the class of Associate Member on March 11th, 1897, and to full Membership on May 11th, 1905. He was made a life member on May 19th, 1931.

PERSONALS

W. J. Lecky, S.E.I.C., who graduated from McGill University this spring with the degree of B.Eng., has joined the engineering staff of Noranda Mines Limited, and is now located at Noranda, Que.

G. Moes, A.M.E.I.C., has been appointed general manager of the Hamilton Sterling Electrical Company Ltd., Hamilton, Ont. Mr. Moes was formerly associated with the Allen Engineering Company, Hamilton.

J. H. Irvine, A.M.E.I.C., has been appointed office and designing engineer in the city engineer's department, Ottawa, Ont. Mr. Irvine, who is a graduate of the University of Manitoba in civil engineering of the year 1912, was formerly manager of the Dominion Reinforcing Steel Company Ltd., Toronto, Ont., and at one time was connected with the sewer section, city hall, Toronto, Ont.

H. V. Haight, M.E.I.C., of the Ingersoll-Rand Company, New York, has been transferred by that company to England, where he will be located at Manchester. Mr. Haight graduated from the University of Toronto in 1897 with the degree of B.A.Sc., and following graduation was for two years sales engineer in Nova Scotia for the Canadian Rand Drill Company (afterwards the Canadian Ingersoll-Rand Company Ltd.), and in 1900 was draughtsman with the same company. In July 1900 he was appointed chief engineer, which position he held until 1931, when he was transferred to Painted Post, N.Y.

FORTY-SEVENTH ANNUAL GENERAL MEETING AT OTTAWA

FEBRUARY 7th and 8th, 1933

In accordance with the By-laws, the Forty-Seventh Annual General Meeting of The Engineering Institute of Canada will be convened at Headquarters, 2050 Mansfield Street, Montreal, during the third week in January, 1933, for the reading of the minutes of the last Annual General Meeting and the appointment of Scrutineers and Auditors, after which the meeting will be adjourned to reconvene on TUESDAY, FEBRUARY 7th, AT THE CHATEAU LAURIER, OTTAWA, continuing on the following day.

It has been thought advisable this year to limit the proceedings to two days instead of the three days which have been usual. The Ottawa Branch, however, whose members are sponsoring the meeting, may be relied upon to provide a programme of a quality which will fully make up for its brevity.

Details of the arrangements will be announced in the December number of The Journal.

H. G. Acres, D.Sc., M.E.I.C., consulting engineer, Niagara Falls, Ont., sailed recently for England, and later will proceed to India. Dr. Acres, it is stated, has been retained by an English syndicate to report on a large power development in India. He expects to be away about four months.

Dr. Acres has spent practically the whole of his professional life in the various branches of hydraulic engineering, including surveys, design, construction and operation. As chief hydraulic engineer of the Hydro-Electric Power Commission of Ontario, he had under his engineering supervision twenty-five operating hydro-electric installations. Of this total he directed the design and construction of eighteen plants, having a total installed capacity of 725,000 e.h.p.

H. G. ACRES, M.E.I.C.

He has acted as the technical associate of counsel in connection with matters of contention between Canada and the United States relating to boundary waters.

Dr. Acres graduated from the University of Toronto in 1903, and the degree of Doctor of Science was conferred upon him by the same university in May 1924.

S. S. Colle, A.M.E.I.C., joined the engineer staff of Beauharnois Light Heat and Power Company at Montreal on August 8th, 1932. Mr. Colle was for fifteen years in the employ of Walter J. Francis and Company, and its successor, Frederick B. Brown, consulting engineers. During recent years he acted as principal assistant engineer to the late Frederick B. Brown, M.E.I.C.

P. E. Doncaster, M.E.I.C., of the Department of Public Works, Canada, has been appointed district engineer to the Fort William-Port Arthur district. Mr. Doncaster has been in the service of the Department since 1908, when he joined as an assistant engineer, at Toronto. During the years 1912-1915, he was chief assistant to the district engineer at Chase and New Westminster offices. From 1915 to 1917 Mr. Doncaster was overseas with the Canadian Expeditionary Force, as works officer on construction and maintenance of trench light railways. In 1918 he resumed his duties with the Department of Public Works as chief assistant to the district engineer at New Westminster, B.C., and in 1921 became district engineer, Kootenay Yale Cariboo district, which office he held until his recent promotion.

Lieut-Colonel W. A. Steel, A.M.E.I.C., a Member of Canadian Radio Broadcasting Commission

Lieut.-Colonel W. A. Steel, M.C., A.M.E.I.C., chief of the Radio Branch, National Research Council, Ottawa, Ont., has been appointed a member of the new Canadian radio broadcasting commission, which is empowered to carry on the business of broadcasting in Canada, and to regulate and control broadcasting by other agencies.

Lieut.-Colonel Steel commenced his military career in the ranks of the 2nd Field Company, Canadian Engineers, Toronto, and served in that unit from October 1911 to September 1914, when he transferred to the Toronto University Contingent of the Canadian Officers Training Corps, in which unit he received a commission as lieutenant in February 1916. He served in the Canadian Expeditionary Force as an officer of the Canadian Signal Service, and was twice mentioned in despatches, being awarded the Military Cross. During the last year and a half of the War Colonel Steel had charge of all radio work of the Canadian Corps in France.

Following demobilization in 1919, he was engaged on radio research work at the University of Toronto under the direction of Professor T. R. Rosebrugh, and in June 1920 was appointed to the permanent force with the rank of Major in the Royal Canadian Corps of Signals. He was promoted to the rank of Lieutenant-Colonel on August 7th, 1930, in recognition of the outstanding technical work in signals and communication which he had performed for the Department of National Defence. In co-operation with other officers of the Department, Colonel Steel has invented a direct reading radio compass which is now in general use both on this continent and in Europe. As a result of his investigations, important improvements have been made in transmitting and receiving equipment and directive beacon apparatus.

H. C. Lott, A.M.E.I.C., is at present paying a two months' visit to Nigeria in connection with the electricity supply schemes in that country. Last year Mr. Lott visited Madras, in southern India, in connection with a hydro-electric scheme in the Nilgeris, in which a head of 3,094 feet is being utilized in the initial development. This plant, in the construction of which the firm with which Mr. Lott is connected, Balfour Beatty and Company Ltd., has a contract on the hydraulic and electrical works, is nearing completion. In 1929 Mr. Lott's work took him to East Africa and to Shanghai (via Moscow and the trans-Siberian Railway). Mr. Lott, who was born at Ashen, Essex, England, and received his education in the Old Country, was for a number of years engaged on engineering works in Canada.

R. F. Legget, A.M.E.I.C., formerly on the staff of the Power Corporation of Canada, Ltd., Montreal, has become connected with the Canadian Sheet Piling Company, Montreal. Mr. Legget graduated from Liverpool University with the degree of B.Eng. in 1925, and secured his M.Sc. from the same institution in 1927.

ELECTIONS AND TRANSFERS

At the meeting of Council held on October 18th, 1932, the following elections and transfers were effected:

Associate Members

DAVISON, Charles Fraser, B.Sc., (Queen's Univ.), supt., salt plant, Canadian Industries Limited, Sandwich, Ont.

PANNETON, Frank, B.A.Sc., C.E., (Ecole Polytech.), 1st asst. engr. and chief designer, City of Three Rivers, Que.

RAY, Walter Reginald Gubbins, B.Sc., (McGill Univ.), sales engr., Canadian Fairbanks Morse Co. Ltd., Montreal, Que.

Affiliate

CLARIDGE, Richard Earl, (Univ. of Toronto), 2 Cameron St., Toronto, Ont.

Transferred from the class of Junior to that of Associate Member

BRUMBY, Walter William, (City and Guilds of London Inst.), transformer design engr., Canadian General Electric Co. Ltd., Toronto, Ont.

COSSITT, Lawrence Sulis, B.Sc., (McGill Univ.), Smith's Cove, N.S.

EVANS, Maurice John, (Grad. R.M.C.), asst. engr., Dept. Public Works of Alberta, Belvedere, Alta.

HUNTER, Lionel McLaren, (Glasgow Tech. Coll.), principal asst. engr., engrg. dept., City of Ottawa, Ont.

JENKINS, Thomas Harding, B.A.Sc., (Univ. of Toronto), designer and squad boss, bridges and bldgs., Grand Trunk Western Railroad Co., Detroit, Mich.

Transferred from the class of Student to that of Associate Member

MONTGOMERY, Hugh Richardson, B.Sc., (McGill Univ.), res. engr. on Saint John Harbour Improvements, for the Atlas Construction Co. Ltd., West Saint John, N.B.

Transferred from the class of Student to that of Junior

ROPER, Charles Parsons, B.Sc., (N.S. Tech. Coll.), res. engr., Dept. of Highways of Nova Scotia, Halifax, N.S.

WEATHERBIE, Weston Ewart, B.Sc., (N.S. Tech. Coll.), Tatamagouche, N.S.

Students Admitted

DAVIS, Clinton Harold, (Montreal Tech. School), 5608 St. Urbain St., Montreal, Que.

HUTCHISON, William Harper, (McGill Univ.), 26 Aberdeen Ave., Westmount, Que.

KAY, Alan Geoffrey, (McGill Univ.), 478 Victoria Ave., Westmount, Que.

MELLOR, Alfred Geoffrey, (McGill Univ.), 619 Belmont Ave., Westmount, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Association of Ontario Land Surveyors: Annual Report, 1932.
Institute of Radio Engineers: Year Book, 1932.
Society for the Promotion of Engineering Education: Proceedings, vol. 39, 1931.
Institution of Naval Architects: Transactions, vols. 65-73, 1923-1931.
American Society for Testing Materials: Supplement to 1931 Year Book, Sept. 1, 1932; 1932 Supplement to Book of A.S.T.M. Standards.
The Institution of Civil Engineers of Ireland: Transactions, vol. 58, 1932.
The New Zealand Society of Civil Engineers: Proceedings, vol. 18, 1931-32.
Canadian Electrical Association: Proceedings of the Forty-second Annual Convention, June 15-17, 1932.
National Research Council, Highway Research Board: Proceedings of the Eleventh Annual Meeting, Part 2, 1931.

Reports, etc.

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No. 1437: Pitot-Static Tube Factor at Low Reynolds Numbers.
No. 1450: Reports and Memoranda Published between 1st January, 1931, and 1st April, 1932.
No. 1456: Relation between Ground Contours, Atmospheric Turbulence, Wind Speed, and Direction.
No. 1459: Interference on Characteristics of Aerofoil in Wind Tunnel of Rectangular Section.
No. 1461: Design and Test Data for Aircraft Radiators.
No. 1463: Acceleration of Aeroplanes in Vertical Air Currents, Part 1.
No. 1464: Wind Tunnel Tests of Recommendations for Prevention of Wing Flutter.
No. 1469: Induced Flow Through a Partially Choked Pipe.
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515: Safety Organizations at Lake Superior Iron Mines.
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Canadian Mining Manual, 1932 edition.
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Presented by Canadian Industries, Limited:
Indexes, 1930 and 1931, to British Chemical Abstracts.
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Preprints 62-1 to 62-31 [Papers presented at the Society's Sixty-second General Meeting, September 22-24, 1932].
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Electrical Tables and Memoranda, by S. P. Thompson, 3rd ed., 1932.
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The Trend of Paving in the Leading American Cities [16 pp.].
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The Story of the Hoover Dam, vol. 2 [39 pp.].
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Heaton's Commercial Handbook of Canada, 1932.
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BOOK REVIEWS

Mechanical Fabrics

By George B. Haven. Wiley, New York, 1932, cloth, 6 x 9 in., 905 pp., figs., tables, $10.00.

Reviewed by J. R. DONALD, M.E.I.C.*

This book will be found a very complete reference work for those having to deal with the strong textile fabrics which form a basis of strength in so many mechanical components. The development of automobile tires first brought this subject to the fore and the field of mechanical fabrics is enlarging rapidly with the development of the aeroplane, dirigible, etc. Problems arise in their manufacture which are entirely different from those connected with textiles used for clothing or ornamental purposes.

To one unfamiliar with textile practice, the number of factors that enter into the making of a fabric will be a revelation.

While the title of the volume would indicate that the author has dealt only with manufacture, construction, testing and specifications, the reader will find a full description of the various types of fibre, the recovery of cotton from the raw product, and a great deal of practical information on textile mill organization and management.

The chemical engineer will find much of interest in the chapters dealing with the design and equipment of laboratories, textile laboratory practice, specifications and tolerances and textile microscopy.

The reviewer unhesitatingly recommends this book to anyone manufacturing, using or purchasing mechanical fabrics or who is interested in the materials employed in their manufacture.

*Managing Director, J. T. Donald & Co. Ltd., Montreal, Que.

The Physics of Solids and Fluids

By P. P. Ewald, Th. Pöschl, and L. Prandtl. Blackie & Son, London, 1930, cloth, 6 x 9 in., 372 p., photos, figs., $5.25.

Reviewed by PROF. J. N. FINLAYSON, M.E.I.C.*

The authors of the articles translated in this book are: P. P. Ewald, Professor of Theoretical Physics at the Technical College, Stuttgart; Th. Pöschl, Professor of General Mechanics and Hydromechanics at the Technical College, Karlsruhe; and L. Prandtl, Professor of Applied Mechanics in the University of Göttingen and Director of the Aerodynamical Institute at Göttingen.

The work comprises selected articles—translated from the new edition (the eleventh) of Müller-Pouillets *Lehrbuch der Physik*. In the first two chapters (pp. 1-80), Pöschl writes on Elasticity. Chapter III (pp. 81-151) is by Ewald on Lattice Theory of Crystals and Single Crystals. More than half the book is taken up by the article by Prandtl on Hydrodynamics, including applications to aviation, a subject on which the author is one of the most distinguished authorities.

Pöschl's chapters contain matter found in nearly all text books on Strength of Materials; the derivation of formulae used in calculating tension, torsional and bending stresses, descriptions and illustrations of testing machines, an excellent chapter on friction of solid bodies. His derivation of Hooke's Law is rigid as is his treatment of the equations of equilibrium of an elastic body. The brief exposition of the phenomena of elastic after-working hysteresis, fatigue and dependence of strain upon time embody some modern theories not noted in text books on Strength of Materials. The accompanying illustrations of slip-lines, flow figures, twinning markings, changes in crystal structures due to heat treatment, etc., most of which are published here for the first time, were prepared by Dr. G. Sachs of the Kaiser Wilhelm Institut für Metallforschung in Berlin-Dahlem. These are very distinct and add materially to the value of the chapter.

The chapters by Prandtl include much material contained in standard text books on hydraulics. Considerable space is devoted to discussions of theories of velocities of flow of liquids and gases exceeding the velocity of sound and of the formation of waves on the surface of a liquid. The application of the theory of the *standing wave* or *hydraulic jump* as a means of dissipating energy is not developed, which will be disappointing to students who are interested in this important branch of hydraulics. The discussions on hydraulic turbines are meagre. The ten pages devoted to ships and aircraft leave the reader with an appetite for a more generous helping of such excellent food.

The most complete treatise in the book under review is that (Chapter III) contributed by Ewald on The Mechanical Structure of Solids from the Atomic Standpoint. After defining single crystals, polycrystals, polar, non-polar and metallic crystals, the author proceeds to discuss the main hypothesis of Born's lattice theory of polar crystals, also some of the problems and hypotheses beyond the scope of Born's lattice theory. The geometry of simple glide and the principle of recrystallization after previous stretching, are treated comprehensively, and Prandtl's Theory of Elastic After-working and Hysteresis is developed more fully in this chapter than in Pöschl's treatise in Chapter I. In short, this chapter contains a comprehensive summary of recent studies in the crystallography of metals and non-metals up to 1927-28. The rapid progress of research in this domain of physics has since that time led to many new discoveries, some part of which has been recorded by the addition of references. Unfortunately these references are in nearly all cases to periodicals printed in German, not available to many readers on this continent.

As was mentioned above, the book contains selected articles from a more elaborate treatise. It is consequently lacking in continuity. It can not be regarded as a text in any of the subjects treated, but it does contain much useful information which will be welcomed by students who have familiarized themselves with the elements of these subjects by previous study.

*Professor of Civil Engineering, University of Manitoba, Winnipeg, Man.

Correction

Through an unfortunate error, on page 479 of the October Journal, the membership of two of the medal committees of The Institute for the year 1932 was incorrectly given. These should read as follows:

Leonard Medal Committee
- L. H. Cole, M.E.I.C., Chairman
- F. D. Adams, Hon.M.E.I.C.
- C. V. Corless, M.E.I.C.
- A. E. MacRae, A.M.E.I.C.
- R. A. Strong, A.M.E.I.C.

Plummer Medal Committee
- H. J. Roast, M.E.I.C., Chairman
- D. E. Blair, M.E.I.C.
- L. F. Goodwin, M.E.I.C.
- F. T. Kaelin, M.E.I.C.
- A. Stansfield, M.E.I.C.

BRANCH NEWS

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
R. B. McKenzie, S.E.I.C., Branch News Editor.

The members of the Lethbridge Branch met on October 15th in the Marquis hotel for dinner and the regular meeting. After the usual business and recess periods, Wm. Meldrum, A.M.E.I.C., chairman, introduced the speaker, Mr. R. J. Ritchie Paterson, C.A.

ACCOUNTANCY

In beginning his remarks Mr. Paterson said that he had a large and prosaic subject to cover, but hoped that it would be of some interest to engineers since accountancy required somewhat similar mental equipment.

He showed that accounts were kept in Babylonian times, giving several translations from writings of the times. Also a book had been published in Venice in 1494, largely on accountancy. The first association of professional accountants was formed in Edinburgh in 1854. The development of joint stock companies took place about this time and following this we can trace the rise and spread of accountancy by the formation of societies in all parts of the world.

Mr. Paterson then went on to show the important place occupied by accountancy among the professions. He showed the high qualifications required by the profession, these being: strict honesty and generally good character; a knowledge of figures, law and statistics, both practical and theoretical; and a clear analytical mind capable of sound judgment and constructive criticism. He said that accountancy was not an exact science but a mode of presentation and procedure.

Mr. Paterson pointed out that the balance sheet might be defined as a form for the summary of investments and values which were supposed to be taken at a given time. Its aim was to specify the quantity and to measure the value of the owners wealth at that moment of time. A balance sheet of the city of Lethbridge was taken as an example and Mr. Paterson proceeded to point out the method of reading and the various parts of interest. He showed how a public concern of this kind had no capital and named the entries required for operation under this condition.

Much interesting discussion resulted and many points uncovered, such as "hidden assets" and the methods of "watering stock." Due to this long discussion, some remarks that Mr. Paterson was to make on the gold standard were omitted. The meeting closed with a hearty vote of thanks to the speaker and the singing of "God Save the King."

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.
F. V. Dowd, A.M.E.I.C., Branch News Editor.

The first of the regular weekly meetings of the Montreal Branch of The Engineering Institute of Canada was held on October 8th, 1932.

NOVA SCOTIA COAL MINING AND DISTRIBUTION

The speaker of the evening was C. Gerow, A.M.E.I.C., assistant general manager of coal sales, Dominion Steel and Coal Corporation, Ltd., who explained coal mining in Canada from its first recorded date, in the year 1720, by workmen at the building of the fortress at Louisburg.

The Cape Breton or Sydney coalfields have an area of some 250 square miles and form a segment of which the chord is about 35 miles long with 9 miles the greatest distance inland and extending about three miles under the Atlantic ocean.

In 1893 the output of all the Nova Scotia mines amounted to 1,500,000 tons a year; in the year 1900, when the steel industry was established, the production increased to 3,000,000 tons, and in 1913 it was 4,749,000 tons.

The estimated quantity of coal available within five miles of the shore is 2,500,000,000 tons of which 135,000,000 tons have already been extracted. The coal is mined under the ocean under a 700-foot cover which has proved safe and sufficient to keep the mines comparatively dry.

The mines employ about 13,000 men who are entirely dependent upon the Nova Scotia mining industry for a living.

The meeting was well attended and the chairman, P. E. Jarman, A.M.E.I.C., asked Geo. Templeman, M.E.I.C., to say a few words expressing the sympathy of the meeting and The Engineering Institute at the loss by death of F. B. Brown, M.E.I.C., consulting engineer, and Lieut.-Colonel H. R. Lordly, M.E.I.C.

The vote of thanks to the speaker of the evening was proposed by F. V. Dowd, A.M.E.I.C., after which the chairman invited the members present to partake of light refreshments.

The second regular meeting of the Montreal Branch was held on October 13th, 1932.

C.P.R. MULTIPRESSURE LOCOMOTIVE NO. 8000

This paper, by H. B. Bowen, chief of motive power and rolling stock of the Canadian Pacific Railway, was read by W. A. Newman, chief mechanical engineer of the Canadian Pacific Railway Company.

It was explained how the development of greater power at reduced cost was achieved as a result of this new locomotive. Such development constituted a measure of progress towards increased steam pressures and temperatures; the multipressure locomotive No. 8000 is a joint production of the Superheater Company, the American Locomotive Company and the Canadian Pacific Railway Company, who are respectively responsible for the high pressure generating system. The three-cylinder arrangement and valve motion and general locomotive proportions, design and construction was the result of the C.P.R. engineering staff and the Angus Shops staff.

The giant locomotive is designed for burning oil as fuel and has recorded a fuel saving of 14.8 per cent under regular service in the Rocky Mountains.

Many innovations had to be introduced in the construction of this giant locomotive of over 5,000 h.p., slightly under one hundred feet long and weighing 392½ tons.

Animated motion pictures were shown of each separate phase of the boiler operation and of the construction of the complete engine at C.P.R. Angus Shops, Montreal.

J. L. Clarke, M.E.I.C., was chairman and the customary vote of thanks was proposed by R. A. Ross, M.E.I.C.

Ottawa Branch

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

The fall programme of the Ottawa Branch commenced with a luncheon meeting at the Chateau Laurier on October 6th, at which the speaker was D. Alan Stevenson, M.Inst.C.E., of Edinburgh, Scotland. Mr. Stevenson spoke on "The Evolution of Lighthouses from the Ancient Fire Beacon," a subject upon which he was eminently fitted to speak, inasmuch as his is the fifth generation of his family which has been responsible for the Engineering Scottish Lighthouse Service since 1786. The present firm in Edinburgh has carried out work on many Scottish harbours and piers including the lower Clyde channel. In 1926-27 Mr. Stevenson was lighthouse engineer to the government of India and instituted a new lighthouse service in India, Burma, and the Persian gulf.

C. McL. Pitts, A.M.E.I.C., chairman of the local branch, presided at the meeting, and the head table guests included Lt.-Col. J. E. Robins, of the British South Africa Company of Rhodesia; Commander C. P. Edwards, A.M.E.I.C., Colonel S. H. Hill; E. Hawken, Acting Deputy Minister of Marine; Dr. H. M. Tory; Dr. Charles Camsell, M.E.I.C., G. J. Desbarats, M.E.I.C., W. A. Found; J. G. Macphail, M.E.I.C., Commissioner of Lights, Department of Marine; R. Meldrum Stewart, M.E.I.C., and F. H. Peters, M.E.I.C.

Evolution of Lighthouses

Mr. Stevenson's address, illustrated by lantern slides, traced the history of lighthouses from the primitive sort of the early days, with its arrangement for raising an open fire on a tower, down to the very efficient structure of the present day. The first known lighthouse was located in Asia Minor near the ancient city of Troy. The first of which there is any detailed knowledge was that at Alexandria, built in the third century B.C. By the end of the first century B.C. there were thirty known lights, one of which was that at Dover, constructed by the Romans.

So far as the British Isles were concerned the early lighthouses were maintained locally. They consisted mostly of coal fires elevated above the level of prominent head lands wherein the flames and smoke served to direct attention to the location of dangers to navigation. One of these is reputed to have made use of four hundred tons of coal annually.

Unfortunately these open fire beacons were frequently rendered useless by stormy weather. In an effort to remedy this situation, pitch was used, then sperm oil, and lamps covered with glass chimneys. Now the light is obtained from incandescent mantles, from acetylene or other gas under pressure, or from electricity. In present-day lighthouses the light rays are directed outward parallel to each other by means of parabolic reflectors or by dioptric systems of lenses made up of prisms suitably arranged in steps. Combinations of these reflecting and refracting systems may also be used. In the interests of economy, Canada is tending toward the use of the reflecting rather than the refracting media in her lighthouse services.

Light ships, bell buoys, sirens, radio and other aids to navigation were also referred to by the speaker.

Vancouver Branch

W. O. Scott, A.M.E.I.C., Secretary-Treasurer.

The Vancouver Branch opened its fall session by an inspection of the pressure tunnel under the First Narrows.

Through the courtesy of the Northern Construction Company, contractors, and E. A. Cleveland, M.E.I.C., chief commissioner of the Greater Vancouver Water District, this opportunity was taken advantage of on Thanksgiving Day, October 10th, 1932.

The pressure tunnel is designed to carry all of the water capable of being developed from the Capilano system of the Greater Vancouver Water District and will replace the six 18-inch cast iron mains now crossing the First Narrows under the existing system.

The members gathered at the construction company's office at the south shaft in Stanley Park. From here they were transferred to the north shaft by boat across the Narrows.

The cage or bucket in this case would allow five, six or seven to be lowered down the shaft to the tunnel. The shaft is vertical, will have a finished internal diameter of 8 feet and is 400 feet deep.

Arriving now on the bottom, the party was escorted through the tunnel towards the south shaft. The tunnel is 3,100 feet long between shafts and will have a finished internal diameter of 7 feet 6 inches; at present about 1,300 feet have been lined.

The south shaft is vertical, will have a finished internal diameter of 8 feet and is 400 feet deep.

There was an attendance of seventy-five which included a number of visitors from the Engineering Bureau of the Vancouver Board of Trade.

Messrs. N. D. Lambert, general superintendent, and H. E. Carlton, construction superintendent, officiated for the Northern Construction Company and Messrs. E. A. Cleveland, chief commissioner, and W. H. Powell, M.E.I.C., engineer, were present for the Greater Vancouver Water District, the latter acting as guide and lecturer in response to the barrage of questions from the members.

P. H. Buchan, A.M.E.I.C., chairman, voiced the appreciation of the Branch and thanked the various officials and staff of the contractors and the Greater Vancouver Water District for their co-operation in making the expedition a success.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. G. Clark, S.E.I.C., Branch News Editor.

On Friday afternoon, September 2nd, 1932, the Saint John Branch of The Engineering Institute of Canada held an inspection visit to the new harbour terminals in process of construction at West Saint John. This visit was made at the invitation of Alex. Gray, M.E.I.C., chief engineer of the Saint John Harbour Commission.

In the course of the visit some forty members under the chairmanship of A.A. Turnbull, A.M.E.I.C., were taken over the site of the new concrete pier and the Navy Island quay wall. The visitors were then shown through the new grain storage elevator and shipping house which has been erected at the shore end of the most southerly of the two slips.

Owing to the high level of the bed rock at this part of the harbour it was found to be more economical to excavate for the slips "in the dry" than by rock dredging and as a consequence of this decision a steel and rock cofferdam 5,900 feet long was thrown around the area enclosing 43 acres. This area was unwatered by electrically driven pumps at the rate of five million gallons per day.

Behind the cofferdam the clay and rock were excavated to form two slips 300 feet wide and 35 feet deep at low water.

The visitors were particularly interested in the unique design of the concrete pier walls and the construction which employs a system of

Saint John Branch Inspection Visit to New Harbour Terminals, West Saint John.

Front Row, left to right: G. Stead, M.E.I.C., F. G. Wilson, A. Gray, M.E.I.C., A. A. Turnbull, A.M.E.I.C., G. G. Murdoch, M.E.I.C., J. R. Freeman, M.E.I.C., W.R. Pearce, M.E.I.C., S. Hogg, A.M.E.I.C., and H. R. Montgomery, S.E.I.C.

Second Row: G. H. Thurber, A.M.E.I.C., H. F. Morrisey, A.M.E.I.C., Gordon MacDonald, J. Reed, G. M. Donohue, S.E.I.C., F. A. Patriquen, S.E.I.C., and R.T.A. Moore.

Third Row: C. N. Wilson, H. D. MacAulay, V. S. Chesnut, A.M.E.I.C., J. H. McKinney, A.M.E.I.C., P. M. Blanchet, S.E.I.C., D. A. MacDonald and Wm. Morrison.

Back Row: J. M. Lamb, F. B. Rolphe, J. B. Christie, H. Sheehan, G. S. Peterson, P. McMulkin and E. A. Farren.

arches at approximately low water level upon which has been built a solid gravity type concrete wall 32 feet high to contain the rock with which the interior of the pier has been filled. It has been found possible to support the wall at 25-foot intervals on concrete piers five feet thick and between these piers the wall load is carried on these arches. The main pier consists of two concrete walls spaced 300 feet apart and extending 700 feet from the shore line. The Navy Island quay wall lying 300 feet north of the main pier and parallel to it has a length of 850 feet.

Preliminary Notice

of Applications for Admission and for Transfer

October 21st, 1932

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, 1932.

R. J. Durley, *Secretary.*

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* The professional requirements are as follows—

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

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

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

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

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

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

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

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

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

FOR ADMISSION

BROOKS—JOHN KENNETH, of Saint John, N.B., Born at Plymouth, England, Aug. 13th, 1900; Educ., 1917-19, McGill Univ.; Passed exams. for Assoc. Membership Inst. C.E., and elected Assoc. Member 1926; 1919-21, engrg. asst. with Sir John Jackson Ltd.; 1921-24, engrg. asst. with Thames Conservancy; 1924-25, section engr. and later in charge road contract for Sir W. G. Armstrong Whitworth & Co. Ltd.; 1925-27, chief engr. (road contract), Fordyce Bros.; 1927-29, asst. engr. and later sectional sub-agent, Topham, Jones & Railton Ltd., dam constrn. in Federated Malay States: 1929-30, asst. engr., Sir John Jackson Ltd.; 1931 (Apr.-July), in charge survey party, for the late Frederick B. Brown, M.E.I.C.; at present, engr. for Brodrick Contractors, Ltd., West Saint John harbour improvements.

References: J. M. R Fairbairn, A. Gray, A. D. Swan, E. H. James, V. S. Chesnut, S. S. Colle, A. Brooks.

CRYER—EDWARD, of 35 Stratford Road, Town of Hampstead, Que., Born at Dalton-in-Furness, England, May 29th, 1882; Educ., 1898-1901, Barrow-in-Furness Technical School. 1898-1903, pupil to the late William Richardson, M.M.C.E., engr. and surveyor, municipality of Dalton-in-Furness; 1903-06, asst. engr. and surveyor to the municipality of Dalton-in-Furness; 1906-11, chief asst. to the engr. of above municipality, including preparation of plans, specifications, estimates, supervising carrying out of sewerage and sewage disposal schemes, constrn. of roads, sidewalks, etc., etc.; 1911-12, asst. engr., St. Lambert, Que.; 1912-14, dftsman and engr. in charge of constrn. work and computation for various subdivisions in and around city of Montreal; 1914-32, with Leonard E. Schlemn, M.E.I.C., town planning consultant and consltg. engr. Preparation of pla s, estimates and specifications in connection with various important engineering developments. At present, engr. and bldg. inspr., Town of Hampstead, Que.

References: L. E. Schlemm, G. R. MacLeod, J. E. Blanchard, P. E. Jarman, S. Howard, M. D. Barclay.

HOPKINS—CECIL GEORGE, of Toronto, Ont., Born at Waterford, Ont., Jan. 22nd, 1900; Educ., 1920-21, special course, D.S.C.R. 1923-25, Toronto Technical Schools (Struct'l. Design); 1915-19, overseas, C.E.F.; 1919-20, chainman, Spreight & Van Nostrand, O.L.S.; 1921-23, Dept. Public Highways Ontario, concrete and grading inspr.; 1923-30, dftsman., and 1930 to date, asst. engr., distribution section, elec. engrg. dept., on final location surveys and ground testing, H.E.P.C. of Ontario, Toronto, Ont. (August 1930 granted Commission in R.C.E., and has now passed all military examinations.)

References: J. J. Traill, J. R. Cockburn, A. E. Nourse, W. B. Redman, C. Anderson, W. G. Hewson.

LAMBERT—ZEPHIRIN, of 534 Laviolette St., Three Rivers, Que., Born at Yamachiche, St. Maurice Co., Que., March 19th, 1885; Educ., Civil Engineer, Ecole Polytechnique, Montreal, 1913; 1908-11 (summers), Dept. Public Works, Ottawa; 1913-14, asst. engr., 1915-22, city engr., City of Three Rivers; 1923-26, road and bridges contractor; 1926-28, city engr., 1928-29, city engr. and city mgr., 1929 to date, city engr., City of Three Rivers.

References: B. Grandmont, J. E. Fleury, C. H. Jette, J. A. Bernier, J. A. Vermette.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

JACKSON—JOHN HERBERT, of Niagara Falls, Ont., Born at Windsor, Ont., Jan. 30th, 1878; Educ., two years, Univ. of Toronto; 3 years in office of City Engineer, Windsor; 1902-03, gen. municipal and hydraulic investigations, in office of C. H. Mitchell, M.E.I.C., Niagara Falls, Ont.; 1903-08, city engr., Niagara Falls, and in private practice; 1908 to date, chief executive officer, and at present general manager, for Niagara Parks Commission, in responsible charge of all constrn. and mtce. of parks and parkways along Niagara River, including financial recommendations, design of structures and bldg. of works. (*S. 1899, A.M. 1905.*)

References: C. H. Mitchell, H. G. Acres, F. A. Gaby, T. H. Hogg, R. A. Ross, W. Storrie, J. J. MacKay, F. W. Paulin.

FOR TRANSFER FROM THE CLASS OF STUDENT

GRAVEL—LOUIS PHILIPPE, of 498 Royale Ave., Beauport, Que., Born at Quebec, Que., March 9th, 1905; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1927; 1927 to date, dept. of bridges, Dept. of Public Works of Quebec. (*S. 1923.*)

References: I. E. Vallee, O. Desjardins, C. Milot, J. G. O'Donnell, J. M. Dechene, A. B. Normandin, H. Cimon, P. Marcotte.

Jordan-Roberts Sales Limited—A six-cylinder, 300 b.h.p., Merrlees Ricardo high-speed Diesel engine was on display at the booth of this firm at the Canadian National Exhibition, and who have recently been appointed representatives for Merrlees-Bickerton and Day Limited of Great Britain.

This engine operates at 900 r.p.m., with a 7½-inch bore and 12-inch stroke, and is a four-stroke cycle, cold-starting, sleeve valve engine. The injection system is in the form of a single jet, with the whole fuel system and working parts most carefully and accurately made. These engines are procurable in two standard sizes, i.e., 20 b.h.p. per cylinder and 50 b.h.p. per cylinder, to operate at 1,200 and 900 r.p.m. respectively.

Ferranti Electric Limited—The display by this company at the Canadian National Exhibition recently, featured complete testing kits containing a clip-on-ammeter two range 0-100-500 and portable voltmeter of the two or three range 0-150-300-600 type as required, all in a leather carrying case. Also on display were ignition and sign lighting transformers and surge absorbers, all manufactured in Canada.

During the last year, arrangements have been made by this Company to manufacture a complete line of surge absorbers in Canada, these having voltage ratings from about 600-110,000 with standard current ratings from 5, 25 or 50 to 300 or 600 amperes. These are, of course, fundamentally the same as the British types but have somewhat different mechanical features.

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MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

YOUNG ENGINEER, B.A., B.Sc., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C., Jr.A.S.C.E., age 28, married. Experience: construction, design, cost estimating on hydro-electric and storage work, also railway. Desires work in engineering, industrial or commercial fields. Available at once. Apply to Box No. 447-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, graduate of McGill University, B.Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, B.Sc., '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. At present in Montreal. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B. '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C., experienced on survey and installation of telephone and electrical equipment, desires position with electrical concern or telephone company. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate. One year building construction, one year hydro-electric construction in South America, six months resident engineering on road construction. Working knowledge of Spanish. Desires permanent position with good possibilities. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate, '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box No. 770-W.

ELECTRICAL ENGINEER, Queen's Univ. '24, Jr.E.I.C., age 32, married. Experience includes, student Test Course, Can. Gen. Elec. Co., four years dial system telephone engineering with large manufacturing company. Available at once. Apply to Box No. 772-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

SALES REPRESENTATIVE. Electrical engineer with ten years experience in power field interested in representing established firm for electrical or mechanical product in Montreal territory. Excellent connections. Apply to Box No. 795-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C., with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments, in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C. B.Sc. (Queen's '32), age 21. Three summers surveying in Northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

AERONAUTICAL ENGINEER, B.Sc. (McGill), M.Sc. (Mass. Inst. Tech.). Canadian. Age 26, recent graduate. Capable of aeroplane design and stress analysis. Apply to Box No. 838-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. Toronto '22), age 32, married, Jr.E.I.C., Jr.A.S.M.E., P.E. (Ont.). Experience includes executive power plant, plant layout, maintenance, development, research, consultation, testing, inspection, laboratory instruction and lecturing. Available immediately for any location. At present in Toronto. Apply to Box No. 842-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience, B.O.T. certificate, thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ENGINEER, McGill Sci. '21-'25, S.E.I.C., Aerial mapping, stereoscopic contour work; lumber classification; highway, railway and transmission line locations; estimates; water storage investigations, etc. Five years ground surveys; three years aerial mapping. Bilingual. Available on short notice. Apply to Box No. 872-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of bldgs., etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting. requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Dept. checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial At present in Toronto. Apply to Box No. 899-W.

ENGINEER, Jr.E.I.C., specializing in reconnaissance and preliminary surveys in connection with hydro-electric and storage projects. Expert on location and construction of transmission lines, railways and highways. Capable of taking charge. Location immaterial. Apply to Box No. 901-W.

MECHANICAL ENGINEER, Canadian, age 25, B.Sc. (Queen's '32). Since graduation on supervision of large building construction. Undergraduate experience in electrical, plumbing and heating, and locomotive trades. Available at once. Apply to Box No. 903-W.

For Sale

TRANSIT, maker Cooke & Sons, inverting telescope, stadia diaphragm, full horizontal and vertical circles, vernier reading to minutes, compass, shifting head, gradienter, ordinary tripod, price $100.

LEVEL, maker Troughton & Sims, dumpy level, inverting telescope, ordinary tripod, price $25. Both instruments in Montreal. Apply to Box No. S-12.

THE

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Construction of a Variable Radius Arch Dam

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With an Appendix by

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Paper presented before the Victoria Branch of The Engineering Institute of Canada, March 18th, 1932.

SUMMARY.—The author describes the construction of a variable radius concrete arch dam on the Nanaimo River, B.C., 84 feet high and 166 feet long, for the water supply of Nanaimo, B.C. The geological and construction conditions are outlined and the contractor's methods discussed. The dam is interesting as an application of pressure grouting to correct the secondary stresses. Costs are given and the calculations as to the strength of the dam are explained in an appendix.

In 1908 and 1909, due to the demand for an increased and improved water supply, a rock filled crib dam was constructed on the south fork of the Nanaimo river, fifteen miles from the city of Nanaimo, B.C. A wood stave pipe line of 14 inches and 12 inches diameter was laid from this dam to a point about one and one-half miles from No. 1 reservoir, and discharged into the Chase river, a feeder to the reservoir. The following year the pipe line was continued to No. 2 reservoir, which is connected to, and situated alongside No. 1.

These two reservoirs have a storage capacity of 27,000,000 gallons, and supply the city of Nanaimo and district with water through a 12-inch cast iron main, and an 18-inch wood stave pipe, the population of the area being ninety-five hundred.

The wood stave pipe line was located through difficult country, and it would now appear that a better location could have been found if a little more care had been taken, but there may have been mitigating circumstances deciding the final location which are not now obvious.

The line passes over many summits: one at Crystal Creek, 20,500 feet from the dam, and another at Extension Ridge, 41,000 feet from the dam, being controlling points.

The line from the dam to Extension Ridge gave a fall of 50 feet in 41,000 feet or an effective gradient of 1.22 feet per 1,000. Due to somewhat poor alignment, obstructions due to growths in pipe, silt and air locks, the pipe line would not deliver in 1929 more than about 670,000 gallons per day.

Lowering the grade at Extension Ridge would not greatly improve the discharge as it would thereby bring the controlling point back to Crystal Creek Summit, and as Crystal Creek Summit is only 34 feet below intake, it would give a gradient of 1.66 feet per 1,000, or a discharge under the same conditions of not more than 770,000 gallons per day.

To improve the supply a pump was installed in 1922 at the Nanaimo river, 29,000 feet from the dam. This pump is a semi-Diesel engine connected to a Deane triplex plunger pump, and can deliver 600 gallons per minute, directly into the pipe line from the river.

The best this pump could do would be to raise the effective head to an elevation of 750 feet, the level of the crest at crib dam, and since the pump is at an elevation of 420 feet, this would necessitate its working against a head of 330 feet.

The discharge with the pump working and gravity supply practically stopped amounted to approximately 870,000 gallons per day.

Somewhat more than this would be, and occasionally was obtained, but it meant pumping a considerable fraction of the total pump delivery back into the river through the intake of the gravity line. On more than one occasion, too, the pump was worked during the winter with the result that the pipe line above it promptly froze.

The pump from the time of its installation was used continuously each summer for a longer or shorter period, depending on climatic conditions, and merely kept the supply to the reservoirs just about equal to the demand and that only when sprinkling restrictions were enforced by the city.

The margin was much too low for comfort, and the requirements of the fire underwriters.

This state of affairs continued over a period of years with various aldermanic engineers propounding schemes for the improvement of the supply, and unfortunately carrying them out, with a consequent great waste of public money and no visible improvement to the supply.

The system had been reported on by engineers, in November, 1919; November, 1923; October, 1926, June, 1929, and finally in December, 1929, by H. B. Muckleston, M.E.I.C.

In January, 1930, a forceful and unanimous council came into office determined to improve the water supply, and alleviate the seasonal shortage.

An exhaustive review by a committee of the council of all reports submitted, led to the adoption of one scheme of the three submitted by Mr. Muckleston.

Detail of Scheme

Briefly this scheme was to build a variable radius arch concrete dam in the canyon of the south fork of the Nanaimo river 600 feet above the existing dam, the crest of the new dam to be at elevation 821.25 giving 71.25 feet additional head above the old dam, and relaying the pipe line where necessary with steel pipe varying in size from 15 inches at the dam to 8 inches at reservoir No. 1.

The effect of this scheme was to improve the effective gradient to 2.92 feet per 1,000 feet to the Extension Ridge, and the discharge to 1,170,000 gallons per day to No. 1 reservoir. Ten years later, when the pipe line would be completely relaid, the discharge would be 2,000,000 gallons per day.

Immediately this scheme was approved by the council, a by-law was prepared and placed before the ratepayers for ratification, and on March 29th, 1930, a seven to one vote in favour of the expenditure of $145,000 for the construction of the dam made the scheme a reality.

A survey party under the author was immediately sent to the site of the dam, a detailed survey was made of the canyon and the area proposed to be flooded, and the survey plans completed in June, 1930.

From the plans thus made and the data supplied, the site of the dam was determined; construction plans, specifications and form of contract were prepared and advertised and the contract for the dam let for the sum of $78,328.70.

Nine tenders were submitted, the lowest being as stated, and the highest $147,843.90.

The successful contractor moved his equipment and material to the site of the work on August 2nd, 1930, and immediately commenced operations, with ideal weather conditions in his favour.

Under the terms of the contract the city undertook to put the tote road to the site of the dam into a passable condition so that the contractor could haul in material, supplies, and equipment.

Due to destructive forest fires, one double 60-foot span bridge across the south fork of the Nanaimo river had been completely destroyed; two others of a similar description were in a dangerous condition due to age and lack of maintenance and numerous trestle bridges erected as temporary structures were unsafe.

As a consequence the following work was carried out before the contractor could haul over the road, and it had to be done speedily:

Two double 60-foot bridges were rebuilt using timbers felled and squared at the site of the bridges, and the iron from the original bridges, which was in good condition. One double 60-foot span bridge was partly reconstructed, and one high trestle bridge rebuilt. Numerous small bridges were also strengthened, and corduroy composed of planking on sills placed over swampy ground. The road was reconstructed on new alignment where necessary to reduce excessive grade and generally reconditioned for a distance of eight miles.

A tree telephone line was constructed for a distance of ten miles to connect with the Mount Benson Forestry Service line, and proved invaluable throughout the progress of the work.

The above work involved the expenditure of $20,000, and was sufficiently advanced to allow the contractor to haul in his material on the date arranged.

The road and bridge work was done by day labour by city forces under the supervision of the author, the men being housed in camps at the site of the work.

Geological Features of the Canyon

Prior to the letting of the contract for the dam, a geologist made a thorough examination of the canyon and the site of the dam.

The canyon occupied by the river is a comparatively recent geological freak of a type which is not uncommon on streams in the coast ranges. Prior to the last of the glacial

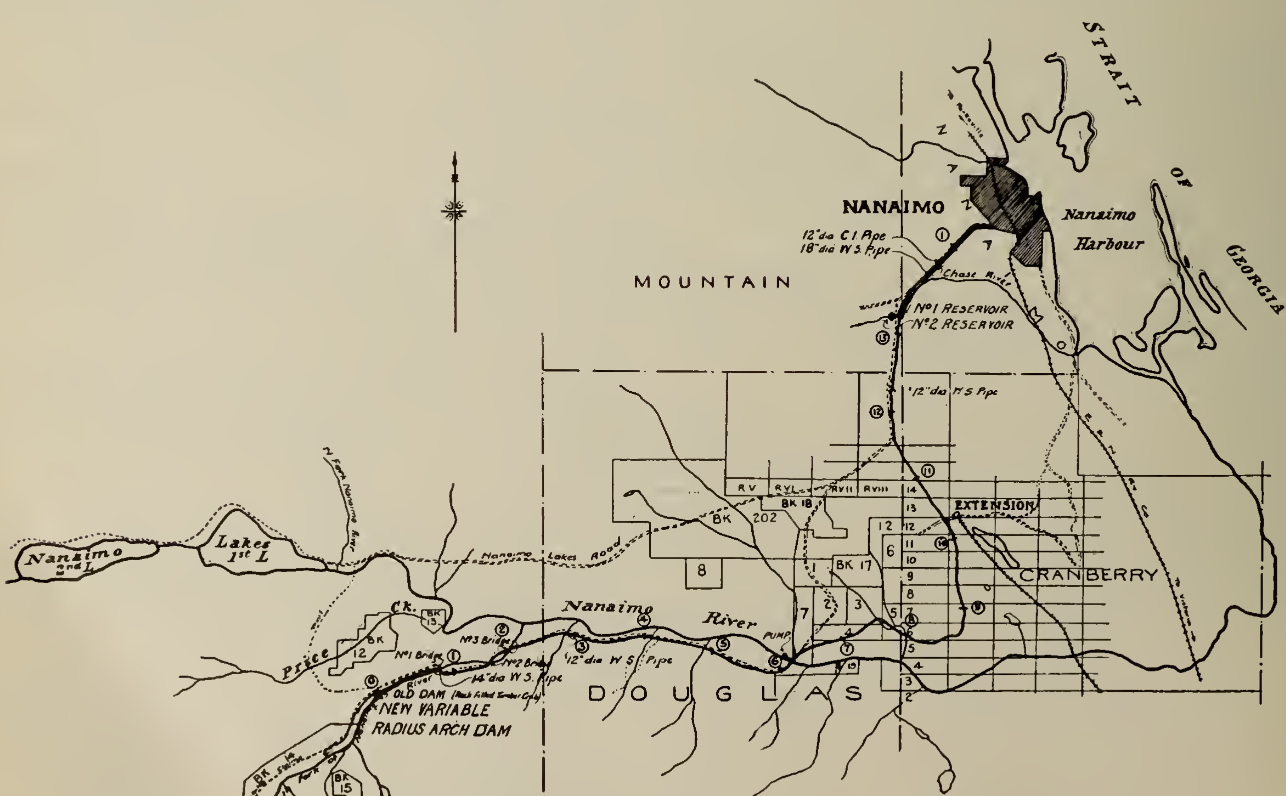

Fig. 1—Supply Line to Nanaimo.

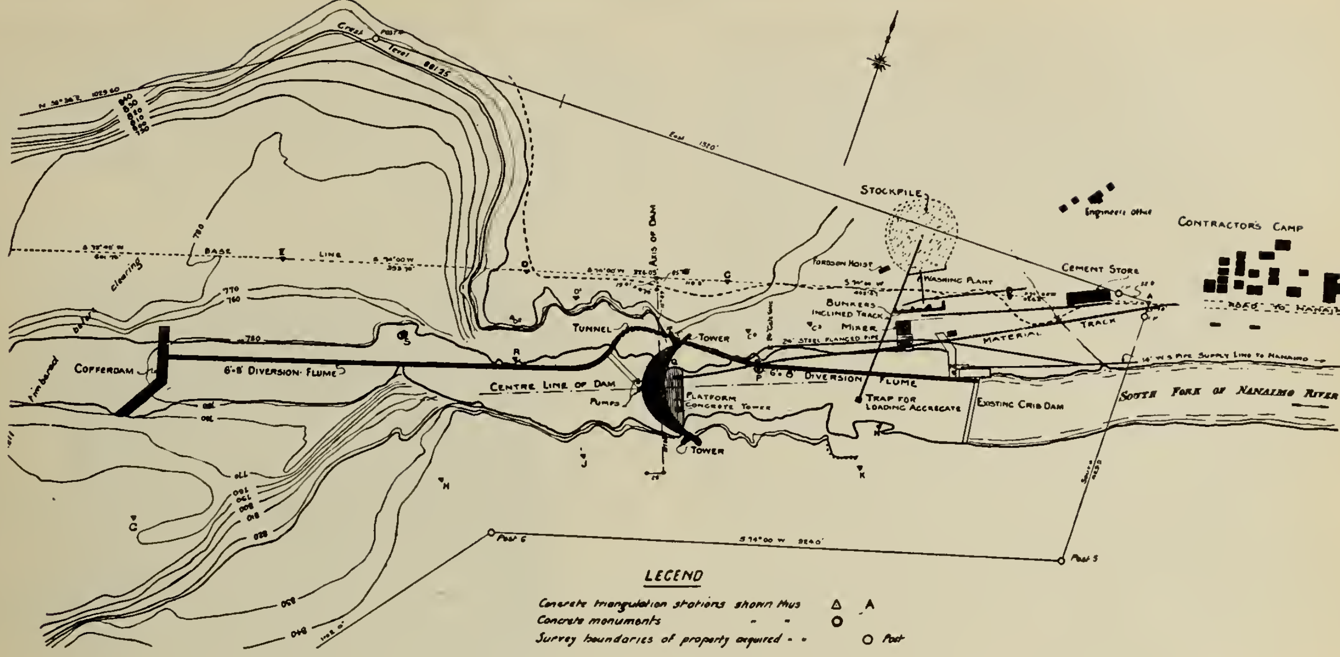

Fig. 2—Contractor's Layout Plan.

periods, the river flowed in the usual kind of crooked erosion valley passing in a sharp bend around the north end of an intrusive dyke of very hard rock. At the close of the era, probably during one of the periodic temporary glacier advances, the old channel was blocked by a terminal moraine several hundred feet deep and 1,000 to 2,000 feet long, which effectively dammed the old channel and forced the river to flow over a low spot in the dyke.

As the rock appeared to have been subjected to heavy shearing the question arose as to whether it would permit of excessive leaks, and also if there was danger of leakage through the old channel. Both the questions were answered in the negative.

The rock consists almost entirely of gneissic andesite with a small amount of granodiorite. The andesite is of Triassic age and has been subjected to powerful stresses which have developed in it an indistinct banding of "gneissic foliation."

The rock was pronounced hard and strong, and there were no faults apparent in the canyon, nor any likelihood of any occurring. The veins, dykes, and other irregularities were also examined, and no soluble minerals or dangerous weaknesses were found.

With these conditions, grouting of the rock in foundations and abutments was considered unnecessary.

Items of Contractor's Tender

The contractor's tender covered the following items:

(1) Clearing of area to be flooded.
(2) Diversion tunnel for dewatering canyon.
(3) Excavation for foundations and abutments of dam, tunnel portal, tunnel plug, and pipe bench.
(4) Coffer dams.
(5) Concrete in dam, tunnel plug, pipe line (short length).
(6) Pressure grouting.
(7) Premium on bond.
(8) Extras—cost plus 10 per cent.

Under the terms of the contract the contractor was understood to have examined all the known records relative to floods and general behaviour of the river.

The consulting engineer's scheme for dewatering the foundations consisted of two coffer dams, above and below the site, with a 6-foot by 8-foot tunnel to pass the river round the site. The contractor submitted an alternative scheme, in which one coffer dam was to be built some 600 feet upstream, and the river carried over the site in a flume discharging over the old crib dam. As soon as the tunnel was completed, the flume would be diverted to pass water through it. This scheme had the supposed advantage that work on the foundations could go on simultaneously with the driving of the tunnel, instead of waiting until the tunnel and the coffer dams had been completed. After work was started the scheme was modified somewhat and the flume allowed to discharge into an open ditch in the stream bed, and an opening was cut in the old crib to pass the water. At the same time the supply to the city had to be maintained by means of a temporary flume connecting with the wood stave supply line.

Construction

The cofferdam was the first objective of the contractor, this being built in the ordinary way of logs, faced with sheeting on a one to one slope upstream, and the crib thus formed filled with rock with an opening to take the 6-foot by 8-foot diversion flume.

Whilst the cofferdam was in progress the diversion tunnel was commenced at the east portal, and shortly after a commencement was made at the west portal, work thus proceeding from both ends.

The three jack-hammers used were supplied with compressed air from a 220 c.f.m. compressor, set up on the old crib dam.

The rock in the bottom of the canyon was overlaid with a bed of coarse sand, gravel, and boulders, to a depth of from 12 to 14 feet, and the contractor commenced the removal of this sand and gravel by manual labour and wheelbarrows.

The actual area to be flooded was 70 acres, 54 of which were covered with heavy timber, the remainder of the area being river bottom.

The clearing was commenced by a separate crew and was carried out on the high line principle, a Fordson donkey hauling the felled logs to a gin pole, and the piles of timber thus formed eventually burnt, the stumps being cut as close as possible.

The bed rock in the canyon from the old crib dam westward for a distance of 1,000 feet was overlaid with excellent aggregate, except for a deficiency of fine sand, and from the bottom of the canyon an inclined track was constructed on which the aggregate was hauled to a stockpile 120 feet above the bed of the canyon.

The aggregate was hauled up the inclined track in a car loaded by hand, and hoisted by a tractor to stockpile.

From the stockpile the aggregate was washed into a small flume and carried by the water through a series of screens which separated it into the various specified sizes. Water for hydraulicking the aggregate was obtained from a small creek close at hand. The head and quantity were both too small for best results and a considerable force of men were required in consequence to keep the aggregate moving in the flume. The final sand box was too small, with the result that the rapid current through it carried off some of the finer sand, the sizes in which the pit run of aggregate was deficient. To make good this deficiency, about 350 cubic yards of fine sand was imported from the Fraser river.

The aggregate was screened to pass into bunkers in the following order:—

(*a*) Aggregate not passing through a 3-inch square hole.
(*b*) Aggregate passing through a 3-inch square hole.
(*c*) Fine aggregate passing No. 4 screen.

The mixer was placed below the bunkers, and a platform giving access to a material track constructed to the site of the dam, completed the layout for making and transferring concrete to the dam.

In the meantime, cement in paper bags was being brought to the site and stored in a cement shed. A track from this shed led to the mixer plant on the same level as the bunker platform.

Floods

During the month of August the preliminary work was well under way—at the latter end of September the weather broke and a flood occurred which flooded the foundations, and did considerable damage to the flumes.

In rapid sequence further floods followed and towards the end of November it became apparent that the contractor could not possibly complete the work within the stipulated time. He accordingly applied for an extension and also for permission to close down for the winter.

After prolonged negotiations, a supplementary contract was drawn up whereby the time was extended to October 15th, 1931, and the contractor undertook to deliver into the city main, when and for as long as the city should require, not more than 1,250,000 gallons per day at a pressure of not over 160 pounds per square inch. The city agreed to pay one-quarter of the cost of such supply provided the cost did not exceed $10,000. The contractor proceeded with what work he could do in the meantime and completed the tunnel, did a good deal on the excavation of the abutments, and laid and connected the steel supply pipe in the tunnel. This pipe, a 24-inch electrically-welded steel pipe (flanged), was laid from a bronze intake screen immediately west of the west portal of tunnel to a junction with the existing wood stave supply pipe line serving the reservoirs.

Through the tunnel the steel pipe was laid in a trench 3 feet by 3 feet excavated in the floor of the tunnel, and encased with concrete.

By mid-December the work was practically closed down; all the timbers in the flumes were salvaged and laid aside, and the bed of the canyon cleared of all material and plant. A crew of three men were left to take care of, and turn over the ten thousand odd bags of cement in the cement shed, keep the cement shed warm, and to salvage all the material possible.

By January, 1931, the river had won the day and the bed of the canyon was in exactly the condition in which it was found in August, 1930, with one exception—the cofferdam was still in position. However even this was not allowed to remain undisturbed, and the winter floods swept out the bank of the river around the south wing of the cofferdam.

To meet conditions of the supplementary agreement, the contractor arranged to install a pump just below the lower portal of the tunnel, to deliver into the supply main. This unit consisted of a 25-h.p. Fairbanks-Morse semi-Diesel engine, and a 6-inch Worthington type single-stage centrifugal pump, and was to be ready for use not later than April 12th, 1931.

Resumption of Operations 1931

The contractor resumed operations again at the beginning of April and with a small crew commenced the rebuilding of material tracks and diversion flume, and closure of gap at south end of cofferdam.

Profiting by his experience of the previous year, the contractor constructed his flumes and tracks to careful grades and brought in a one-half cubic yard 30-h.p. gas shovel to handle excavation, load aggregate, and do the necessary hoisting work.

By the end of June the canyon had been de-watered; excavation was commenced in the foundations, and on July 27th excavation of bed-rock in the bottom of the canyon had been completed.

Pouring of concrete commenced the following day, and the closure in foundations was made on August 13th without anything untoward happening.

The seepage into foundations was taken care of by two 6-inch centrifugal pumps working alternately.

Pouring of foundations was commenced on the north side of the canyon, and the pourings alternated from north to south, giving four pourings to each lift of five feet, the final pouring in each case being completed at the centre line.

In the foundations three 24-inch diameter culverts were set, passing through the dam, two at elevations of 737, and one at 735.

When the concrete reached the elevation of 750, the pumps were removed, and the seepage allowed to pass through the culverts in the arch, and the culverts were at a later date plugged with wooden plugs on the upstream face, and filled with concrete and grout. The pouring of concrete in the dam was carried on more or less continuously day and night, and was completed on October 12th, 1931.

The concrete was proportioned using the water-cement-ratio system, the specification calling for not more than 6 gallons of water to 100 pounds of cement with a workable mix, slump between three and four inches, the strength of concrete to be 2,000 pounds per square inch at twenty-eight days.

The contractor was required to submit a mix for approval to a firm of consulting engineers, who calculated the mix, and after trial the following proportions were finally fixed:—

Fine sand, passing No. 4 screen (brought from Fraser river)	1.30 cubic feet
Coarse sand, passing No. 4 screen, with not sufficient fines	3.50 " "
Coarse aggregate, passing through a 3-inch square hole	6.35 " "
Cobbles up to 6 inches	1.10 " "
Cement, 1½ sacks	1.39 " "
Water, 7 to 8 gallons.	

This quantity constituted one batch, and each batch was given a mix of not less than two minutes.

A patented compound was used in the mix in the proportion of one pound to the cubic yard.

This compound was supposed to give a more workable mix, but did not prove satisfactory and its use was discontinued.

At the option of the contractor, plums up to 12 inches were allowed to be placed in the mass concrete in foundations and up to the 780 level. He exercised the option with satisfactory results, insofar as the quality of the work was concerned.

The aggregate was carefully measured, dumped into a hopper, passed through the mixer, and discharged into buggies, and the buggies were then loaded on to a gasoline speeder, transferred along the material track to a platform erected across the canyon at the 760 level, and again transferred from speeder to hoisting tower. At the required elevation the buggies passed from hoisting platform to a movable platform, from whence the concrete was deposited in the forms.

Fig. 3—Downstream Face of Dam.

The placing and tamping of concrete was given more than ordinary careful and constant supervision and inspection, both day and night.

At each pouring a key or offset was left horizontally and vertically, to take any shear and prevent leakage.

FORM-WORK

The method to be adopted for the support of the forms constituted a problem. Owing to the overhang of the dam, 3 feet in 10 feet for the downstream face at the centre, it was necessary to design the forms to support not only the ordinary hydrostatic load of the fluid concrete but also the weight of the overhanging enclosed concrete. It was early realized that the cost of supporting the forms by falsework from the stream bed would be prohibitive, and that some other method must be devised. At the suggestion of the consulting engineer, a method of hanging the down stream form from the upstream form which, in turn, was hung from vertical cantilevers, was worked out. This involved pouring each five-foot lift complete and allowing it to set sufficiently to act as a horizontal arch, and also to obtain such hardening that vibrations from passing buggies and workmen should not invite deterioration.

The fact that the surfaces to be formed were curved in all directions suggested difficulty in using panels and the contractor therefore decided to use ordinary dressed lumber for the forming surfaces. These were supported on 2-inch by 6-inch vertical studs, which in turn were carried by 6-inch by 6-inch horizontal walings at intervals of about 5 feet vertical. To carry the walings 2-inch by 12-inch cantilevers about 20 feet long were set vertically at intervals of about 6 feet. These cantilevers were held to correct position at their lower ends by long-threaded bolts anchored into the concrete and by twin wedges resting on the concrete, by which means their inclination could be closely adjusted. Wedges and bolts were also used to adjust the studs to the horizontal curve, and in this way the upstream forms were adjusted to the proper position. The downstream forms were then hung by bolts and wire ties from the upstream form. The bolts supporting the downstream forms were in three pieces, joined by coned coupling nuts at the form faces, and the same cones were also used as washers for the wire ties. On removal of the forms, the cones were unscrewed and withdrawn, and the cavities filled with stiff mortar.

Fig. 4 will make this construction clear and also show the method of supporting the working platforms.

Each lift was allowed to set for seventy-two hours, later reduced to fifty, before the next was poured. This allowed time to raise the cantilevers to the new position, place new studding, walings, raise the pouring platform, put on the new sheeting and adjust the whole ready for the next lift. The cantilevers and platforms were raised bodily in sections of forms 30 to 40 feet long, using chain blocks hooked to the walings.

Owing to the overhang and the constantly changing radius of the upstream face, it was necessary to do a great deal of instrumental work during construction. As soon as each five-foot lift was poured the arc of the upstream face for the level five feet next above was run in and marked on the surface of the lift just poured. The points were set at very close intervals and after the forms were set up, as already described, they were adjusted to the correct curvature of the lift to be poured. To allow for deflection of the cantilevers, the forms were adjusted somewhat upstream from true theoretical curve. As might be expected, the actual deflection was not uniform, but in very few cases, and this only in the first two or three lifts, did it exceed one-half inch and, in the upper lifts, the allowance for deflection was made uniformly one-half inch. The downstream forms were adjusted to the upstream forms to give correct thickness for the particular level.

The dam being of the overflow type, an air duct 24 inches in diameter was constructed in the crest with 6-inch outlets at 10-foot centres, opening under the lip of crest, the air duct being built vertically in the abutment towers with inlets at elevation 833.

Fig. 4—Formwork on Downstream Face.

The inlets were covered with cast iron gratings. The object of the air duct is, of course, to prevent the vacuum which would otherwise form between the falling sheet of water and the structure.

GROUTING POCKETS

The distinctive feature of this dam is the differential pressure grouting to correct the secondary stresses. The process is the invention of Dr. Fredrik Vogt, an eminent

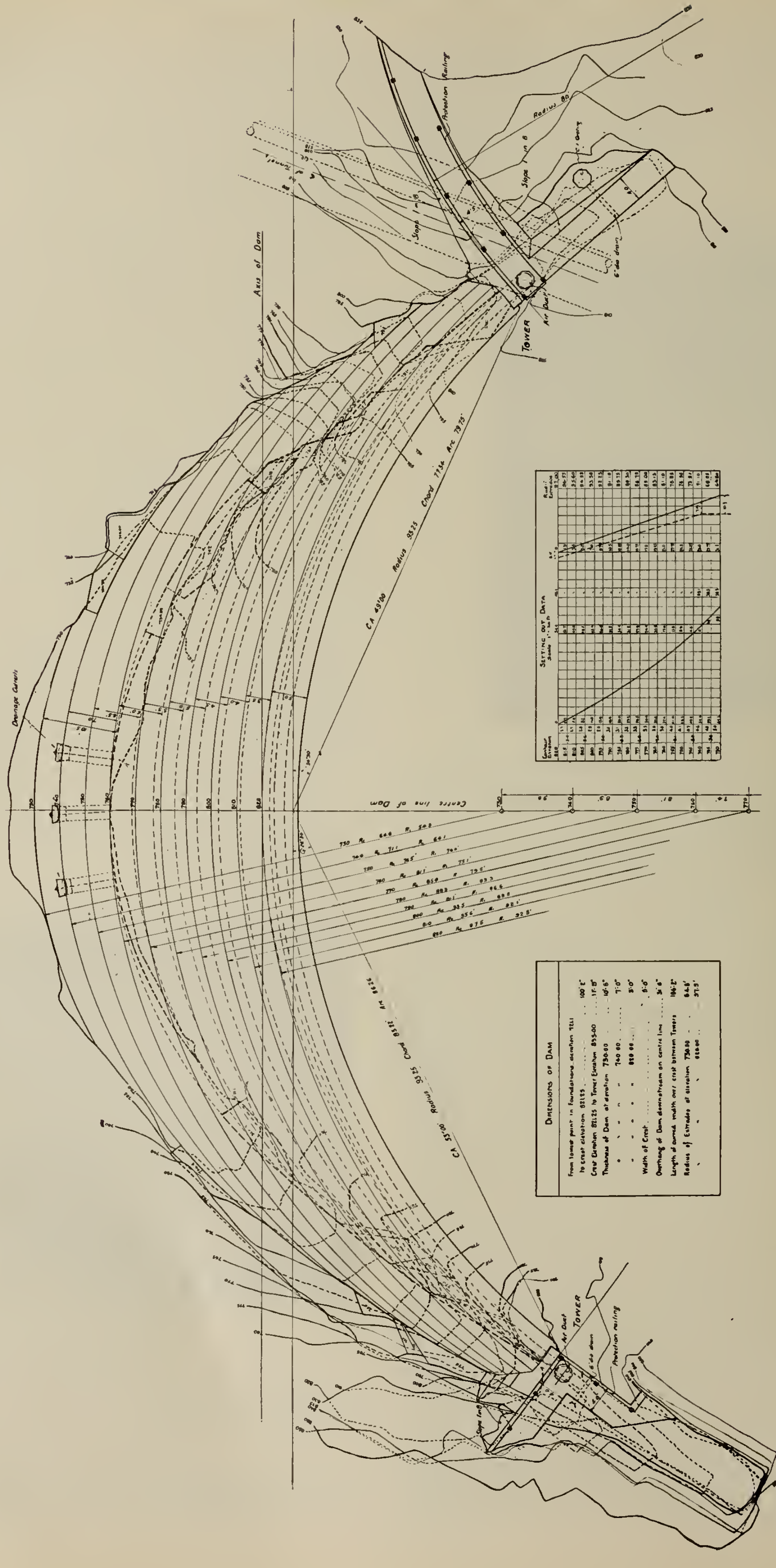

Fig. 5—Plan of Variable Radius Arch Dam.

Norwegian engineer, and is patented under the name of the "Vogt patent process of differential pressure grouting."*

Briefly, the main advantages claimed for the process are:

(1) Equalization of the arch stresses is effected by correcting for distortion due to the water load.

(2) The cantilever stresses are much reduced and tension altogether eliminated in the cantilever elements.

(3) It compensates for shrinkage, and accelerates cooling.

(4) It compensates for the Lamé effect in thick arches.

The grouting pocket was commenced at the 740-foot level, on the centre line of the dam, and continued to the crest.

A copper strip forms the stop on the downstream face, and a strip of galvanized iron is also placed at the neutral axis of the arch. A form with galvanized iron faces was used for the sides of the pocket, and this was moved upward with each lift.

Tell tale pipes were connected at 10-foot intervals with an outlet on the downstream face and an upward bend provided with a screw cap. The pocket for pressure grouting occupied the downstream half of the thickness of the dam. At each lift galvanized iron stops were placed to prevent leakage of grout along the horizontal joints. On the upstream half of arch a plain keyed joint was formed with two cored holes for simple grouting. To prevent blowing out the stops 2-inch by 12-inch plank scabs were bolted against the concrete.

After the completion of concrete at each level a circulation of cold water was kept up through the pocket until ready for the pressure grouting. The tell tale pipes were closed and the structure examined for leaks, the water pressure at the crest being 30 pounds per square inch. Great care had been taken with the pockets and only very minor leaks were found. A plate was then bolted down over the open top of the grouting pocket at the crest and a filling pipe screwed into the plate.

A soupy grout consisting of one part of Ciment Fondu to two parts of fine sand passing the No. 8 screen was poured into the pocket in one continuous operation. As the grout reached the top of each tell tale pipe any trapped air and water was expelled and the pipe capped. On completion of the filling process, a pressure of 30 pounds per square inch was put on the grout at crest level and maintained for twenty-four hours. This pressure was obtained by tapping a small creek at an elevation which gave the necessary head to maintain the pressure, the pressure being observed on a gauge attached to the pipe. The grouting operation took an hour and was completely successful.

As the pocket full of fluid grout at a hydrostatic pressure varying from 30 to 110 pounds per square inch acts as an hydraulic jack of Brobdingnagian proportions it was thought that there might be some visible movement of the dam when the pressure was applied. Calculations indicated a possible movement of about one-eighth inch. A transit point was set on the crest and observed after the pressure was turned on, but any movement which occurred was too small to be detected by this rather crude test. It was also thought that the centre points might open up under the pressure and twin points had been set three inches on either side of the joint by which any movement could be detected. No movement was observed, but this was not unexpected as the concrete in the upstream half was under considerable compression before grouting and this would have to be entirely relieved before any visible opening of the joint could occur.

Twenty-four hours after the grout had been put under pressure, one of the tell tale pipes was sawed off and a 6-inch length cut from the vertical leg. The enclosing pipe was cut off and the resulting 3-inch by 6-inch cylinder of grout was tested for compression, and broke at 6,900 pounds per square inch, so there is no doubt that the grout went home and did what it was intended to do. After the period required for setting had elapsed, the two core holes in upstream half of arch were filled with a similar grout.

Completion of Dam

The grouting process completed the dam, and on October 14th, 1931, the contractor formally handed over the work to the mayor and council on behalf of the corporation.

The ceremony in this connection consisted in firing a charge attached to the cable holding up the closure gate at the entrance to the diversion tunnel. Immediately the closure gate had dropped at the west portal of tunnel, a wedge-shaped closure plug 10 feet long was poured in the tunnel directly under the north abutment. For future requirements a 16-inch diameter cast iron pipe was placed

*Published in Transactions E.I.C., Volume XXXVI, page 248.

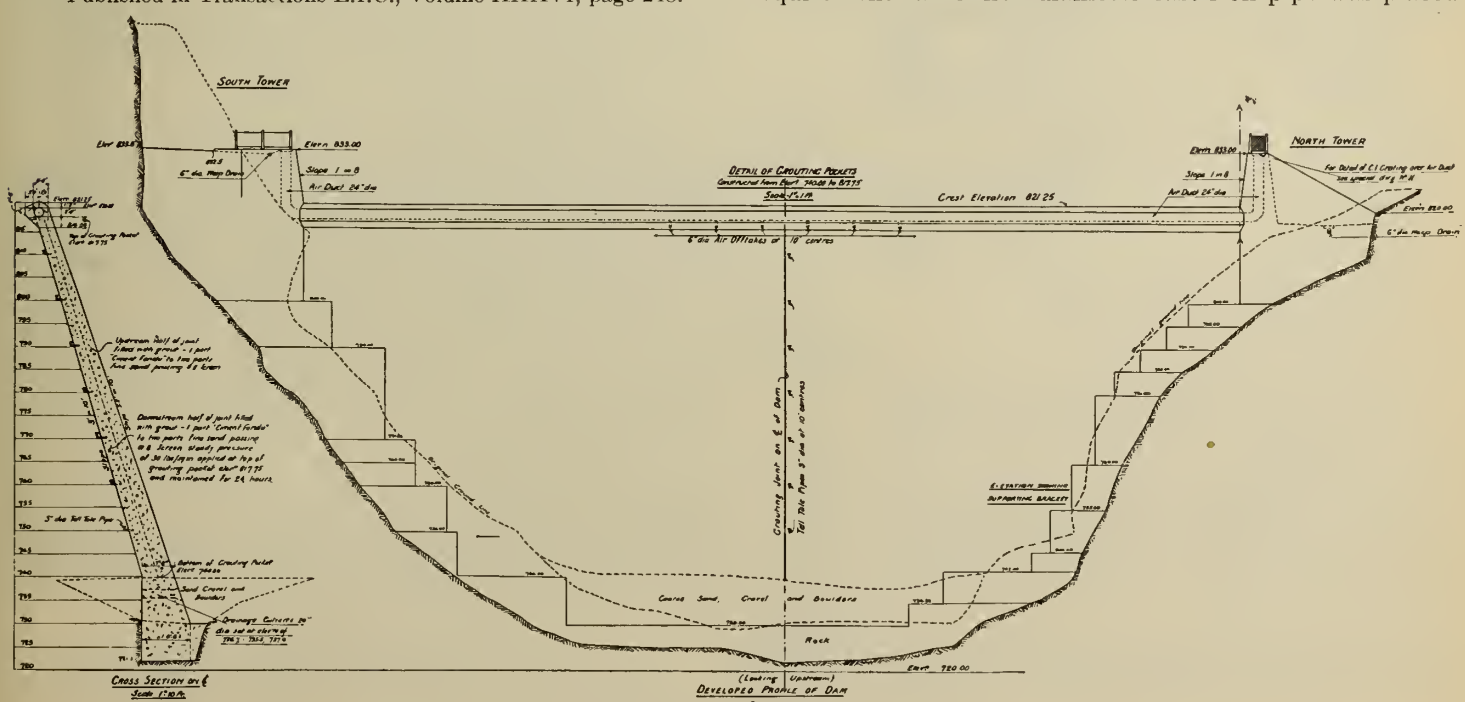

Fig. 6—Developed Profile of Dam.

in the closure plug, with bolts in the concrete to attach future fittings. With the completion of the closure plug the contractor completed clearing up and removed his forces from the site. In Fig. 7 the tunnel has been closed and the water is rising in the pool.

Floods

During the period of construction the river was more than usually rampant. On September 30th, 1931, a flood occurred and the river rose 45 feet on the dam in thirteen hours, reaching a level on the unfinished structure of 802. On October 4th, the river again rose 60 feet in fifteen hours, and at this stage the forms had to be cut to allow the flood to spill over the top of the structure, this in spite of the fact that the tunnel was discharging full bore under the head of 70 feet.

No observable damage was done to the structure, although the grouting pocket was empty at the time of the flood.

Dimensions of Work

The following are some particulars of the work:—

From lowest point in foundation, elevation 721.1, to crest of dam, elevation 821.25	100 feet 2 inches
Top of towers on north and south abutments, elevation 833.00, or above lowest point in foundations	111 feet 11 inches
Crest of dam to bottom of canyon	84 feet 0 inch
Length of curved width over crest between towers	166 feet 2 inches
Thickness of dam at 730 elevation	10 feet 6 inches
Thickness of dam at 740 elevation	7 feet 0 inch
Thickness of dam at 820 elevation	3 feet 0 inch
Width of crest	5 feet 0 inch
Overhang of dam downstream on centre line	31.5 feet
Radius of extrados at 730 elevation	64.8 feet
Radius of extrados at 820 elevation	97.5 feet
Area flooded	70 acres
Impounded water approximately	550,000,000 gallons
Number of bags of cement used	18,447

From tests of thirty-two cylinders taken from pourings, an average of 2,950 pounds per square inch was obtained and no single cylinder was recorded below the specified strength of 2,000 pounds per square inch. A test cylinder of the grout taken at the mixer broke at 7,019 pounds per square inch.

Cost of Work

The following are the actual quantities comprising the various items of construction

Clearing 70 acres total			
16 river bed			
54 acres to be cleared			$ 16,200.00
Tunnel 189.2 feet			2,270.40
Excavation:	Cubic yards		
Foundations and abutments	2,363.64	$18,909.12	
Tunnel portal	106.80	854.40	
Tunnel plug	11.05	88.40	
Pipe bench	553.03	4,424.24	
Overbreak	198.01	1,584.08	
			25,860.24
Cofferdam, water connections and flumes			3,500.00
Concrete:	Cubic yards		
Dam	3,623.14	$61,593.38	
Tunnel plug	28.83	490.11	
Pipe line	99.66	1,694.22	
Tunnel portal	7.26	123.42	
			63,901.13
Pipe line laying, lineal feet	774.10		774.10
Pressure grouting, cubic feet	66.18		734.16
Miscellaneous			2,430.61
Total amount of contract			$115,670.64
The city supplied 774.10 feet of electrically-welded flanged steel pipe 24 inches in diameter, and one 24-inch gate valve, the pipe fabricated by the Vancouver Engineering Works			$9,206.00
The area acquired for the flooded area has been purchased and surveyed, and comprises an area bought from the E. & N. Railway Company, known as Lot "B," Dunsmuir District			92.38 acres
And an area bought from Victoria Logging and Manufacturing Company, comprising part of Block 14, Dunsmuir District			25.10 acres
			117.48 acres
Total cost of timber and land amounted to			$6,034.37

The surveys for purchase of property, and posting of boundaries was done by Mr. J. B. Green, B.C.L.S., Duncan, B.C.

Criticism

The writer has a great regard for the contractor as an individual, and has no intention of being over critical, nor is it the wish to conduct a post mortem after the completion of the work, as criticism is always easy after a thing is done, but some of the methods of the contractor will bear analysis.

(*a*) In the area cleared there was approximately 1¼ million F.B.M. of fine timber piled and burnt.

With a small portable saw mill, timber could have been cut on the site for cofferdams, flumes, form-work, and camp

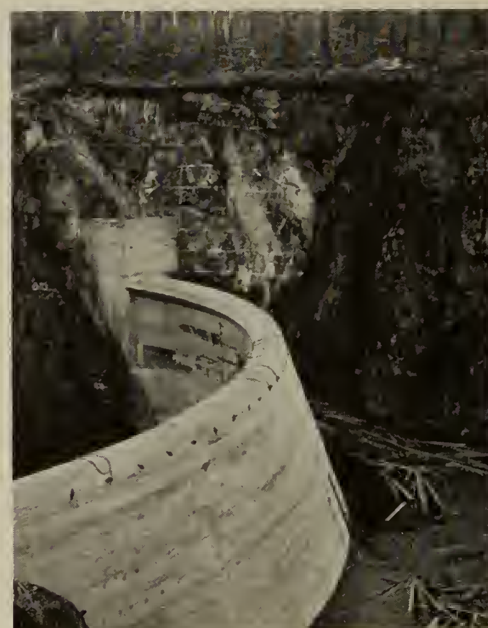

Fig. 7—North side of Dam showing South Tower Crest and Overhang.

The contractor preferred to haul in his timber 15 miles from Nanaimo over an extremely difficult road.

(*b*) To place concrete in forms required eight operations:—

1. Loading material in bed of canyon.
2. Hauling up to stock pile.
3. Chuting to bunkers and mixer.
4. Transfer from mixer to low level platform.
5. Transfer along platform to concrete hoist tower.
6. Hoisting in tower.
7. Moving from tower to platform.
8. Depositing in place.

It would appear that had a high line cable-way been placed across the canyon, and the bunkers, stock-pile, mixer, and cement store placed immediately above the north abutment, considerable amount of handling would have been avoided, and material tracks would not have been required at all.

There were many other minor details which could have been improved,—the supply of air to the jackhammers was always insufficient and unreliable, manual labour was employed at one stage when mechanical appliances were obviously called for, and the method of curing the concrete was not satisfactory.

In justice to the contractor, he undertook in his contract, other things being equal, to employ local labour, with the exception of his permanent staff. He was handicapped to a certain extent by this labour being unskilled in the type of construction, and none too efficient. His labour turnover was unduly high.

Features of Dam

In summarizing, the following points in regard to the structure and its appurtenant works are worthy of note:—

(*a*) No reinforcement of any description was used in any part of the dam.
(*b*) No separate spillway was provided in the design, the crest being also the spillway.
(*c*) The economy in design resulted in a large saving to the city of Nanaimo.
(*d*) The use of the "Vogt" system of pressure grouting.
(*e*) The overhang on centre line of 31.5 feet downstream.
(*f*) The air ducts for breaking vacuum.
(*g*) No pressure grouting in foundations and abutments.
(*h*) The tenacity and determination of the contractor to complete the work in spite of financial loss, and in face of setbacks by fire and flood.
(*i*) And finally, the most important contribution to the success of the work, from the engineer's point of view, the city council of the day had the foresight to put the whole work unconditionally into the hands of the consulting engineer, and to stick to the principle of non-interference, asking only in return a finished piece of work.

APPENDIX

By H. B. Muckleston, M.E.I.C.

The general principles underlying the Vogt system of differential pressure grouting were outlined in a paper by the writer.*

This appendix will outline in more detail the principles on which the calculations for the South Fork dam were made.

(1) The dam is conceived as a series of arched elements in horizontal planes superimposed on a series of cantilever elements in vertical planes.

(2) Under a hydrostatic load, the arch elements will shorten elastically giving rise to the so-called negative thrust acting through the elastic centre and setting up bending moments in the ring.

(3) In order to neutralize the effect of the negative thrust, the arch is cut at the crown, Fig. 1a, and an initial positive thrust, X_g, Fig. 1, is set up by injecting grout under high pressure into the pocket. This thrust forces the two halves of the arch apart and causes each point on the half arch to deflect radially upstream. These deflections cause bending moments in the vertical and horizontal elements, which oppose the upstream deflection of the arch. Under any given force, X_g, the upstream deflections will increase until the half arch is in equilibrium under the force, X_g, combined with the radially downstream reactions of the vertical elements.

(4) Let the radial force at the crown due to cantilever action be p_c; at any other point, distant angularly from the crown by the angle ψ, the radial force, $p\psi$, will differ from that at the crown by some amount depending on the variable stiffness of the vertical elements. The law governing this variation cannot be determined with precision. If the developed profile is reasonably regular a sufficient and safe approximation can usually be obtained by the assumption that

$$\frac{p\psi}{p_c} = 1 - \left(\frac{\psi}{\phi_1}\right)^n \qquad (1)$$

The moment at any point in the arch, distant ϕ from the crown, will then be

$$M_\phi = -X_g(B - r\cos\phi) + \int_o^\phi p_c r^2\left(1 - \frac{\psi^n}{\phi_1{}^n}\right)\sin(\phi - \psi)\,d\psi \qquad (2)$$

M is considered as positive when it causes tension in the extrados, and the radial deflection of the arch at the crown, y_c, will be

$$y_c = \frac{r^2}{EI}\int_o^{\phi_1} M_\phi \sin\phi\, d\phi \qquad (3)$$

Upstream deflection is negative.

* Published in Transactions E.I.C., Volume XXXVI, page 248.

The integrations in these formulae can be performed when n is known. The expression for $\frac{p\psi}{p_c}$ would be substantially correct if the developed profile of the dam were a mathematical curve; it is closely approximate if the profile is trapezoidal or triangular. If the developed profile does not materially differ from a parabola, n may be taken as infinite giving $\frac{p\psi}{p_c} = 1$. For a distinctly trapezoidal profile, n may be taken as 2; and for a rectangular profile as unity. For these values the formulae reduce to the following:—

(A) for $n = \infty$; $\frac{p\psi}{p_c} = 1$

$$M_\phi = -X_g(B - r\cos\phi) + p_c r^2(1 - \cos\phi)$$

$$\frac{y_c EI}{r^2} = -X_g\left\{B(1 - \cos\phi_1) - \frac{r}{2}\sin^2\phi_1\right\} + p_c r^2\left(1 - \cos\phi_1 - \frac{1}{2}\sin^2\phi_1\right)$$

(B) for $n = 2$; $\frac{p\psi}{p_c} = 1 - \left(\frac{\psi}{\phi_1}\right)^2$

$$M_\phi = -X_g(B - r\cos\phi) + p_c r^2\left[1 - \cos\phi - \frac{\phi^2 - 2}{\phi_1{}^2} - \frac{2\cos\phi}{\phi_1{}^2}\right]$$

$$\frac{y_c EI}{r^2} = -X_g\left\{B(1 - \cos\phi_1) - \frac{r}{2}\sin^2\phi_1\right\}$$
$$+ p_c r^2\left\{1 - \sin^2\phi_1\left(\frac{1}{2} + \frac{1}{\phi_1{}^2}\right) - \frac{2\sin\phi}{\phi_1} + \frac{4}{\phi_1{}^2}(1 - \cos\phi_1)\right\}$$

(C) for $n = 1$; $\frac{p\psi}{p_c} = 1 - \frac{\psi}{\phi_1}$

$$M_\phi = -X_g(B - r\cos\phi) + p_c r^2\left\{1 - \cos\phi - \frac{\phi - \sin\phi}{\phi_1}\right\}$$

$$\frac{y_c EI}{r^2} = -X_g\left\{B(1 - \cos\phi_1) - \frac{r}{2}\sin^2\phi_1\right\} + p_c r^2\left\{1 + \frac{\cos^2\phi_1}{2} - \frac{\sin\phi_1}{\phi_1}\left(\frac{1 + \cos\phi_1}{2}\right)\right\}$$

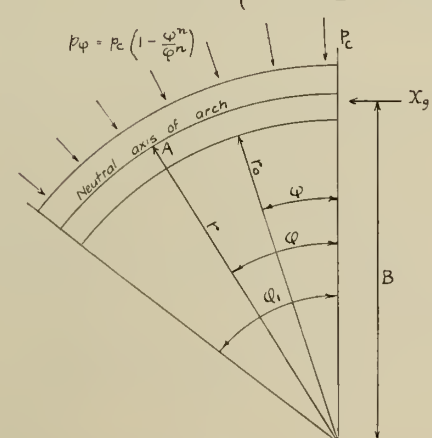

Fig. 1

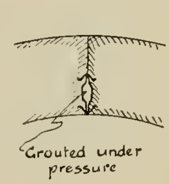

Fig. 1-A

(5) To determine p_c; consider a vertical element at the crown one unit thick, Fig. 2a, and divide this into sections by horizontal planes at convenient intervals. Calculate the weights of these sections, W_1, W_2, W_3, etc. and find the total moments about the points 1, 2, 3, etc., of all the weights above each point. Plot these moments as "righting moments," Fig. 2b. Next, calculate the maximum bending moments which the sections at points 1, 2, 3, etc. will stand without causing tension greater than, say 50

pounds per square inch, and plot these as "bending moments," Fig. 2c. Add the bending moments to the righting moments and plot the sums as "overturning moments," Fig. 2d. Differentiate this curve once from top to bottom giving the "shear curve," Fig. 2e, and differentiate this curve from top to bottom to get the "load curve," Fig 2f. The ordinates to the latter curve will be the maximum possible values of p_c, for the cantilever standing alone.

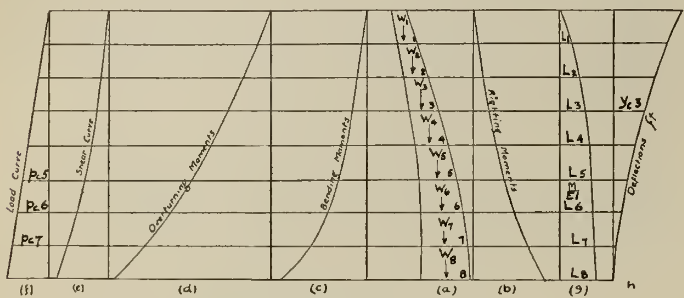

Fig. 2

Considered as part of an arched dam, the values so found may be increased by 10 per cent to 15 per cent without danger.

To find y_c, divide the ordinates of curve 2c by EI in which I is the moment of inertia of the section at the corresponding point. Plot the result as the $\frac{M}{EI}$ curve, Fig. 2g. Integrating this curve twice from bottom to top will give the "deflection curve," Fig. 2h, and the ordinates to this curve will be the deflection of the corresponding points, y_c. Throughout this calculation, dimensions must be in the same units: for instance, lengths in feet, weights in pounds, moments in foot-pounds, E in pounds per square foot and the scales for plotting and measuring must be in units per unit, i.e. feet per foot, foot-pounds per foot, etc.

(6) We thus get p_c, and y_c, to be substituted in equations (3) from which the term involving X_g can be calculated. It should be noted that the real value of E is very uncertain and ultra refinement in calculation of y_c is liable to be misleading. Moreover, elastic yielding of the foundations, effects of shear, Poisson's ratio and so forth do not appear in the usual method of calculating.

However, it will be found that the value of $\frac{y_c EI}{r^2}$ in equation (3) is so small in proportion to the term involving p_c that errors in y_c of even 100 per cent are of no practical importance. Unless the dam is very thin, y_c may be safely taken as zero.

To complete the calculation, either X_g or B must be assumed and B or X_g calculated. This is a matter of trial.

(7) B must be less than the radius of the neutral axis and greater than the radius of the intrados. Between these limits any value may be chosen.

(8) The normal thrust at any point ϕ is, Fig. 3,

$$N_\phi = X_g \cos\phi + p_c r \int_o^{\phi_1} \left(1 - \frac{\psi^n}{\phi_1{}^n}\right) \sin(\phi - \psi)\, d\psi \ldots (4)$$

This equation can be integrated when n is known. Note that the integral in equation (2) is r times the integral in equation (4).

(9) The moment at the abutment can be calculated from equation (2); and the fibre stresses due to X_g can be determined from the normal thrust and moment. To these must be added, algebraically, the stresses due to the full hydrostatic load. These can be most easily determined by using Fowler's curves for Cain's formulae*. The resulting stresses will always be somewhat worse than will be found in the dam, since we neglect the assistance given by the vertical elements in taking some of the load off the arches.

(10) The vertical elements do carry some of the load, but there is very great doubt as to how much. The proportion is influenced by so many factors of very uncertain effect that it is safer to neglect the relieving section of the cantilevers altogether, relying on it only as an additional factor of safety. The vertical elements also act to transfer some of the load from the lower arches to those near the crest. As these are always very much stronger than the theoretical arch load on them would require, the neglect of this section is also justified. Pressure grouting as described, by putting an initial upstream deflection into the vertical elements, acts to equalize the stresses in these members also. The real magnitude of this effect can not be calculated as there are too many uncertain factors in the problem. There is no real danger of the vertical elements failing.

(11) In the above outline, we have considered only the radial components of the deflections of the arches and vertical elements. The application of the force X_g will produce tangential as well as radial components. In order to provide for these components it will be necessary to deform the dam initially by an amount equal and opposite to the tangential deflections which will afterwards occur under the force X_g. If we calculate the normal thrust and moment at several equally spaced points between the crown and abutment, we can, by grouting first at these points with a proportional part of the calculated thrusts and moments, beginning at the abutment and working toward the crown, counteract the tangential deflections which will afterward occur when the joint at the crown is finally treated. The correction will not be exact but will be near enough to the right amount for all practical purposes.

(12) In addition to the action of the grouting pressures in correcting for the distortion of the arch and vertical elements under load, they also enable a correction to be made for the effects of shrinkage of the concrete and the contraction due to a fall in temperature. Under a fall

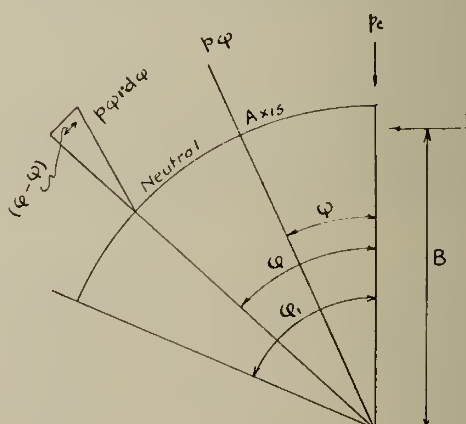

Fig. 3

Normal Thrust due to $X_g = X_g \cos\phi$

Normal Thrust due to $p = p_c r \int_o^{\phi_1} \left(1 - \frac{\psi^n}{\phi_1{}^n}\right) \sin(\phi - \psi)\, d\psi$

$$N_\phi = X_g \cos\phi + p_c r \int_o^{\phi_1} \left(1 - \frac{\psi^n}{\phi_1{}^n}\right) \sin(\phi - \psi)\, d\psi$$

in temperature, the axes of the arch elements in the dam contract and, therefore, induce bending moments throughout the ring in the same way as the shortening under the hydrostatic load. The same action is also induced by the shrinkage of the concrete in setting. Much of this latter is due to the dissipation of the chemical heat of setting. The amount is roughly ¾ inch in 100 feet. If not corrected in some way, this shrinkage results in a permanent condition

* Transactions A.S.C.E., Volume 92, page 1512 seq.

of strain which, in the worst case, may be too much for the concrete to stand with the result that vertical cracks form extending through the dam. In a thick dam, it may require months for all the heat to disappear. By circulating cold water through the grouting compartments the process can be greatly accelerated so that the period may be measured in days rather than months. Even should no actual cracks develop, the condition of strain will remain, that is, the concrete will be in tension. The grouting pressure, if sufficient, will at least neutralize this tension and may be made to convert it into compression, so that the formation of cracks is avoided. Also, since the arches have an initial compression, the subsequent effects of temperature are discounted in advance.

If the developed profile of the dam is very irregular, equation (1) will not hold and we must put

$$\frac{p\psi}{p_c} = 1 - f\left(\frac{\psi}{\phi_1}\right)$$

It will then be necessary to calculate $p\psi$ by a process of trial analogous to the trial load method for arch dams.

Equation (2) cannot then be integrated directly and recourse must be had to graphical integrations of the plotted curves. If an integraph is available an immense amount of labour can be avoided.

With a profile which is not grossly irregular it is safe enough to make calculations by all three sets of equations, A, B, and C, and use the results of that set which gives the worst conditions.

Diesel Electric Propulsion on the Prescott-Ogdensburg Car-Ferry

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and
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Paper presented before the Ottawa Branch of The Engineering Institute of Canada, November 13th, 1931.

SUMMARY.—After discussing briefly the advantages and disadvantages of the electric drive for marine propulsion, the paper describes one of its applications on a Diesel-electric tug and car float for ferry service on the St. Lawrence. The installation is of interest since the tug may be used independently or may be connected electrically and mechanically to the car float, in which case the propulsion and steering of the combined unit may be operated either from the bridge of the tug or from that of the car float.

While the first steamboat, the *Fulton*, is claimed by the United States, the modern development of the science of naval architecture owes much to the initiative of France, Germany and Great Britain. On the other hand, America has been very much to the fore in the progress attained by electricity, more particularly in its adaptation to new purposes, and it is not surprising to find that the electric drive for marine propulsion originated in the United States, and has there been developed to the greatest extent.

This method of propulsion comprises a primary power unit or units, usually an internal combustion engine or a steam turbine, coupled to and driving a generator, developing electrical energy which is transmitted to the propelling shaft of a vessel through the medium of an electric motor.

There is of course nothing essentially novel in such an arrangement. The rather surprising aspect of the development at first sight is how such a conception could be considered attractive in the case of a ship, where first and operating costs are so competitively vital, having regard to the loss of power occurring between the prime mover and the propelling motor, which is not far short of twenty per cent.

As a matter of fact, the electric drive cannot be justified strictly upon its merits for the average ship, and its legitimate use for marine purposes should be confined to certain services where its peculiar advantages offer sufficiently definite attraction to outweigh its other somewhat obvious disadvantages.

Electric drive for marine purposes received its principal initial impetus many years ago by reason of its adoption by the United States navy for the propulsion of its battleships, a development which has only recently been discarded in favour of steam turbines associated with mechanical gears.

The usual prime mover in the initial installations was the steam turbine, but except for very large powers, it is now more usual to find the Diesel engine associated with electric drive, for the reason that electric control removes one of the chief objections to the Diesel, namely, its inferior flexibility, whilst on the other hand, the economical Diesel to some extent obviates the main disadvantage of the electric drive in association with steam, namely, its transmission loss.

The principal advantages claimed for the electric drive for marine propulsion may be enumerated as follows:

1. *Delicacy of power control over the full range from stationary to full power, irrespective of adjustments to the prime mover.*

For navigating in crowded waters, creeping up to wharves and manœuvring through artificial canals and locks, steam propulsion has proved superior to the direct drive Diesel, by reason of its definite control at all speeds. By means of the electric drive the exerted power of the Diesel can be reduced to any desirable extent through the propelling motor, so that the control becomes just as delicate and definite as steam.

2. *The ability to develop full power to the propelling shaft at various revolution speeds.*

In such types of vessels as tugs, where big power is installed in small hulls, and where the load fluctuates tremendously, proper propeller efficiencies are not possible to meet all operating conditions. A propeller may be designed to suit the designed revolutions of the engine when the vessel is running free, but when attached to a heavy tow, the revolutions fall, due to the increased load and slower movement of the vessel through the water, and the engine power developed falls in like proportion. The ability to apply full power at the slower propeller speed, made possible by the interposition of the electric motor, as will be described later, definitely increases the towing efficiency.

3. *The convenience of controlling the propelling machinery directly from the pilot house, instead of through the agency of signals from the pilot house to the engineer or watch.*

The practice of indirect control by mechanical telegraphs is so universal and ingrained by usage that the desirability of direct machinery control by the navigator is not readily apparent and has occasioned such prejudice that difficulty has been experienced sometimes in obtaining for pilot house control the full co-operation of the deck and engine room personnel.

Possibly the simplest way to appreciate its value is to endeavour to imagine the inconvenience and trouble which would inevitably ensue if the motorman of a street car operated signals instead of a motor control, and the actual movement of the car was actuated by the conductor in the rear.

4. *Undivided responsibility in controlling the movement of the vessel.*

This advantage cannot be better exemplified than by recalling an accident which occurred in the Lachine canal in 1931 and which is typical. The passenger vessel *Rapids*

Fig. 1—Tug and Car Float.

Prince, due to the engineer on watch incorrectly interpreting his orders from the pilot house, failed to reverse his engines, with the result that the vessel crashed the lock gates, flooding the lower level, with great danger to life, damage to property estimated to amount to a quarter of a million dollars, and considerable disorganization and delay to traffic.

5. *Freedom from difficulties and compromises occasioned by considerations of propeller efficiencies.*

One of the chief difficulties which the marine engineer encounters in the installation of various types of machinery is the comparative inefficiency of the screw propeller except at slow revolution speeds. Such limitations proved a considerable obstacle to the use of the steam turbine and of high speed Diesels, but do not operate in the case of electric drive. Further, the association of light weight Diesel engines with fast running generators without requiring an unsatisfactory compromise in propeller speed, and enabling propeller efficiencies to be limited by conditions of draught only, is definitely attractive. The propelling motor in this case operates virtually in the same way as a reduction gear.

Electric drive possesses other attractive characteristics for certain vessels of special types and it is obvious that to no one type of vessel do all the above mentioned advantages apply. In the main, it may be assumed that it is definitely attractive in the case of vessels required to manœuvre their engines with frequency or where the power required is subject to considerable fluctuation.

Even in such cases the improved efficiencies obtainable are not always commensurate with the price which is paid for them, and signs are not wanting that certain of the desirable features of electric drive may be shortly attainable in a more simple and less costly way.

The principle of remote control as exemplified by pilot house operation of machinery is one, however, which is capable of further development and has inherent possibilities having peculiar advantages in many spheres of engineering activity.

For instance, the possibility was conceived many years ago of actuating propelling motors in several vessels from one master unit in one of them by power transmitted over a kind of marine trolley line. Certain research has also been carried out with a view to controlling the propulsion and steering of a crewless vessel by wireless from a point many miles away, but possibly the first commercial development of this conception of what might be termed "more remote control" is in a tug and car float unit placed in commission in 1930 to ferry the railroad traffic of the New York Central Railroad and of the Canadian Pacific Railway across the St. Lawrence river at Prescott, Ont., and Ogdensburg, N.Y.

The requirements of this particular service had previously been met by the self-propelled steam carfloat *Charles Lyon* which, having propellers at each end, did not require to be turned during transit. This vessel had rendered excellent service all the year around under all climatic conditions, and was built by one of Canada's pioneer shipyards, the Polson Iron Works of Toronto.

Due to the exigencies of depreciation, obsolescence and traffic growth, it became necessary to provide new equipment, and careful study of marine engineering development and the experience obtained in carfloat navigation determined a radical departure in design.

In New York harbour, where considerable traffic of a similar nature exists, the self-propelled float would be uneconomical, owing to the varying periods required for loading or discharging. There are many more floats than tugs and the tugs are kept to a minimum, moving to the fullest extent.

The tugs carry a considerable crew and the floats none; the tugs consume fuel while the floats have no machinery so that the frequent enforced idleness of the floats is of little consequence so far as operating costs are concerned.

For reasons of fuel economy, Diesel machinery has in recent years tended to replace steam as motive power for the tugs. Easy manœuvring ability is, however, so essential for this class of traffic in the crowded waters of New York harbour that it became apparent that some means of overcoming the lack of flexibility inherent to Diesel direct drive must be found. Even with the most careful design it is usually found impracticable to reduce the Diesel's revolutions to less than about 25 per cent of its maximum speed and at the same time maintain reliable and smooth running.

The tug required for such heavy work is much overpowered for the size of the hull when running free, and a reduction in propeller revolutions does not reduce its speed through the water sufficiently to avoid difficulty in the intricate navigation around congested wharves under varying conditions of wind and current.

One has to be aboard one of these tugs when handling car floats to realize the excessive number of engine orders and manœuvres which this service requires, and to appreciate the serious damage which would on many occasions ensue in case of misunderstanding arising between the pilot house and engine room.

Here are many of the peculiar operating conditions so favourable to electric drive, with the result that most of the tugs built in recent years for this service have been so designed.

The captain in the pilot house becomes virtually the motorman, and the engineer in the engine room merely keeps the machinery in good running order. The engine telegraph becomes redundant and is retained for emergencies only. The response to decisions in the wheelhouse is positive and immediate. The possibility of misunderstanding is eliminated. The responsibility for safe and efficient control of the tug and its float is in one man's hands.

The conditions obtaining in the ferry service across the St. Lawrence at Prescott are not quite similar to those experienced in New York habour. There is no necessity for the tug leaving one float to pick up another and the service requires only one tug and one float, with one shore connection on each side of the river. There existed some doubt at the time, however, whether, before the useful life of the new equipment terminated, the St. Lawrence river might not be bridged at this point, thereby rendering a costly self-propelled unit useless. It was also necessary to incorporate in the scheme equipment suitable for breaking ice and it was conceived that equipment could be devised, comprising a tug and a float, which would possess the conveniences of a self-propelled vessel without its disadvantages for car ferry or ice-breaking service, so that in case of a bridge rendering the equipment obsolete for the purpose intended, the tug at least could be used for other purposes.

It should be noted that carfloats are moved by the tug tied up alongside the float, rather than by a tow rope, and once the relative positions of tug to float are determined to best convenience and steering control, this position may be considered semi-permanent.

This condition led to the query—If the propelling machinery and steering gear of the tug can be controlled from its pilot house, why not carry the idea further and control it also and alternatively from a navigating bridge erected on the float? Why not also assist steering qualities by installing rudders on the float and having them controllable from either the pilot house on the tug or the bridge of the float at will, and in unison with the rudder on the tug?

It is readily appreciated that to place an unwieldy and easy swaying carfloat exactly in position, and to make the contact with sufficient delicacy to prevent damage to the suspended shore apron, is a task requiring extreme care, particularly when weather conditions are adverse. To sponsor this operation from a tug wheelhouse which is situated towards the after end of the float, with intervening

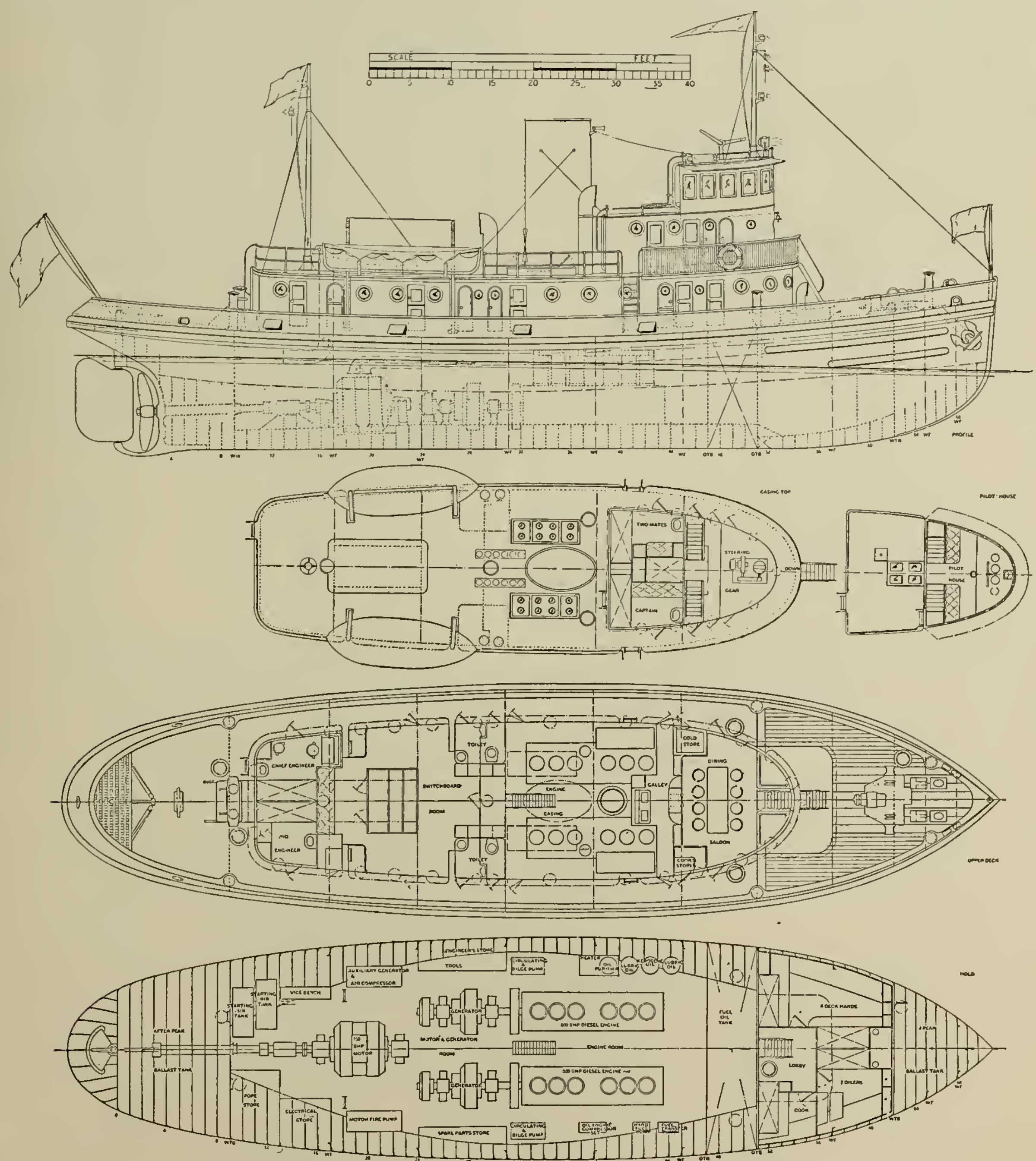

Fig. 2—Diesel Electric Tug *Prescotont.*

rows of box cars impeding the view, makes its execution still more difficult and renders necessary the placing of a man at the forward end of the float to signal to the tug pilot house.

Here is another instance of objectionable dual control which goes far to destroy the ordinary operating advantages of eliminating engine room control. Such an unfortunate situation is avoided by placing the propelling and steering controls in the wheelhouse of the float, where a perfect view of the docking operation is obtainable.

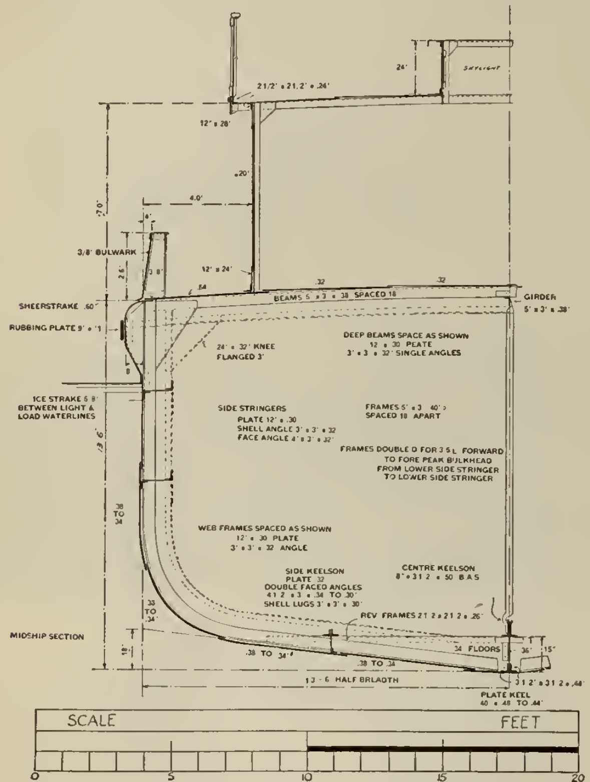

Fig. 3.—Half Section of Tug.

The new equipment has accordingly been designed, built and equipped along these lines under the direction of Mr. M. McD. Duff, manager of the Great Lakes Steamship Department of the Canadian Pacific Railway, with the valuable co-operation and technical assistance of officials of the New York Central Railroad and of the Canadian Pacific Railway, joint owners of the operating company.

The tug *Prescotont* was built by the Davie Shipbuilding and Repairing Company, Ltd. of Lauzon, Que., the keel being laid on June 30th, 1930. The vessel was delivered ready for service after completion of satisfactory trials on October 10th.

The carfloat, named the *Ogdensburg*, was built simultaneously at the Lorain plant of the American Shipbuilding Company, and was one of the first vessels to pass through the new Welland canal, the hull being too large to pass through the old canal.

Both vessels have been built to the requirements of Lloyd's Register of Shipping with a view to all-year-round service. Particular care has been devoted to the design of the tug for ice-breaking, the lines and framing being determined accordingly, with an ice-belt of heavy plating fitted at the waterline. The forward and after peak tanks are interconnected and arranged to supply engine circulating water, in case frazil ice interferes with the entry of cooling water from the river.

The main propulsion motor drives a nickel steel propeller through a Michell patent thrust block.

The principal dimensions of the tug are as follows:

Length	117 feet
Breadth	27 feet
Depth moulded	13 feet 6 inches
Draught—extreme	12 feet
S.H.P.	800

A complete fire-fighting installation has been provided, comprising three stand pipe connections on the main deck, and a monitor mounted on the top of the pilot house.

The crew accommodation is to a high standard of comfort and includes a large dining saloon, panelled in oak, and the forward under deck crew space is entered by a stairway from this room, thus eliminating outside companionways.

The culinary arrangements have received special attention and the galley is complete with a cold store, cooled by a Frigidaire unit.

While advantage has been taken of the valuable experience gained by the New York Central Railway, the equipment described has been developed beyond previous marine practice, and in addition departs in many minor respects from New York harbour practice.

Neither sleeping nor messing accommodation is provided in the New York tugs, the crews working double shift, and living ashore, but in the case of the *Prescotont*, the conception that unforeseen circumstances might require the tug being used for some other purpose, necessitated arrangements being made for independent operation, so that while the actual service in which the equipment is at present engaged permits the crew to live ashore, complete sleeping, culinary and messing arrangements have been incorporated with the result that it is probably the most powerful and completely equipped Diesel electric tug on the American continent.

That such a vessel was the first of its kind to be built in Canada, and was built in record time, is a tribute to the Canadian shipbuilding industry, although it must not be ignored that the machinery was manufactured in the United States.

The principal particulars of the carfloat *Ogdensburg* are:

Length	290 feet
Breadth	45 feet
Depth	12 feet 6 inches
No. of tracks	3
Capacity	18 railroad cars

It is designed on a combined transverse and longitudinal system of construction, fitted with a belt of ice plating of extra thickness, and is subdivided into no less than thirteen watertight compartments. The equipment includes two large balanced rudders, operated by an electric steering gear, and two electric capstans for handling anchors and for warping purposes.

A feature of the float, however, is the navigating bridge and the dual controls which are installed and enable the captain to operate the propelling and steering machinery of the complete unit of tug and float from this position.

To facilitate operation at night, both vessels are equipped with searchlights and floodlights in addition to the usual electric illumination along ordinary lines.

It will be obvious, from the fact that the tug was built at Lauzon, Que., the float at Lorain, Ohio, the Diesel engines in Cleveland, Ohio, the electric generators at Schenectady, N.Y., and the electric auxiliaries at Superior, Wis., all for service at Prescott, Ont., and to suit existing landing aprons and piers, and involving many features entirely novel, that very careful and systematic consideration of the various details was involved.

A winter's operation has been completed, and during this period the tug was used as an icebreaker and when

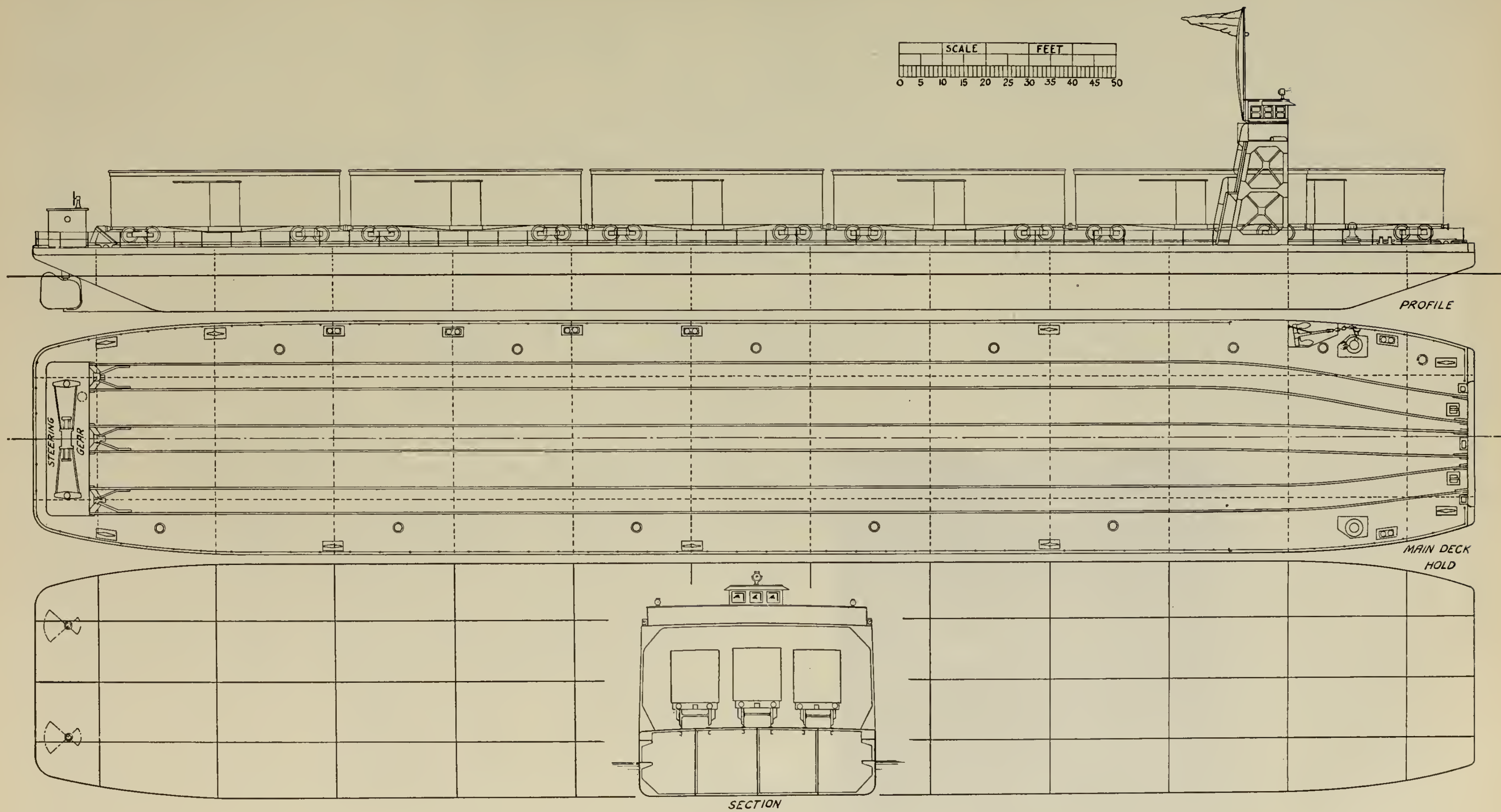

Fig. 4—Car Float *Ogdensburg*

released from the carfloat it cleared the channel for navigation. Due to the flexibility of control and the ease of manœuvring, considerable saving was realized in the performance of these duties compared with former practice.

While actual comparative costs of operation for the Diesel-electric tug against former operation of the steam ferry are not available at this time, it may be stated that sufficient saving has been effected with the new equipment to warrant the capital expenditure involved.

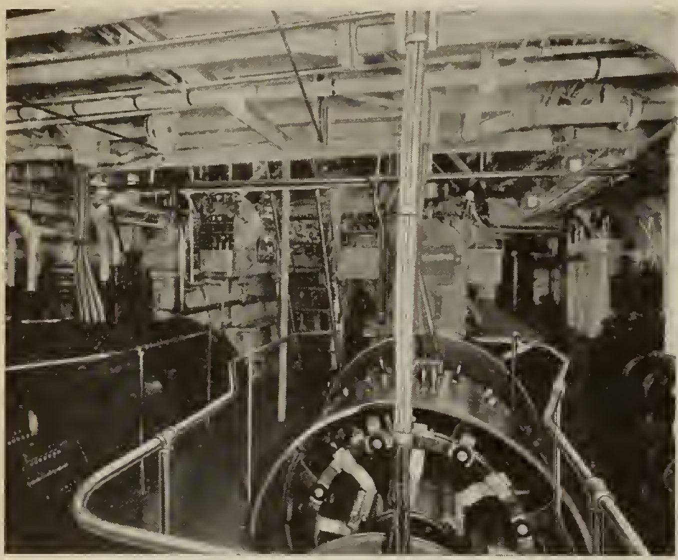

Fig. 5—Engine Room of Tug, showing Generators and Diesel Engine.

Description of Electrical Equipment on Tug and Carfloat

The propelling machinery comprises two Diesel engines of 500 h.p. each, direct connected to two main direct current generators of 330 k.w. each, and to two auxiliary direct current generators of 50 k.w. capacity each. The main generators are normally operated in series, and supply current at 500 volts to the double unit propulsion motor of 800 h.p. which is direct connected to the propeller shaft. The auxiliary generators are used for excitation of the fields of the main generators and of the propulsion motor, and have sufficient capacity to supply requirements for lighting and for the various engine room auxiliaries.

The control of the propulsion motor is of the variable voltage type and variation in speed of this motor is obtained by increasing or decreasing the strength of the fields of the main generators, and consequently the voltage generated. Variation in the motor torque at any given voltage is accomplished by adjusting the strength of the motor fields.

The above is a general outline of the main propulsion equipment, and before enlarging on the method of operation or describing auxiliary equipment, a brief general outline of the Diesel-electric drive will be given.

The motor lends itself ideally to a propeller drive. The speed and torque can be readily adjusted to suit operating conditions and the change of direction from full speed ahead to full speed astern can be accomplished in twelve seconds. The revolution characteristic of the type of motor used for propelling is nearly constant with constant field and voltage supply. This feature prevents racing of propeller in rough weather, and provides high average speeds under all conditions.

Latitude of Power Application and Control

One of the principal advantages of the Diesel-electric drive, and one on which particular stress should be laid, is its ability to develop and apply full power to the propelling shaft at various propelling speeds. The Diesel engines and generators operate at all times at constant speed, and in one direction. The main generators are separately excited from the auxiliary generators. The main generator voltage is varied by varying the field excitation by controllers located at the point from which the vessel is manœuvred. This control accounts for the variation of voltage applied to the propulsion motor, and with constant field excitation on this motor, the revolutions vary practically with the applied voltages. The armature current of the propelling motor at any given voltage may be varied by adjusting its field strength, thereby varying the motor torque practically directly as the armature current. The main generator field control rheostats are located in each of the positions from which the vessel is to be manœuvred. As the controlling circuits handle only small values of current the actual control system is very simple and flexible and the manœuvring of the vessel can be accomplished from any one of several positions, such as engine room, pilot house, etc.

Propulsion and Control Equipment of Tug *Prescotont*

The two main generators are of special marine design, 330 k.w., 250 volts, 245 r.p.m., separately excited. They are the self-ventilated type and provided with shields for protecting current-carrying parts from dripping water. The temperature rise guaranteed was 40 degrees C. for all parts with exception for commutator which was 45 degrees. Acceptance tests were carried out at the manufacturers' factory and included mechanical balance, regulation, high potential and adjustment for commutation. The main generators as already mentioned are normally operated in series to provide 500 volts to the propulsion motor. The two auxiliary generators are 50 k.w. capacity, 120 volts, and of same general design as the main generators. They are used to excite the fields of main generators, and propulsion motor, to supply lighting and to operate the various engine room auxiliaries. One main and one auxiliary generator are direct connected to a 4-cycle, airless injection Diesel engine, having six cylinders, 15-inch bore by 22-inch stroke, developing 500 b.h.p. at 245 r.p.m.

The main propelling motor is shunt wound with interpoles, semi-enclosed, with capacity to deliver 800 h.p. continuously to propeller shaft at any speed from 105 to 135 r.p.m. This motor is of the double unit type, consisting of two separate motors on the same base with their armatures mounted on the same shaft, and with the commutators outward. Connections from each motor are made at an accessible place to a series of links which permit readily disconnecting of one motor so that operation can be carried on with the other. The bearings are of the ball seated, or self-aligning type, split through the horizontal diameter and lined with a high grade babbit. They are lubricated with flood disc and wiper. The double unit type motor has the advantage of smaller diameter than the single motor for the same output and consequently is attractive with a limited depth of hull.

The space between the two frames is enclosed and is connected to a ventilating duct by which air is forced through the motor by means of a conoidal fan, capable of delivering 6,100 c.f.m. at 2.1 static pressure and driven by a 5-h.p., 850-950-r.p.m., 115-volt, shunt wound motor. The starter of this motor which is of the magnetic type is so connected as to start or stop its motor automatically in accordance with the operation of the main motor. It is of the same general design as the main generators.

The free end of the motor shaft has a small speed-indicating generator direct connected, indicating the r.p.m. of the propeller, by means of suitably calibrated voltmeters located on the engine room control panel, and on the pilot house instrument panel.

The general principles of control have already been explained. The tug and the carfloat can be manœuvred from one of three stations, i.e. the engine room, pilot house of tug and bridge of carfloat. One of the features of the control system is the interlocking arrangements to prevent interference from one point while operation is in hand at another point.

The engine room control equipment consists of three switchboard panels of the dead front type, one for each main generator and one for propulsion motor. The engine room control station is mounted on the motor panel. The switchboard has two additional panels, one for the axuiliary generators and the other for distribution circuits. Each main generator panel contains voltmeter, ammeter, field rheostat and main switch operated by hand wheel. This is a triple pole three-position switch, and a drum switch, both operated by a pinion rotated by the hand wheel shaft. The three positions of switch are "fire pump," "off" and "propulsion." A lever is provided for the purpose of interlocking between the main and fire pump circuits, in such a manner that the main switch cannot be operated unless the respective fire pump switch is in the "off" position, and so that the fire pump switch cannot be thrown to the "propulsion" position unless its main switch is in the "propulsion" position, and cannot be thrown to the "fire pump" position unless its main switch is in the "fire pump" position. The propulsion motor panel contains voltmeter,

While control from the engine room is obtained by a hand wheel mounted on the main motor panel, the other two stations are equipped with pedestal type controllers. Duplicate controllers mechanically connected are provided for each station so that operation can be carried on from either port or starboard side. These controllers are equipped with separate levers for control and reverse, and so interlocked as to make it impossible to bring the control lever from full ahead to full reverse without stopping at the neutral position and throwing the reverse lever.

The Method of Operation

1. The operating station is first selected by moving the transfer switch in the engine room to "engine room," "tug" or "float."
2. Turn the main switches on the generator panels to "propulsion."
3. Move control switches which complete the field circuit to "propulsion" position.

The tug can now be operated by moving the controller at the operating station, from the "off" to the "ahead" position. The generator field strength is gradually increased, increasing the voltage applied to the motor and hence the speed of the tug. When the controller is moved

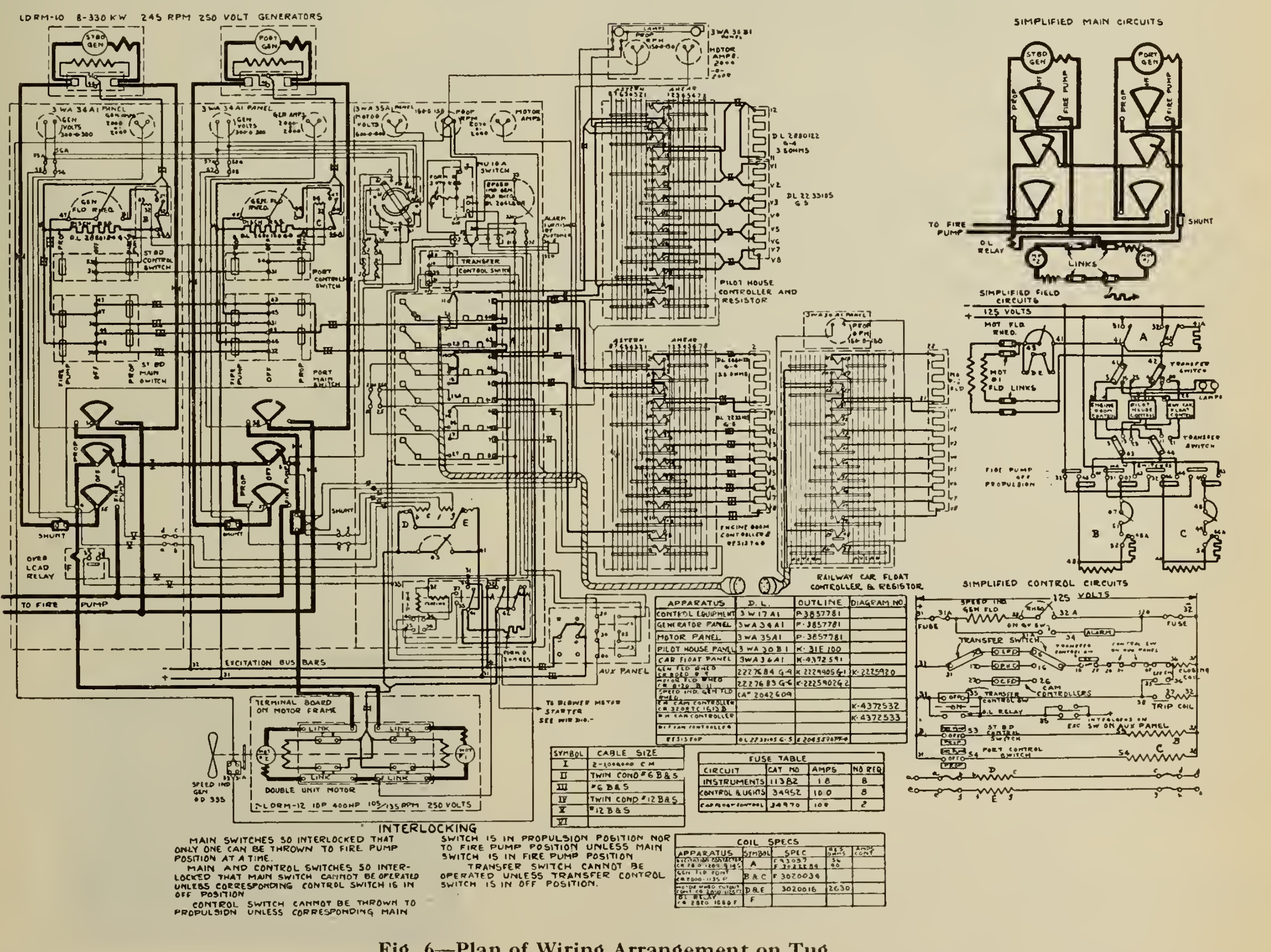

Fig. 6—Plan of Wiring Arrangement on Tug.

ammeter, propeller speed indicator, ground detector with alarm bell, control transfer switch, transfer switch, motor field rheostat and hand wheel for engine room control station.

The transfer switch which selects the point where manipulation will be carried out cannot be operated nor can the main generator switches be operated unless the control transfer switch is in the "off" position, at which time main generators fields are open.

to "astern" position the generator field is reversed and hence the polarity of the main motor.

The pilot house has a small panel equipped with meters showing the output in amperes (full load being 1,320 amperes) and the r.p.m. of the main motor.

The various circuits for propulsion control, power and light circuits and steering control on the carfloat, are brought from the main switchboard to a series of receptacles mounted on the side of the tug, and are connected to corresponding receptacles mounted on steel framework on the carfloat by flexible "cab type" rubber covered jumpers with suitable plugs at each end. The receptacles are polarized and identified to ensure proper connections.

A Hill Diesel 10-k.w., direct-connected, 125-volt, direct-current generator is provided for lighting at times when the main generators are shut down. The air compressor motor

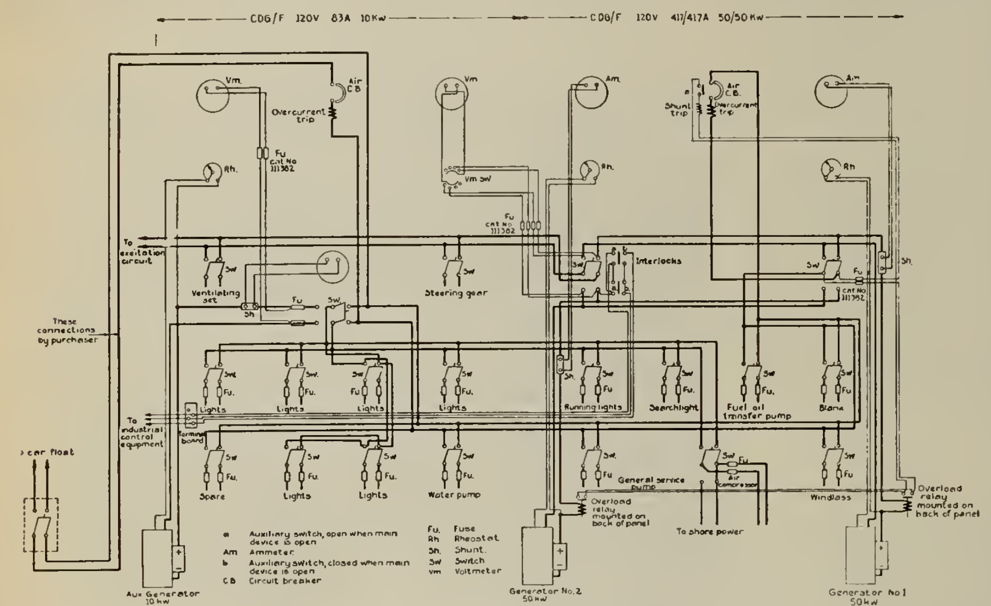

Fig. 7—Switchboard Wiring on Tug.

is connected to this set making it possible to attain full pressure of compressed air prior to starting main engines. It also feeds the motor of the oil burning apparatus for the heating system. To avoid the necessity of operating this set at light load when tug is docked a shore circuit was provided for lighting circuits and heating motor, controlled by a double-throw switch.

The fire pump has a capacity of 500 U.S. gallons per minute against a total head of 150 pounds per square inch. This pump is of the centrifugal type and direct-connected to a 75-h.p., 1,700-r.p.m., 230-volt, compound wound motor.

Various auxiliary equipment besides that already mentioned is provided in the engine room of the tug, such as air compressor, water circulating pump, general water service pump, oil transfer pump, centrifuge pump, each driven with a separate motor of suitable design.

The anchor winch on tug is driven by a 15-h.p. motor, whereas the one on carfloat is equipped with a 25-h.p. motor. They are controlled by pedestal type controllers and protected by overload relays. The motors are specially built for marine service, being totally enclosed, and designed to resist the entrance of water, even if submerged for a short period. They are located in water-proof compartments beneath decks.

Electric Steering System

The tug is equipped with a single rudder and the carfloat with twin rudders. The electric steering system is the Benson electric "steermotor" type with follow-up control.

By means of a throwover switch in the pilot house of the tug, the rudders of both tug and float can be controlled from either position, or the steering gear of the float can be cut off and the tug rudder only controlled. It is not possible or advisable, however, to cut out the steering control of the tug. When the tug and float are arranged for common steering, interference at poisition No. 1 when manœuvring is controlled from position No. 2, is rectified automatically by the follow-up feature, which causes controller of position No. 1 to return to a position corresponding with controller at station No. 2.

In the event of loss of power on steering motor circuits a large alarm bell is sounded in the engine room.

Limit switches are located on the port and starboard end of rudder quadrant on the tug. The Benson control cuts off the steering power one degree ahead of the limit switches, and the limit switches in turn operate one degree ahead of the rudder stops. The car float rudder being twin type the limit switches are operated by a travelling nut on the worm drive. The opening of a limit switch opens the contactor on the main propelling motor circuit. The motors on the steering equipment are 15 h.p. capacity.

When the tug and float were first placed in service a system of careful regular periodic inspection of the electrical equipment was inaugurated. This inspection is made in detail and includes the electrical installation in its entirety. The results are recorded on an ample report sheet and note made of any repairs or adjustments which are carried out and any occurrences of interest pertaining to operation of equipment since the last inspection are noted also. This procedure was taken as a precaution against unforeseen troubles which might develop in the installation. At first these inspections were made weekly, but it soon became apparent that bi-monthly periods would be ample, as no particular attention was found necessary with the exception of adjustments to limit switches and the odd contactor.

The docking of the tug and float at both sides of the river requires considerable careful manœuvring, involving

Fig. 8—Electric Connections Between Tug and Float.

frequent changes of direction and speed, accompanied by rapid variations of load on the propelling motor, but from the start of operations very little difficulty was experienced by the crew in handling the craft, although it was their first experience with this type of drive.

The performance of this unit under fair or adverse weather conditions has been entirely satisfactory.

Discussion on "Secondary Stresses in Bridge Trusses"

Paper by S. Hogg, A.M.E.I.C.[1]

C. W. Deans, s.e.i.c.[2]

Mr. Hogg, in the first paragraph of his article, stated "This article is presented with the hope that it will interest the younger members of the profession and perhaps induce them to reciprocate in the interchange of professional knowledge, which is a function of The Journal." This article has interested the writer, a younger member, and has induced him to write the following discussion.

It is the object of the writer to indicate how the moment distribution part of the computations may be considerably shortened.

The first apparent way to reduce the arithmetic operations is to use distribution-carryover factors and record in the body of the table only the carryover moments and unbalanced moments as indicated in Table A, which is a modification of the Joint 1, part of the author's Fig. 4.

Table A

Joint	1		
Member	1-3	1-2	U.M.
k	7.64	6.57	
D.F.(%)	53.7	46.3	
(D.F.) (C.O.F.)	26.9	23.1	
F.E.M. (Original)	+15700	+18070	+33770
C.O.M. 1	− 7197	− 6875	−14072
C.O.M. 2	+ 3222	+ 2871	+ 6093
C.O.M. 3	− 1306	− 1144	− 2450
C.O.M. 4	+ 571	+ 490	+ 1061
Sum of U.M.'s	−13100	−11302	+24402
Final Moments	− 2110	+ 2110	

(1) This paper was published in the October, 1932, issue of The Engineering Journal.

(2) Graduate assistant in civil engineering, Iowa State College, Ames, Iowa.

The writer finds that the computations can be reduced beyond that indicated in Table A by keeping on the alert, as joint releasing proceeds, to release joints of largest unbalance first. This tends to bring the structure into moment equilibrium sooner. The consequent reduction in labour due to this modification is more appreciated the greater the number of joints and number of unsymmetrical loading conditions to be considered. In this particular case, considering the results in Fig. 5, the writer made a reduction from 91 addition operations to 67 and from 35 distribution operations to 22 and eliminated the 102 individual carryover operations altogether.

It is well to note that this method of computation reduction makes the physical conception of releasing the joints in the order of their unbalance more vivid and more appreciated.

The author is to be commended highly on the arrangement of computations in Fig. 4; it is a good idea to visibly record the unbalanced moments.

In some cases, when there are a great number of joints and different loading conditions it will often be found economical to write the carryover moments on the truss outline and to make a separate table of the successive unbalanced moments only. This, however, is probably a matter of taste.

It should be pointed out that this method of computation reduction by releasing joints of greatest unbalance first, may be very economically applied to the study of stress distribution in multistorey building frames, continuous viaducts, girders and beams and various many-jointed framed structures where structural continuity is the true condition.

The writer has found that it is sometimes possible to so predict joint rotations that the initial unbalanced moments will be considerably reduced and believes that all structural analysts should try to develop skill at deflection and rotation prediction. In connection with the secondary stresses in bridge trusses it is possible to reduce the initial unbalanced moments considerably by artificially holding the joints so that the chord members at any joint make equal angles with straight lines connecting the chord joints in their deflected position, as calculated or graphically determined on the assumption that the members are connected by frictionless pins.

An Engineer's Conception of Matter and Its Application to Materials of Construction

Group Captain E. W. Stedman, M.Inst.C.E., M.E.I.C., F.R.Ae.S., A.R.C.Sc., etc.
Chief Aeronautical Engineer, R.C.A.F., Department of National Defence, Ottawa, Ont

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SUMMARY.—This paper is intended to explain for the benefit of engineers some of the fundamental ideas regarding the constitution of matter, and particularly the structure of metals, which have been developed as a result of recent investigations. These researches have thrown new light upon many of the properties of materials used in engineering construction.

I.—Introduction

Most engineers have a sound working knowledge of the handling of materials of different kinds, and of their properties, and make use of these well-known properties. If, however, the engineer attempts to explain any of these properties he frequently finds that his training has not equipped him with an acceptable explanation.

In recent years much work has been done towards explaining these properties, but this work is dealt with in the specialist works of chemists, physicists and metallurgists, and is usually not easily available for the engineer, involving as it does a great deal of reading and investigation.

The types of questions referred to are:—

(1) Duralumin if heated to about 500 degrees C. and quenched is soft, but with time and in some instances with slight heating it hardens. Why?

(2) Pure copper is an excellent electrical conductor, but its resistance is greatly increased by the addition of a small quantity of impurities. Why?

(3) If a small quantity of one metal is added to a second metal, the melting point of the alloy so formed is usually lower than the melting point of the second metal, but may be higher. Why?

In preparing this memorandum the object has been to give by easy stages a theoretical explanation of as many phenomena as possible. At each step it is realized that many alternative explanations can be put forward by the specialists. These alternatives have been purposely avoided in order to avoid confusion.

The author appreciates that he will be accused of inaccuracy or misstatement, but if the memorandum gives to those engineers who have not the time or opportunity to study the books referred to, a working idea of the trend of modern investigations, its purpose will have been achieved.

For the reader who wishes to pursue the subject further, the two books, "Introduction to Physical Chemistry," Maass and Steacie, "The Science of Metals," Jeffries and Archer, which have been largely consulted and quoted, are strongly recommended.

The author wishes to express his appreciation of the assistance and kindly criticism given by Professor Sproule, of McGill University, and Dr. Boyle and his associates of the National Research Council, Ottawa.

II.—The Atom

(References:—"Modern Scientific Ideas," by Sir Oliver Lodge; "X-ray Past and Present," by Pullin and Wiltshire; "Metals and Metallic Compounds," Vol. I., by Evans; "Science of Metals," by Jeffries and Archer; "Introduction to Contemporary Physics," by Darrow.)

The *atom* is wholly composed of electricity. It is a grouping of electrons and protons and consists of nothing else. A proton is much heavier than an electron (1,850 times) and carries a positive charge of electricity, the electron carrying a negative charge of electricity. The atom can be considered as a heavy centre or nucleus surrounded by what might be called a miniature solar system of electrons.

The nucleus consists of a number of protons interleaved with a number of electrons, but as there are fewer electrons than protons the nucleus as a whole is positively charged. The number of excess protons in the nucleus is equalled by the number of planetary electrons outside the nucleus.

It is essential to obtain an idea of the small size of the atoms and of the electric charge carried by the electrons and protons; 250,000,000 atoms in a row would be about an inch; 100,000 electrons in a row would stretch something like an atom. It is also necessary to appreciate that the atom is mainly space. If the atom were magnified to the size of a cathedral each component electron would be something like the size of a gnat. The mass of an electron is about 9×10^{-28} grams, and its electrostatic charge is 4.77×10^{-10} electrostatic units.

At this stage it might seem desirable to indicate by a sketch the construction of an atom, but it seems to be impossible to represent the atom due to its dynamic rather than the static nature.

It is known, however, that the central nucleus is surrounded by a collection of orbits, in each of which an electron is or may be revolving. These orbits may be circular or eccentric elliptical orbits reaching out to quite a distance from the nucleus.

The elements can be considered as being made up of various kinds of atoms differing only in so far as the number of electrons and protons is concerned. Some reserve must, however, be made upon the character of a nucleus in the hydrogen atom. The atom is, therefore, the smallest possible unit of an element, and excepting the atoms of the so-called radio-active elements it is extraordinarily stable, passing from one state to another, or combining with other elements, but always retaining its identity as the atom of an element.

Starting at the lighter elements, omitting hydrogen, the first is helium, which is known to be inert. It does not like combining with other elements. The helium atom is found to contain a nucleus with two electrons circulating around it. From the known properties of helium it is deduced that this system consisting of the nucleus with two electrons is very stable.

The next element is lithium which has a nucleus and three planetary electrons. It is known that the helium atom with two electrons is inert. Therefore, it can be expected that the lithium atom would have one electron too many to be itself inert. This is exactly borne out by the action of lithium, which always tends to combine its one extra electron with another system.

Other elements follow lithium, but it is better at this stage to consider another type of element, i.e., the element which is short of its supply of electrons. Fluorine is an example. This element has a nucleus and nine planetary electrons. It is known that two electrons form an inert body, and it is found that if the system has an additional system of eight electrons as in neon the result is another inert body. Therefore, fluorine having only nine planetary electrons is short by one electron of becoming inert. Fluorine can, therefore, be regarded as seeking continually that extra electron. Sodium like lithium, has one excess electron, having a nucleus and eleven planetary electrons.

Sodium having eleven planetary electrons, the system can be assumed to be built up of inner orbits carrying two electrons, followed by larger orbits carrying eight electrons, finally one solitary electron in a still larger orbit.

The fluorine atom can be considered as consisting of the nucleus with two electrons in the inner orbits followed by seven electrons in the next system of orbits. This would be a closed and inert system if it were not for the lacking electron. It can, therefore, be predicted that the sodium atom and the fluorine atom will combine to form a compound NaF, in which the extra electron of the sodium atom fits into vacant space in the fluorine atom. It will be seen later when considering electrical conductivity that this compound could also be predicted to be a non-conductor, because in the crystalline state it has no excess electrons. Actually NaF is a crystalline solid, which is a non-conductor and has a high melting point.

It has been seen that starting with the inert gas helium and adding electrons a series of elements is built up which finally again become inert when a total of ten electrons is reached, which form a closed system and exists as the inert gas neon. Starting from neon and adding electrons another series of elements is built up which finishes with a total of eighteen electrons arranged as (2, 8, 8) in the inert gas argon. Similarly starting from argon and adding electrons a long series of elements is built up ending with thirty-six electrons arranged (2, 8, 8, 18) in the inert gas krypton.

Similarly starting from krypton and adding electrons another long series of elements is built up ending with a substance with the electrons arranged (2, 8, 8, 18, 18, 32) which is niton, the first product of disintegration of radium. Similarly, starting from niton and adding electrons the elements of the radium thorium and uranium series are built up. This series is not complete, and is composed entirely of elements which are continually decomposing.

By arranging the elements in the manner indicated the "periodic table" (Fig. 1) of the chemists is produced. Those elements having no free electrons are the inert gases. Those elements having one excess electron form the potassium group. Those elements having two excess electrons form the calcium group. Those elements lacking one electron form the chlorine group, and those lacking three electrons form the nitrogen group. A typical abridged periodic table is shown in the attached figure.

It will be found that by regarding elements in the manner indicated, a good understanding can be obtained for the reasons why certain elements of vastly different atomic weights have similar properties.

It is particularly interesting to find that other properties such as melting points, coefficients of thermal expansion, etc., vary periodically in accordance with the grouping found in the periodic table.

The atomic weights of the elements increase continuously through the periodic table, with the exception of some pairs of elements such as argon and potassium, in which the element with the greater atomic weight is placed before the other. The positions given to these elements can, however, be checked by the curious fact that the square root of the frequency of any particular X-ray line obtained with different elements, follows a straight line law, without any periodic variation as found for other physical properties.

The various properties of the elements can be considered as being related as follows:—

(*a*) Radio-activity and mass as related to the nucleus.
(*b*) X-ray spectra to the inner electrons.
(*c*) Periodic properties such as valency and optical spectra to the outer electrons.

III.—Gases, Liquids and Solids

(References:—"Introduction to Physical Chemistry," by Maass and Steacie; "Metallography," by Tammann, translation by Dean and Swenson.)

Gases

A useful way of regarding a gas is as follows:—

It is assumed to be composed of molecules. The molecule can be regarded as a collection of atoms arranged in the manner previously described, that is, if the gas is an inert element the molecules are single atoms; otherwise the molecules consist of two similar atoms such as O_2, N_2, etc., or the requisite number of atoms of dissimilar elements to form a stable molecule as H_2O, CH_4, etc. It is also of assistance to think of the molecule as behaving like a perfectly elastic sphere.

The molecules themselves are in continual motion in all directions and obey Newton's Laws of Motion. The pressure which the gas exerts on the walls of the containing vessel is due to the hits recorded by its moving molecules. The temperature of a gas is a measure of the kinetic energy of the molecules.

Boyle's Law

If the *temperature* of the gas is kept constant and the volume is decreased, the number of molecules per unit volume is increased, and the number of impacts in unit time is increased. The pressure is, therefore, increased. If the *volume* is kept constant and the temperature is increased, the average energy or velocity of the molecules is increased, and the force with which they strike the wall, i.e., the pressure, is increased. If the *pressure* is kept constant and the temperature is increased, the average velocity of the molecules is increased and, therefore, fewer hits are necessary to maintain the same pressure. In order to satisfy this condition the volume must increase.

PERIODIC TABLE. (abridged)

0	IA.*	IIA.†	IIIA.	IVA.	VA.	VIA.	VIIA.	Transition Elements.			IB.	IIB.	IIIB.	IVB.	VB.**	VIB.	VIIB.††	0
2	3	4	5	—	—	—	—	—	—	—	—	—	—	6	7	8	9	10
He	Li	Be	B	—	—	—	—	—	—	—	—	—	—	C	N	O	F	Ne
10	11	12	13	—	—	—	—	—	—	—	—	—	—	14	15	16	17	18
Ne	Na	Mg	Al	—	—	—	—	—	—	—	—	—	—	Si	P	S	Cl	A
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Kr	Rb	Sr	Y	Zr	Nb	Mo	—	Ru	Rh	Pd	Aq	Cl	In	Sn	Sb	Te	I	Xe
54	55	56	57	58	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Xe	Cs	Ba	La	Ce	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	73	74	75	76	77	78	79	80	81	82	83	84	85	86
—	—	—	—	—	Ta	W	—	Os	Ir	Pt	Au	Hq	Tl	Pb	Bi	Po	—	Nt
86	87	88	89	90	91	92	—	—	—	—	—	—	—	—	—	—	—	—
Nt	—	Ba	Ae	Th	VX2	V	—	—	—	—	—	—	—	—	—	—	—	—

* Potassium group. † Calcium group. ** Nitrogen group. †† Chlorine group.

Fig. 1

We know that Boyle's law only applies to an ideal gas, and at low pressures, because it has been assumed that the molecules themselves have a negligible volume, and that they have no influence on one another. The changes due to these additional factors can be made and result in Van der Waal's equation.

Van der Waal's Equation

If the molecules have a finite volume then the space available for molecular motion is not the volume of the container V, but is the free space $(V - b)$ where b is the volume of the molecules themselves. As the pressure increases, or as the temperature decreases, the volume of the molecules becomes greater and greater compared with the free space available for molecular motion. Consequently the error due to neglecting the volume of the molecules becomes greater as the pressure is increased, or the temperature is decreased.

A molecule colliding with a manometer for measuring pressure is necessarily on the surface of the gas body. It is, therefore, subjected to a resultant inward force due to the lack of attraction of gas molecules on the wall side, and consequently on moving upwards towards the manometer it must have its velocity diminished.

The pressure recorded on the manometer is, therefore, due to the impacts of molecules with a kinetic energy less than the average kinetic energy of all the molecules in the gas. It follows that the actual pressure due to molecular movement in the body of the gas is greater than that recorded on the manometer. The value of P used in the ideal gas law must, therefore, be increased by an amount to account for this difference in pressure, and this extra amount can be assumed to be approximately equal to a/V^2 where "a" is a constant. The gas equation can, therefore, be written $(P + a/V^2)\ (V - b) = C$. This is called Van der Waal's equation. When the pressures are very low V is large, and a/V^2 and b become negligible, the gas then obeys the ideal gas law.

Gases at High Pressures

When gases are subjected to high pressures the molecules are brought very close to one another so that the volume of the molecule and the laws of force governing molecular attraction may be altered. These effects are of small importance up to pressures of say 50 to 100 atmospheres, but eventually they make themselves felt and Van der Waal's equation does not hold.

We also know that by increasing the pressure and decreasing the temperature all gases can be liquefied. There is, however, a critical temperature above which increase in pressure does not cause liquefaction, but instead there remains a dense gas which would expand on release of the pressure. There is so little difference between the gas and the liquid in the neighbourhood of the critical temperature that experiments to determine this temperature depend upon the recognition of the meniscus separating the gas and the liquid in order to determine when liquid begins to form.

The Liquid State

As it is possible for substances to pass from the gaseous to the liquid state and vice versa without any abrupt changes in properties, it follows that there cannot be any very great difference between a liquid and a gas at high pressure. The liquid is very much denser than a gas at atmospheric pressure, yet it is composed of the same sort of molecules from which it follows that in the liquid these molecules must be much closer together.

This proximity of the molecules has an important bearing on the factors which caused the departure from the ideal gas laws, namely, the volume of the molecules and their attraction for one another. In fact the molecular attraction has reached such a large value in the case of liquids that the forces between the molecules tending to hold them together are sufficiently strong to overcome the repulsion between them, due to the kinetic energy or "bounce," and the liquid does not tend to expand as did the gas. The molecules are, therefore, no longer able to escape from one another and liquids thus have a definite volume.

Surface Tension

As a liquid has a definite volume it can be contained in a hollow vessel with a free surface. Molecules situated in the mass of the liquid, therefore, will be subjected to attractive forces equal in all directions, and will move about and possess kinetic energy just as a gas molecule does. This is not true, however, for a molecule at the surface of the liquid where there are more molecules within its sphere of attraction below it than there are above it. Its motion parallel to the surface will not be affected, but its motion upwards will be diminished and its motion downwards increased. All the molecules in the surface of the liquid are, therefore, under a downward force due to molecular attraction. This downward force at the surface gives rise to the property of the liquid known as "surface tension," due to the molecules trying to squeeze themselves into the liquid.

Vapour Pressure—Latent Heat of Evaporation

We know that a liquid exists in equilibrium with its vapour, and this condition can be explained by the same sort of reasoning. The molecules in the liquid move about with average velocity, depending on temperature. The condition which prevents the escape of a molecule moving in a direction perpendicular to the surface is that its kinetic energy is less than the work which must be done in order to pull it out of the region of attractive forces. At any temperature the molecules have a certain average velocity, but there will always be a certain number of molecules which have higher velocities, sufficient to allow them to escape. If the liquid and its vapour occupy a closed vessel, any molecule which escapes from the liquid increases the pressure of the vapour in the space above the liquid. This will result in an increased number of molecules finding their way back again into the liquid, so that eventually for a given temperature an equilibrium pressure will be reached when the number of molecules leaving the liquid is equal to the number returning to it. This definite pressure is known as the "vapour pressure."

If the vapour molecules instead of being confined are allowed to escape, more molecules will leave the surface of the liquid carrying energy away with them and, therefore, the temperature of the liquid will be lowered. The heat required to replace this cooling effect is called the "latent heat of evaporation."

The Solid State—Latent Heat of Solidification—Freezing Point—Raising of Freezing Point by Pressure

When a liquid is cooled contraction occurs due to the increased predominance of molecular attraction as the kinetic energy of the molecules decreases. A temperature must, therefore, be reached where the free motion of the molecule in all directions ceases. This is a definite temperature for every substance, and is known as the "freezing point."

Consider two neighbouring molecules in the body of a liquid. Suppose that on cooling the liquid these molecules are brought together by its contraction, and take up the position in which their forces of attraction for one another are most pronounced. If now the energy which they possessed due to relative motion and rotation is subtracted they will be left in a permanent fixed position relative to one another. The "latent heat of solidification" is the heat which must be extracted at constant temperature in order to bring about this solidification.

The sharply defined freezing temperature is due to the fact that there is a definite degree of proximity necessary to cause the adhesion of the neighbouring molecules. The position assumed by the molecules is that of definite maximum attractive force, and other molecules add themselves to the nucleus thus formed in a definitely arranged manner. This arrangement is manifested by the crystalline form of the substance.

The molecules have now lost their freedom of motion and rotation, but they are left with the energy due to the vibration of the atoms relative to one another. The identity of the *molecule* is now lost, and the solid can best be regarded as being composed of *atoms* arranged in a definite and orderly manner. It should be pointed out that all solid substances are crystalline, but some substances having the appearance of solids may be very viscous liquids.

Increase in pressure increases the temperature at which a metal becomes solid on cooling, or becomes liquid on heating. This is due to the fact that the higher pressure causes the atoms to approach one another sufficiently closely for solidification at a higher temperature than would be the case under normal pressures. Bismuth and antimony are exceptions, having lower melting points at higher pressures. Most metals expand on melting, but bismuth and antimony contract on melting.

These phenomena can be more easily understood by considering the equilibrium diagram for an ideal substance, showing the variation in state with temperature and pressure (Fig. 2).

The curve *ABC* represents the boundary between the vapour and solid and liquid, and the curve *BDE* represents the boundary between the liquid and solid.

For molten metals at atmospheric pressure the condition is represented by the point *F*. Any increase in temperature necessitates an increase in pressure in order to produce solidification. At a point *D* there is a maximum temperature for solidification. For increased pressures beyond this point it is necessary to reduce the temperature in order to produce solidification.

At the point *D* there is no change in volume in solidification; for higher pressures there is an increase in volume, and for lower pressures there is a decrease in volume on solidification. Bismuth falls in the region *DE* at atmospheric pressure.

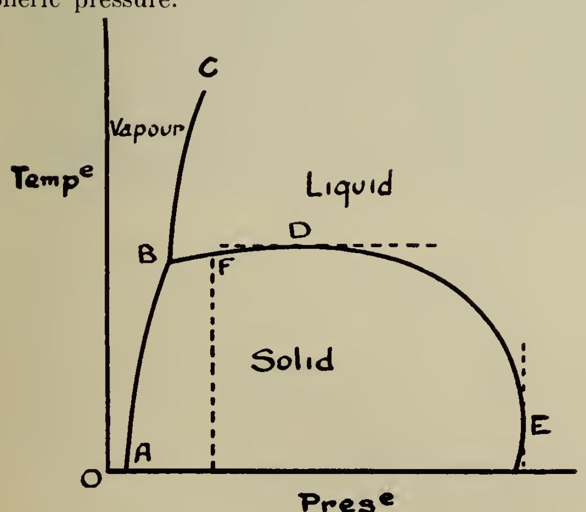


Fig. 2

At some point such as *E* there is a maximum pressure beyond which solid metal cannot be obtained. This point *E* corresponds with the point of no latent heat of solidification.

With metals, the changes in melting point produced by any pressure likely to be met in practice are so small as to be negligible.

Under conditions usually met in nature increase in pressure lowers the freezing temperature of water. This has important applications in such things as the movement of glaciers, in skating, etc. At very high pressures, however, increase in pressure raises the temperature of the freezing point again. These anomalies are due to allotropic changes which occur under different conditions.

IV.—The Crystalline Structure of Metals

(References:—"Science of Metals," by Jeffries and Archer; "X-rays Past and Present," by Pullin and Wiltshire; "X-rays and Crystal Structure," by Bragg and Bragg.)

The application of X-ray analysis has enabled the crystal structure of substances to be investigated and

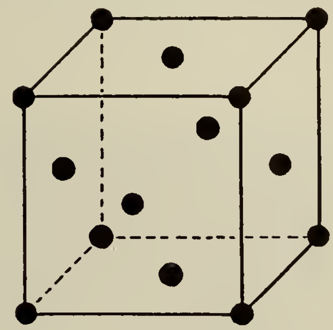


Fig. 3

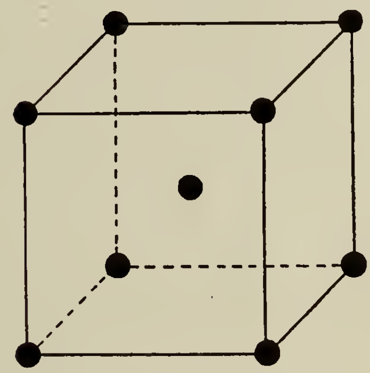


Fig. 4

measured. In the molten condition the molecules are arranged in a haphazard manner, but when the substance crystallizes it has been seen that the molecules group themselves according to definite and repeating patterns.

Space Lattice—Cleavage Planes—Slip Planes

The pattern which forms the foundation upon which the crystal is built is known as a "space lattice." Space may be imagined as divided into cells by three sets of parallel planes. The planes in each set are at equal distances from each other, but the distance between planes may be different in the different systems, and the three sets of planes may form any angles with each other.

When a crystal is allowed free development it assumes a form bounded by plane faces which are determined by the lattice of the crystal. The so-called "cleavage planes" and "slip planes" in crystals are determined also by the space lattice, being the planes upon which there are the greatest concentrations of atoms.

Crystal Systems

Six main types of crystal structures have been recognized, but for the present purpose it is only necessary to consider the cubic system to which most metals belong. In this system three sets of parallel planes are all equally spaced and at right angles to one another.

Two arrangements of atoms on this type of lattice are common among metals. The most common arrangement is called the "face-centred cubic arrangement" in which the atoms are placed at the corners of a cube and also at the centre of each face, Fig. 3. This constitutes the closest possible packing for a number of equal balls and is sometimes referred to as the "cubic close-packed arrangement." The next most common arrangement has an atom at each corner of the tube and one at the centre. This is called the "body-centred cubic arrangement," Fig. 4, and is not so closely packed as the face-centred cubic arrangement. Therefore, if a metal changed from a face-centred arrangement to a body-centred arrangement there would be an expansion due to the greater distance between the atoms.

It is important to keep in mind that if two metals crystallize in the same kind of lattice, the size of the unit cell will be different for each metal. This difference accounts for the distortion of the lattice which occurs in solid solutions, as referred to later.

Interatomic Forces

In order to obtain a clear understanding of the physical properties of metals, it is necessary to visualize the magnitude of the interatomic forces. If a piece of metal is subjected on all sides to hydraulic pressure the whole of the structure is subjected to compression forces tending to make the atoms approach one another, and it is well known that these forces must be exceedingly great in order to produce any appreciable shrinkage of the metal.

The forces between atoms which resist separation are very difficult to imagine because of the lack of anything approaching a negative hydraulic pressure. In an ordinary tensile test the specimen is subjected to tension in one direction and a secondary compression in directions at right angles.

Some idea of the forces, however, can be obtained by measuring the tensile strength of very fine fibres, and from this work it has been estimated that the force required to separate atoms of glass would be of the order of 1,600,000 pounds per square inch. Also an estimate based upon the energy required to separate the atoms of metals by vaporization gives a value of about 5,000,000 pounds per square inch. This is only a rough estimation, but it is sufficient to indicate that in thinking of metals we should not wonder why metals are so strong, but rather we should enquire why metals are so weak. Incidentally this figure shows the enormous possibilities for improving metals.

Thermal Conductivity of Metals

It has been seen that a metal is composed of atoms arranged regularly under the action of their mutual forces, and continually vibrating about their mean positions. It has also been seen that the kinetic energy of the vibrating atoms varies with the temperature. If now the kinetic energy of one atom is increased by increasing its temperature, then the balance of forces between it and surrounding atoms will be disturbed, and the increased motion of this particular atom will result in increasing the motion of surrounding atoms, which in turn will pass on the effect right through the piece of metal.

There is still another means by which energy is transferred through a conductor, and that is by the electrons. It has been shown that the nucleus of the atom is surrounded by planetary electrons travelling in orbits of different sizes and different shapes. When the atoms are located in the crystal lattice the electrons and particularly those of the outer orbits cease to be tied to any particular nucleus, and are free to wander about almost like the molecules in a gas, except that the average concentration of electrons in any part of the metal must remain the same. These electrons similarly transfer energy from one to the other and contribute towards the conductivity of the solid. Any impurity in the metal spoils the continuity of the space in which the electrons move, and, therefore, the impurities reduce the thermal conductivity.

The difference in thermal conductivity of different metals can be attributed to the different construction of the atom, variations in the space lattice, and variations in the number of planetary electrons. Most of the metals which crystallize in the face-centred cubic arrangement are good thermal conductors, soft and good electrical conductors.

Electrical Conductivity—Temperature Coefficient, Superconductivity, Variation of Resistance with Pressure

Each atom of the metal consists of a nucleus and a number of electrons forming a closed system, which is not capable of holding any additional electrons, but some of the electrons in the outer orbits are only loosely held in the system because they form an incomplete series. If now an electron is added to this system one of the original electrons must be passed on to a neighbouring atom, which in turn releases an electron so that the process is continuous. The electric current can, therefore, be considered as the application of a stream of electrons to one terminal of the metallic conductor, resulting in a flow of electrons through the conductor until free electrons are passed out at the other terminal. This process should not be regarded entirely as the passing on of an electron from atom to atom, but rather should be regarded as a general movement, of electrons throughout the piece, upon which is superposed a general drift from one terminal to the other.

The relation between thermal conductivity and electrical conductivity is explained by the fact that the metals which are good electrical conductivities are well supplied with the wandering electrons, which have been shown to contribute also to heat conductivity. In the latter case, however, there is no general drift or current.

In order to account for differences in electrical resistance or conductivity, it is necessary to imagine that some metals have atoms which part with their electrons quite easily, whereas others part with an electron only with great reluctance.

The decrease in the electrical resistance of a pure metal with fall in temperature is considered to be due to improved contact between the atoms, and, therefore, greater ease in the transfer of the electrons. Superconductivity at temperatures approaching absolute zero has been considered as being due to the atoms being continuously in touch with each other at this temperature, and therefore, offering little or no resistance to the passage of electrons from atom to atom.

An interesting point arises when one considers what happens to the electrical resistance of a metal at its melting point. From the theory it would be expected that on melting as the atoms became more widely separated and lose their definite orientation there would be a markedly increased difficulty in exchanging electrons. This is actually borne out in practice because the electrical resistance of a pure metal increases appreciably as it becomes molten, the increase being of the order of two to one. There are exceptions, however, such as antimony and bismuth, in which the resistance first decreases and then increases.

Variation of Resistance with Pressure

With increased pressure the resistance of pure metals decreases as would be expected, but here again antimony and bismuth are exceptions and go the other way.

The concluding portion of this paper will appear in the January, 1933, issue of The Journal.

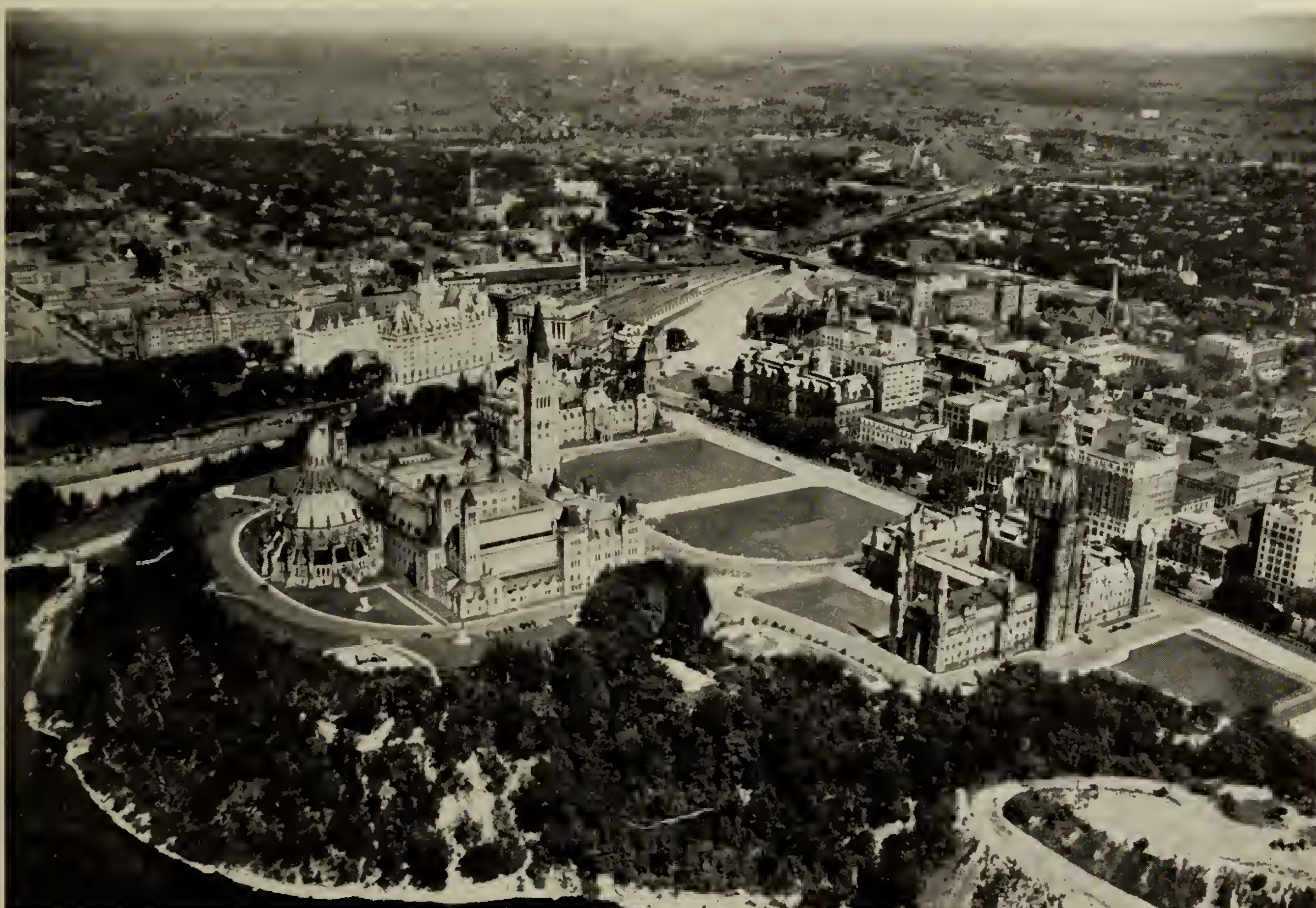
THE ANNUAL MEETING — OTTAWA

The Forty-Seventh Annual General and General Professional Meeting of The Institute will be held in Ottawa

ON

Tuesday and Wednesday, February 7th and 8th, 1933

HEADQUARTERS — THE CHATEAU LAURIER



CITY OF OTTAWA *Photo by Royal Canadian Air Force*

Outline of Programme

Subject to Change

Tuesday, February 7th:

- MORNING........Registration and Business Meeting.
- NOON............Luncheon with Speaker.
- AFTERNOON.......Business Meeting.
- EVENING.........Dinner—followed by a dance. (The speaker at the dinner will be His Excellency, The Right Honourable the Earl of Bessborough, P.C., G.C.M.G., Governor-General of Canada.)

Wednesday, February 8th:

- MORNING........Technical Sessions.
- NOON............Luncheon with Speaker.
- AFTERNOON.......Technical Sessions.
- EVENING.........8.30 to 9.15 p.m.—Lecture on "Exploration for Ore by Magnetic and Electrical Methods," illustrated by experiments and slides, by Dr. A. S. Eve, and Dr. D. A. Keys, Department of Physics, McGill University, Montreal. Following the lecture, members and ladies are invited to visit the new laboratories of the National Research Council, where experimental work will be in progress.

Chairmen of Committees of Ottawa Branch in Change of Arrangements for Annual Meeting

CHAIRMAN........O. S. Finnie, M.E.I.C.
ASSOCIATE CHAIRMAN........J. L. Rannie, M.E.I.C.
FINANCE........L. L. Bolton, M.E.I.C.
HOTEL ARRANGEMENTS........A. E. MacRae, A.M.E.I.C.
INFORMATION, REGISTRATION, PRINTING AND SIGNS........P. Sherrin, A.M.E.I.C.
ENTERTAINMENT AND EXCURSIONS........C. P. Edwards, A.M.E.I.C.
PUBLICITY........W. H. Norrish, A.M.E.I.C.
RECEPTION........John Murphy, M.E.I.C.
LADIES........Mrs. C. Camsell.
EX-OFFICIO........C. Camsell, M.E.I.C.
C. M. Pitts, A.M.E.I.C.
G. J. Desbarats, M.E.I.C.
J. McLeish, M.E.I.C.
F. H. Peters, M.E.I.C.
F. C. C. Lynch, A.M.E.I.C.

THE
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Annual General Meeting for 1933

Notice is hereby given that the Forty-seventh Annual General Meeting of The Institute will begin at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 26th, 1933, at 8 o'clock p.m. After the reading of the minutes of the last Annual General Meeting, the appointment of scrutineers to count the Officers' Ballot, and the appointment of auditors for the ensuing year, the meeting will be adjourned to reconvene at the Chateau Laurier, Ottawa, Ontario, on February 7th and 8th, 1933.

R. J. DURLEY, *Secretary.*

The Structure of Metals

Much of the knowledge of materials of construction upon which our workshop and manufacturing practice is based is still of an empirical, not a theoretical nature, and is derived from experience rather than scientific investigation. Obviously, the engineer, in dealing with the materials which he employs, must know something of their properties; their behaviour under varying conditions of load and temperature; their durability, and the processes by which they are produced. Such knowledge, however, is imperfect and he is working more or less in the dark, if no satisfactory explanations are available as to why certain methods will produce certain effects, such, for example, as the hardening caused by quenching certain kinds of steel, or the remarkable increase in electrical conductivity occurring when certain metals are cooled to low temperatures. To explain these particular results, for instance, we must have some idea as to how a metal conducts electricity, and the mechanical cause of hardening in steel, questions involving the atomic or molecular structure of the material concerned.

For generations mankind has used materials in the daily work of construction, without having definite knowledge as to their ultimate structure. Physicists and chemists have been active in the search for information on this point, but not many engineers have attempted to delve into the basic causes of the phenomena upon which their work depends.

It is a pity that so many of us have failed to retain in later life any of that inquisitiveness about things in general which is so characteristic of healthy childhood, and which gives such pleasure and interest to the fortunate older persons who have never lost it. For these people the results of the scientific investigations of atomic structure are of absorbing interest, even although electrons and space-lattices may seem at first sight to have little to do with the work of the engineer. It is evident that inquiries of this kind are our only means of learning about the ultimate constitution of materials, and upon such research depend the answers to many engineering questions of the greatest practical importance.

As regards the mechanical structure of metals, our present advance in knowledge may be said to have begun with the microscopic work of Sorby some forty years ago, but in more recent years surprising results have been obtained as to the atomic sub-structure of metals, particularly since the discovery of the electron by J. J. Thomson, that of the proton by Rutherford, and the development of X-ray crystal analysis based on the work of Laue and the two Braggs. Investigation of the structure and properties of crystals has completely changed our views on what happens when metal is deformed under stress, and the immensely complicated subject of alloys and their behaviour is constantly being attacked with new and more powerful weapons.

Important as the structure of metals may be to the engineer who seeks information on the subject, he is at once confronted with the task of reading a mass of material selected from a multitude of published papers. This obstacle is so formidable that in many cases he does not attempt to surmount it, though he would willingly study a comparatively brief memorandum summarizing the present state of our knowledge, if such were available. For this reason attention is called to the article by Group-Captain E. W. Stedman, M.E.I.C., the first part of which appears on another page of this issue of The Engineering Journal, and which is reprinted by kind permission of the Royal Aeronautical Society. This paper is made available to readers of The Journal because it gives a readable outline of present day views on the atomic, molecular and crystalline structure of metals and alloys. It is valuable as an example of the kind of knowledge which every engineer should endeavour to secure if he would avoid the restricted outlook of those who confine their interest only to the facts connected with their own limited sphere of work, and who have lost (if they ever possessed it) the youthful desire to investigate and find out "why the wheels go round."

Results of November Examinations of The Institute

The report of the Board of Examiners, presented at the meeting of Council held on November 22nd, 1932, certified that the following candidates, having passed the examinations of The Institute, have satisfied the examiners as regards their educational qualifications for the class of membership named:

Schedule C.—For admission to Associate Membership:

J. T. Lakin..........Three Rivers, Que.

Schedule B.—For admission as Junior:

C. H. Davis..........Montreal, Que.
E. Hinton...........Deer Lake, Nfld.
M. E. Pineau........Montreal, Que.
R. C. Robson........Vancouver, B.C.

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal and the E-I-C News regarding the exchange arrangements which exist between The Engineering Institute of Canada and the founder engineering societies of the United States, whereby members of The Institute may secure the publications of the American societies at special rates which in most instances are the same as charged to their own members. A list of these publications with the amounts charged is given below, and subscriptions may either be sent direct to New York or through Headquarters of The Institute.

	Rate to E.I.C. Members	*Rate to Non-Members*
AMERICAN SOCIETY OF CIVIL ENGINEERS		
Proceedings, single copies	$ 0.50	$ 1.00
Per year	4.00	8.00*
Civil Engineering, single copies	.50	.50
Per year	4.00	5.00
(Plus $.75 to cover Canadian postage.)		
Transactions, per year	6.00	12.00†
Year Book	1.00	2.00
(Other publications 50 per cent reduction on catalogue price to E.I.C. members).		
* *If subscription is received before January 1st, otherwise $10.00.*		
† *If subscription is received before February 1st, Otherwise $16.00.*		
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS		
Electrical Engineering, single copies	$ 0.50	$ 1.00
Per year	5.50	10.50
Transactions, per year (cloth binding), (issued quarterly)	5.00	10.00
Pamphlets	.25	.50
AMERICAN SOCIETY OF MECHANICAL ENGINEERS		
Mechanical Engineering, single copies	$ 0.50	$ 0.60
Per year	4.00	5.00
Transactions, bound, fourteen sections, complete (price of current volume)	10.00	20.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS		
Mining and Metallurgy, single copies	$ 0.50	....
Per Year	3.00	....
(Plus $1.00 for foreign postage.)		
Transactions, per volume	5.00	....
(Plus $.60 for foreign postage.)		
Technical publications: Supplied at $.01 per page, with a minimum charge of $.25 for single copies, or at a subcription rate per year of	7.00	....
(Plus $1.00 for foreign postage.)		

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, November 22nd, 1932, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and seven other members of Council present.

A number of questions in connection with the Annual General Meeting were taken up and decided.

The report of the Finance Committee was received and several reinstatements were effected. Decisions were reached as to the action to be taken in various cases of members in arrears of fees, sympathetic action being taken in all cases in which consideration had been requested. These cases occupied a large proportion of the time of the meeting.

The chairman of the Committee on Development submitted a report outlining the modifications which he would propose in the interim report of the Committee on Development as a result of the expressions of opinion from members and from branches so far as these have been received. Considerable discussion took place on the work of the Committee on Development, and it was decided to prepare a draft of the alterations in By-laws needed to give effect to the revised recommendations of the Committee on Development, this draft to be circulated to all members of Council for study before the next meeting of Council.

The report of the examiners regarding the examinations of The Institute held on November 1st, 1932, was received, from which it was noted that five of the candidates examined had passed.

Consideration was given to the drafts of amendments to By-laws submitted by the Victoria Branch and by the Winnipeg Branch.

Council noted a report forwarded by the Executive Committee of the Toronto Branch informing Council that at the request of the Toronto Board of Control a committee

Peace Tower, Parliament Building, Ottawa, Ont.

of that Branch had advised the city of Toronto with reference to the acceptance of certain tenders for engineering equipment at the John Street pumping station, the contract having ultimately been awarded in accordance with the committee's recommendations.

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

Elections		*Transfers*	
Assoc. Members	2	Assoc. Member to Member	1
Juniors	4	Junior to Assoc. Member	5
Students Admitted	4		

The Council rose at eleven thirty p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 22nd, 1932, the following elections and transfers were effected:

Associate Members

*LAKIN, John Thomas, plant engr., The Wabasso Cotton Co. Ltd., Three Rivers, Que.

MEEHAN, Owen Michael, B.Sc., (N.S. Tech. Coll.), Hydrographer 1, Canadian Hydrographic Service, Hunter Bldg., Ottawa, Ont.

Juniors

*DAVIS, Clinton Harold, 5608 St. Urbain Street, Montreal, Que.

*HINTON, Eric, asst. to hydro-electric engr., Nfld. Power and Paper Company, Ltd., Deer Lake, Nfld.

*PINEAU, Maurice E., designing dftsman., McDougall & Friedman, Montreal, Que.

*ROBSON, Richard Christopher, 138 Windsor Road East, North Vancouver, B.C.

Transferred from the class of Associate Member to that of Member

SPROULE, Gordon St. George, B.Sc., M.Sc., (McGill Univ.), associate professor, metallurgy, McGill University, Montreal, Que.

Transferred from the class of Junior to that of Associate Member

GELDARD, Percy Walter, B.A.Sc., (Univ. of Toronto), supt., West District, Dept. of Distribution, Consumers Gas Company, Toronto, Ont.

GERIN, Maurice, B.Sc., (Univ. of Montreal), M.Sc., (Mass. Inst. Tech.), sales engr., Canadian Fairbanks-Morse Co. Ltd., Montreal, Que.

MACNAUGHTON, Moray Fraser, B.Sc., (McGill Univ.), M.Sc., (Univ. of Mich.), consltg. engr. on concrete, Milton Hersey Co. Ltd., Montreal, Que.

PREVOST, Joseph Edouard Wilfrid, B.A.Sc., C.E., (Ecole Polytech.), constrn. engr., Damien Boileau Ltee. & Ulric Boileau Ltee., Montreal, Que.

ROSS, James Hargrave Drummond, B.Sc., (McGill Univ.), 5 Gage Road, Montreal, Que.

Students Admitted

BROWNIE, Frank Austin, University of Alberta, Edmonton, Alta.

DOVE, Allan Burgess, B.Sc., (Queen's Univ.), chemical engr., Steel Company of Canada, Hamilton, Ont.

MILLER, Dudley Chipman Raphael, (Univ. of Toronto), 21 Delevan Avenue, Toronto, Ont.

SMITH, Walter Alexander, University of Alberta, Edmonton, Alta.

*Has passed Institute's examinations.

OBITUARIES

Thomas Henry Alison, M.E.I.C.

It is with regret that the death of Thomas Henry Alison, M.E.I.C., on July 2nd, 1932, is recorded.

Mr. Alison was born at Toronto on September 25th, 1872, and graduated from the University of Toronto in 1893 with the degree of B.Sc. In 1894-1895 Mr. Alison was assistant engineer with the Central Bridge and Engineering Company at Peterborough, Ont., and in October, 1895, joined the staff of the New Jersey Steel and Iron Company at Trenton, N.J., being engaged on designing and as assistant on cableways, bridges, buildings, etc. In 1896 he was with Post and McCon, New York, and in 1897 was engaged on buildings and foundations with several firms. In July, 1897, he became chief engineer for August Smith, engineer and contractor, New York (later Bergen Point Ironworks). Mr. Alison was president of this concern at the time of his death.

Mr. Alison was a member of The Institute of long standing, having joined as a Student on April 20th, 1893, transferred to the class of Associate Member on May 25th, 1899, and to that of Member on December 15th, 1904.

Morris Knowles, M.E.I.C.

Deep regret is expressed in recording the death of Morris Knowles, M.E.I.C., which occurred at Pittsburgh, Pa., on November 9th, 1932.

Mr. Knowles was born at Lawrence, Mass., on October 13th, 1869, and graduated from the Massachusetts Institute of Technology in 1891 with the degree of B.S.

Following graduation, Mr. Knowles was until 1893 assistant engineer with the East Jersey Water Company, at Paterson, Montclair and Newark, N.J., and at that time was appointed assistant engineer with the Massachusetts State Board of Health and the Boston Metropolitan Water Board, being engaged until 1897 on investigations for a new water supply for Boston and vicinity. In 1897 he made studies and experiments upon purification of the Allegheny river water, at Pittsburgh, Pa., which occupied him until 1899, when he was engaged on investigations for new water supplies for Philadelphia and New York city, and was in charge of filtration experiments at Philadelphia. In 1901 Mr. Knowles was appointed chief engineer in charge of the Bureau of Filtration, Pittsburgh, Pa., which position he held until 1910. Since 1901 he has carried on a general consulting and engineering practice, specializing in water works, sewerage works and sanitation. In 1908 Mr. Knowles was appointed a member of the Engineering Committee of the Pittsburgh Flood Commission, and was Associate Editor of a 900-page report, the studies for which included flood conditions in the Allegheny and Monongahela river valleys and means of protection and prevention. In 1911 he was appointed professor and director in charge of the Department of Sanitary Engineering, University of Pittsburgh.

Mr. Knowles was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, the Engineers Society of Western Pennsylvania and the Franklin Institute, Philadelphia.

He joined The Institute as a Member on February 10th, 1914.

James McAdam, A.M.E.I.C.

Members of The Institute will learn with regret of the death at Toronto, Ont., on October 17th, 1932, of James McAdam, A.M.E.I.C.

Mr. McAdam was born at Edinburgh, Scotland, on July 7th, 1882, and in 1898-1902 attended the Heriot-Watt Technical College, at the same time serving an apprenticeship in quantity surveying and engineering.

In 1903-1904, Mr. McAdam was junior assistant engineer with the Edinburgh and District Water Trust, and from 1905 to 1907 was engineer and surveyor on the Scotch estates of the Marquis of Zetland. In 1907-1909, he was engaged on the construction of buildings, roadways, sewers and watermains as town engineer and sanitary inspector of Lochgelly, Fife, Scotland. Coming to Canada in 1910, Mr. McAdam became draughtsman in the railway section of the Works Department, Toronto, Ont., and in 1911 was promoted to the position of assistant to the outside inspector of work. In 1912 he became engineer of the West Division, and in 1915 was appointed engineer in charge of all contract work on roadways and sidewalks, holding this position until 1919 when he joined the staff of Barber and Wynne-Roberts and Seymour as engineer of construction. From 1925 to 1928 he was with the township of York as chief engineer of construction, and in 1918 was for a short time engineer and superintendent with the Toronto Construction Company, Ltd. From 1928 to 1930 Mr. McAdam was town engineer of Dalhousie, N.B., and in 1930-1931 was in the service of the Department of Highways of New Brunswick. Returning to Toronto in 1931 he was for a short time with Standard Paving Ltd., and later with the Department of Public Highways of Ontario.

Mr. McAdam became an Associate Member of The Institute on June 21st, 1921.

Charles Franklin Medbury, A.M.E.I.C.

We regret to announce the death of Charles Franklin Medbury, A.M.E.I.C., at his home in Montreal on November 2nd, 1932.

Mr. Medbury was born at Foxboro, Mass., on August 6th, 1867, and graduated from Brown University in 1888 with the degree of B.A.

Following graduation Mr. Medbury entered the employ of the Thomson-Houston Electric Company at Lynn, Mass., as draughtsman, and later was engineer with the same company at Boston.

A few years later, Mr. Medbury was sent by the Thomson-Houston Company to Canada as special agent, and continued in that capacity until the consolidation of the various electrical companies, following which he was appointed manager of the Montreal office of the Canadian General Electric Company. After occupying this position for a year, Mr. Medbury joined the firm of Ahearn and Soper of Ottawa, and in 1896 returned to the United States as business manager of "The Electrical World," New York. Shortly afterwards he went to Chicago as salesman for the Westinghouse Electrical and Manufacturing Company, becoming manager of the company's Detroit office a few years later. He remained in Detroit until 1909. when he was transferred to Montreal as manager, which important position he held until his death.

Mr. Medbury joined The Institute as an Associate Member on January 25th, 1921.

PERSONALS

J. B. Carswell, A.M.E.I.C., managing director of the Burlington Steel Company, Ltd., Hamilton, Ont., has been appointed as the representative of The Institute on the special committee formed by the Royal Architectural Institute of Canada and the Canadian Construction Association to consider ways and means of stimulating the recovery of the construction industry.

D. W. Hodsdon, A.M.E.I.C., of Pacific Mills Ltd., Ocean Falls, B.C., has been appointed resident engineer of that company. Mr. Hodsdon was at one time engineer with the Department of Lands, Water Rights Branch, Victoria, B.C., and later was connected with the Canadian Crown Willamette, Ltd., Campbell River, B.C.

C. B. Trowbridge, M.E.I.C., sales manager of the Canadian Mead-Morrison Company, has been transferred by the company from Montreal to Toronto. Mr. Trowbridge graduated from Rose Polytechnic Institute, Terre Haute, Ind., in 1905, following which he was until 1909 with the Illinois Steel Company as draughtsman, joining the staff of the American Bridge Company, Gary, in the same capacity in 1910. From 1912 to 1931 Mr. Trowbridge was with the Mead-Morrison Mfg. Company at Chicago, as chief draughtsman, engineer and salesman, and in July, 1931, was transferred to Montreal, as sales manager.

Retirement of E. G. Evans, M.E.I.C.

E. G. Evans, M.E.I.C., engineer, right-of-way, Atlantic Region, Canadian National Railways, has retired after having spent forty-eight years in engineering work.

Mr. Evans was born at Margate, P.E.I., on June 23rd, 1865, and after studying engineering at Mount Allison University, went to Boston and completed his studies.

In 1884-1886 Mr. Evans was rodman, leveller, transitman and resident engineer on the survey and construction of the Canada Eastern Railway, and in 1886-1887 was assistant engineer on the survey of the Washington Counties Railway in Maine. In 1887 he was engaged by the Albert Manufacturing Company, Albert Co., N.B., to study a project to electrify the tramway from their quarries to the shipping wharf on the Petitcodiac river at Hillsborough. He was appointed representative engineer for United States bond-holders in 1888 to rehabilitate the St. Martins Railway and complete construction of the Central Railway, Norton to Chipman on the Salmon river flowing into Grand Lake. When that work was completed he was appointed superintendent and assistant treasurer of those lines in 1890, and the same year assumed also the superintendence and position of assistant treasurer of the Buctouche and Moncton Railway. It was decided to reorganize the latter line in 1894, when Mr. Evans was appointed receiver.

In 1901 he completed the sale of the St. Martins Railway to a private company and the sale of the Central Railway to the New Brunswick government in 1903, still retaining his connection and management of the Moncton and Buctouche Railway. He engaged in metallurgical research work in New York for four years and acted as consulting engineer in the supervision of contract work deepening and widening the Upper Canadian channel of the St. Lawrence river through the Thousand Islands, for three years. Mr. Evans then engaged in supervisory mining work in the Cobalt district for several years. When the Moncton and Buctouche Railway was transferred to the Dominion government in 1918 he joined the Canadian National Railways as district engineer at Moncton, N.B., and in 1925 was appointed engineer of right-of-way, Atlantic Region.

George J. Desbarats, M.E.I.C., Retires

George J. Desbarats, C.M.G., M.E.I.C., terminated a long and active career as a public official on October 31st, 1932, when he retired from the position of Deputy Minister of Defence, which office he has held since 1922.

Prior to his retirement, Mr. Desbarats was the recipient of three silver rose bowls, the gift of the officials and staff of the Department of National Defence. The presentation was made by Colonel the Hon. D. M. Sutherland, Minister of the Department, in the presence of Major-General A. G. L. McNaughton, M.E.I.C., chief of the general staff, Major-General A. H. Bell, adjutant general, Brigadier Clyde Caldwell, M.E.I.C., quarter-master general, Commodore Walter Hose, chief of the naval staff, Group Captain J. Lindsay Gordon, Wing Commander G. O. Gordon, Group Captain E. W. Stedman, M.E.I.C., Colonel S. H. Hill and the entire staff of the Department. In making the presentation Colonel Sutherland said that the co-relation of Canada's naval, military and air services would remain a monument to Mr. Desbarats' work.

Educated at the Terrebonne College, the Plateau Academy, Ecole Polytechnique and Laval University, Mr. Desbarats graduated with honours at the age of eighteen. In 1879 he entered the Department of Railways and Canals as assistant engineer connected with the construction of the Carillon canal, and later with the construction of the St. Anne's canal and the Lachine canal. Mr. Desbarats was assistant to the late John Page, chief engineer of canals, and was engaged in designing the present Canadian locks at the Soo, the Welland canal and the Soulanges canal. Between 1892 and 1896 he was an inspector of railway construction in British Columbia, particularly on the "Onderdonk" sections of the Canadian Pacific Railway, and coming east in 1896 became associated with Larkin and Sangster, later re-entering the government service, when he was engaged on a hydrographic survey of the St. Lawrence. Following this Mr. Desbarats was placed in charge of the government shipyard at Sorel. Later he was appointed acting and then deputy minister of the Department of Marine and Fisheries, and in 1910 became deputy minister of Naval Service on the decision of the government to establish a Canadian navy. On the amalgamation of the naval, military and air forces of the Dominion Mr. Desbarats was made acting deputy minister of militia and defence and in 1923 became Deputy Minister of National Defence.

Mr. Desbarats was appointed a Companion of the Order of St. Michael and St. George in 1914 in recognition of the important duties performed by him during the war.

CORRESPONDENCE

Fort William, October 14th, 1932.

The Editor,
The Engineering Journal,
Montreal.

Dear Sir,

A recent conversation here, in connection with levels and elevations data, suggested that the usefulness and value of the precise levels work being done by the Geodetic Survey of Canada is too little known, and certainly not adequately appreciated by many engineers across Canada. This is unfortunate, as there can hardly be a corporation, engineering enterprise, city or privately sponsored work, where levels or elevations are concerned, which would not benefit through being tied into and referenced to the Geodetic Survey datum.

It seems to be a case of some individual engineers not being conversant with the work of the Survey and the presence of many thousands of reference benches across Canada, in most cases readily available for the work in hand. It would also seem that our Institute, through The Journal, could do much to advertise the work already done and through executive channels see that representation is made in the proper quarters to the end that the extension of existing levels nets is not unduly curtailed in the present efforts to reduce public expenditures. I am not directly or indirectly connected with the Geodetic Surveys Service of Canada, but in the past ten years we have had continuous reason to be gratified for the service rendered by this service; also to know that other government departments (Dominion and provincial), municipalities, irrigation projects and power companies in British Columbia, have been equally assisted by having a common authentic datum for their elevations and levels.

The obvious advantages attending the use of a common datum plane, or convenient reference thereto, on all works, projects, etc., across Canada, require no illustrations to point them. It would seem, however, that there is need to keep every engineer in Canada apprised of the fact that bench marks are distributed fairly liberally across the continent and that by recognition and use of those already established, further lines of levels into new areas may be expected.

It must take many years to build up and train an organization for precise levels work, and considering the relatively low cost, it would reflect no credit on the present generation of engineers if the present one were allowed to be impaired through lack of voiced appreciation and representations to those in authority who may not be fully apprised of the commercial value of the work of the Survey.

Yours very truly,

P. E. DONCASTER, M.E.I.C.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

North-East Institution of Engineers and Shipbuilders (Inc.): Transactions, vol. 48, 1931-32.
Institution of Naval Architects: Transactions, vol. 74, 1932.
Memorial Volume containing a Record of Those Members and Students of The Institution of Civil Engineers Who Died for Their Country in the Great War, 1914-1919. *Presented by A. F. Stewart, M.E.I.C.*
American Society of Civil Engineers: Transactions, vol. 96, 1932.
National Electric Light Association: Proceedings, vol. 89, 1932.
Liverpool Engineering Society: Transactions, vol. 53, 1932.

Reports, etc.

Department of Mines, Mines Branch, Canada:
Memorandum Series:
No. 56: Summary of Tests on British Columbia Coals...and Notes on Pulverized Fuel Fired Steam Generators vs. Other Types.
No. 57: Refractory Clays in Canada.
Joint Board of Engineers (Reconvened), [Canada and United States]:
Report on the International Section of the St. Lawrence River, with Appendix and Plates, April 9, 1932.
The Quebec Streams Commission:
Twentieth Report, 1931.

Technical Books, etc., Received

Air Conditioning for Comfort, by Samuel R. Lewis. 1932 edition. *Presented by Engineering Publications, Inc.*
Economics of Construction Management, by J. L. Harrison. *Presented by Gillette Publishing Company.*

Catalogues, etc.

Dominion Engineering Works, Ltd.:
Dominion-United Rolling Mill Machinery [10 pp.].
Dominion Farrel-Bacon Jaw Crushers [15 pp.].
Chemical Catalog Company, Inc.:
Chemical Engineering Catalog, 1932. 17th Annual Edition.
American Society of Mechanical Engineers:
Mechanical Catalog, 1932-33. 22nd Annual Volume.
Western Electro-Mechanical Co., Inc.
Commercial Testing Devices, Electrical Tests and Measurements, Phantom Loads [22 pp.].
De Laval Steam Turbine Co.:
De Laval Propeller Pumps [3 pp.].

BOOK REVIEWS

The Wichert Truss

By D. B. Steinman. Van Nostrand, New York, 1932, cloth, 6 x 9 in., 138 pp., figs., $2.75 net.

Reviewed by P. L. Pratley, M.E.I.C.*

The presentation of the case for the "Wichert" framework could not have been placed in more capable hands, as Dr. Steinman, besides being an engineer of wide experience, has also produced many valuable books on various types of bridge work. This volume is admittedly and enthusiastically devoted to the advocacy of this particular framework and to the substantiation of the claims that it is economic both in respect of the labour of computation and of actual material. The analytical treatment is followed by a number of typical computations and a collection of charts likely to be extremely useful in the application of the methods outlined to the problems of design. A discussion on temperature and distortion paves the way for a summarizing of the various advantages claimed for the system, which advantages are constantly held before the readers' attention throughout the work and are again somewhat expansively listed in a series of reports based upon the author's complete studies.

The framework in question consists essentially of a continuous system whose intrinsic geometrical properties not only remove the external indeterminancy usually associated with three or more points of support but also permit, within certain limits, of the predetermination of the magnitude of the reactions and the ordinates to the moment curve. Incidentally, it is almost inconceivable that the adoption of such a framing should constitute a patentable device.

In the opinion of the present reviewer it would seem that the introductory argument might have been arranged in a somewhat more logical order. The first consideration should have been the general question of stability and the peculiar characteristics of this framework in preserving stability in spite of the apparent violation of some of the usual conditions. The limits beyond which stability is not preserved should then be made clear and definite, because the instinctive first reaction of the designing engineer to the shape of the framework is one of doubt as to the sufficiency of its members. At this point the function of the geometry of the quadrilateral could very naturally be introduced and discussed, and the choice of the particular geometrical relationship to be incorporated in the subsequent formulae could be explained and justified. As it is, the so-called "Rhomboid constant" is introduced too suddenly and too early to be appreciated and not until Chapter XV is the real function and advantage of the geometrical control of external reactions made apparent.

The text and illustrations are very clear and unusually free from error. The Y on the horizontal axis of Fig. 35 is an exception and possibly the conclusions *a*, *b*, and *c*, on page 67, might be expressed in terms rather more consistent with one another and with Fig. 27.

The treatise forms a very interesting study well worth the attention of both students and practising engineers, but the present reviewer leaves it with the feeling that after all he would probably put in the missing vertical members. Of course, experience with spans designed to use this "Wichert" framework might dissipate this conservatism, and the whole-hearted endorsement of the system by such an authority as Dr. Steinman will certainly increase the confidence with which other engineers undertake to experiment in the direction of its adoption in practice.

*Monsarrat & Pratley, Consulting Engineers, Montreal, Que.

Air Conditioning for Comfort

By Samuel R. Lewis. Engineering Publications, Inc., Chicago, 1932, cloth, 5½ x 8¼ in., 244 pp., figs., tables, $2.00.

Reviewed by E. A. Ryan, M.E.I.C.*

This work gives a good general outline of the requirements of modern air conditioning and a series of useful formulae and sample calculations illustrating the various points treated.

The book is simply written and well paragraphed for easy reference, and the data tables and graphs are clear and easily read.

Generally the ideas are as modern as printed form can record in this swiftly moving science, and all of the ideas accepted during the last few years' transactions are incorporated.

The question of sun radiation is well explained, but it appears that the figures used do not agree with those set out in other treatises on the subject.

One typographical error was noticed on page 123 with reference to the development of the higher items of the author's calculation sheets.

The reviewer considers this work worth while as a text or reference book.

*Consulting Engineer, Montreal, Que.

Water Analysis for Sanitary and Technical Purposes

By Herbert B. Stocks. Griffin, London, 1932, cloth, 5¼ x 7¾ in., 135 pp., 6 figs., tables, 7/6 net.

Reviewed by M. H. McCrady, A.M.E.I.C.*

In this second edition of a book first published some twenty years ago, the reviser has sought to rearrange the subject matter and add other material to bring it up to date. This is not always a simple task—particularly when the subject is one which has developed rather rapidly during the past few years to include detailed microscopical and bacteriological examination at the expense of emphasis on the chemical analysis which was the all-important feature of water examination at the time of the first publication of the work.

Perhaps this is the cause of the considerable lack of balance in the proportion of space devoted to the various sections in this present volume. Some 90 pages are concerned with the chemical analysis, and less than 10 to the bacteriological examination. The method of collecting material for microscopical examination is limited to simple sedimentation in a conical glass, and no illustrations or figures are given to assist the reader to interpret his findings. Again, although four different methods are presented for determination of nitrates, no details are given for quantitative determination of colour or turbidity, despite the importance of these in the present era of water purification. Adaptation of analytical procedures to sewage analysis is frequently offered, but no mention is made of that most important sewage determination, the biochemical oxygen demand.

The section on chemical analysis is however, on the whole, well done. The procedures are described in considerable detail, and the choice of methods presented usually include those of proved value.

The physical and bacteriological sections are not treated with the same attention to detail. A water analyst could follow the text, since he would be familiar with the procedures outlined, but the beginner would find these sections much more difficult than that devoted to chemical examination.

As in most books on water analysis, the important question of interpretation of results is dismissed with a few notes scattered through the text. We still are waiting for an adequate up-to-date treatment of this subject.

The book will serve as a handy reference particularly to methods of chemical analysis of water. The text is attractively arranged and practically free from typographical errors, and the index is satisfactorily complete.

*Chief of Labs., Prov. Bureau of Health, Montreal, Que.

The Function of Mechanical Engineering in the Economic System

Extract from Presidential Address by President William Taylor, O.B.E., before The Institution of Mechanical Engineers, October 28th, 1932. Reprinted from *Engineering*.

And now, for a little while, I should like to turn attention to the subject of the function of mechanical engineering in our economic system. It has recently been asked by many persons, including two distinguished men, close friends of our Institution, whether what is termed the "mechanization of life" is a blessing or a curse to humanity. If it still be true that he who makes two blades of grass grow where but one grew before, adds to the wealth of the world, then it must be equally true that the mechanical engineer, who so improves the instruments of industry that they produce any good material thing more abundantly or of improved quality, is therein a benefactor of mankind. Of course any material thing good in itself may be misused, like the heavy lorries of which our Dean complains that when driven at excessive speed they shake Westminster Abbey, and of which many rightly object that they break up our roads at immense and unjustified expense to the taxpayers. But heavy lorries, driven at moderate speeds on suitable roads, have a service to perform which nothing else can perform so efficiently. And mechanical engineers may be proud and not ashamed of them.

After all there is no good thing which may not become an evil by misuse. The objections to mechanization generally arise from the abuse rather than from the proper use of the products of mechanical engineering. What are the general purposes attained by those products? One is the reduction of the strain of heavy and often injurious or monotonous labour by man and beast. Many who disparage what is termed mechanization, imagine that the main thing machinery does in industry is to destroy some noble artistic instinct in the operative, and thus make him a mere machine. This is generally a figment of the imagination. Relatively few have the true gifts of the artist craftsman, who is a subject for wonder and admiration, because with but little really exact knowledge to guide him, he has, partly by tradition, but mainly from experience of many failures and some successes, learned how to do good work as a matter of habit. Even his thinking has become largely routine thinking. Improved machinery for lens-making, for example, has not killed a noble art, it has elevated practice based on tradition and habit and rather inexact knowledge, into practice based on the conscious application of principles of science.

It is common to cite weaving as an art which has been killed by machinery. But what machinery has done is, in the main, to relieve the operator of the monotonous physical labour of working pedals with his feet and shuttles with his hands. The art of weaving remains, along with the same need of inventiveness, imagination and taste in devising patterns and mounting the looms. Again, a calculating machine in no way replaces the imaginative thought of the mathematician. All that it can do is to relieve him of the monotonous labour and the mental strain of doing mere arithmetic without error, so that instead of destroying his art, it gives him greater freedom and fitness to exercise it.

A third object is to render the products of industry more uniform and of a higher standard of precision. That it does this is well known to those who have experience of machinery, but a popular belief, which dies hard, is that a hand-made product is essentially better than a machine-made product. In a few cases it is better, as with the imaginative work of some decorative artists, but in most cases the buying public is apt to think that the hand-made product must be the better because it costs more. But with all instruments of utility, beauty of design depends primarily upon perfect adaptation of form to use, and this perfection is better maintained under machine production than by manual work. The fourth object, that about which great current social and economic questions centre, is the saving of time. This, as we have seen, machinery generally effects, and can only effect, by saving monotonous labour. By saving time in satisfying the vital needs of mankind, machinery inevitably increases the aggregate leisure of mankind. And yet the really serious charge made by many persons against machinery is that it reduces employment, by which many mean not that machinery occasionally, for a time, displaces individuals, though that is true, but that machinery promotes universal unemployment and so leads to the collapse of our economic system and to universal starvation. Now, if that be true, we are faced with this paradox: That machinery, which facilitates the satisfaction of man's vital needs, hastens his starvation and ruin. And we should be driven to conclude that mankind has only two alternatives: viz., that he should starve to death or that he should return to a life of increased monotonous labour and reduced leisure. This dreadful but logical conclusion discredits the view of many who attribute to the use of machinery the exceptional amount of unemployment prevailing in the world to-day. But while it discredits that view it hardly disproves it.

Let us, therefore, look at it in another way. If it be anti-social and uneconomic to use machinery, because machinery saves the time of mankind, then to save the time of mankind is anti-social and uneconomic. To save time on any work being wrong, to spend more time on it must be right, and if we carry this to its logical conclusion it proves that for all to spend infinite time on doing nothing is the way to achieve universal human happiness. The only valid objection, if there be one, to the mechanization of our civilization, is that it may increase the productivity of labour, and thereby the aggregate leisure of mankind, faster than man can learn to use his leisure wisely in improving his bodily, mental and ethical vigour. Are we near this danger point? When, after looking backward for a generation or more, we view the facilities for travel which to-day the masses of our people use increasingly, the bicycle, motor-car, train and steamship, all products of the mechanical engineer; when we see the growing interest in radio with its lectures and music and its healthy entertainments and good literature, in healthful sports, and pastimes, can we see any reason to suppose that either we British or any other race of people will fail in learning to use wisely the increased leisure which is the great social fruit of mechanical engineering. Let us, therefore, go forward in our work with courage, stimulated by the confident assurance that mechanical engineering is one of the greatest contributors to the betterment of mankind.

E. Long Limited, Orillia, Ont., have secured the manufacturing rights for central Canada for the Cramp chain gate, which has been developed by Mr. D. L. Cramp, mechanical superintendent of Lake Shore Mines, in an endeavour to eliminate the troubles of other types of gate, all of which presented difficulties particularly underground and in handling rocks. This type of gate is, however, applicable to other materials than rock, and is working successfully in controlling sand at the Lake Shore Mines. The chains and balls have to be proportioned to suit the material they are to handle, and the design of the chute also has to be taken into consideration, but when properly designed the gate will, it is stated, never get out of adjustment and is extremely simple. The sales of the gate for the province of Quebec will be handled by Messrs. Williams and Wilson, Ltd., Montreal.

Busfield, McLeod Limited, of Montreal and Toronto, announce that they have been appointed exclusive agents in the provinces of Quebec and Ontario (southerly) for the Saunders Valve Company, Ltd., manufacturers of the Saunders Patent streamline valves. These valves are of the diaphragm type, and represent the latest development in engineering practice. They are unique in that they have no working parts exposed to the fluid. While primarily designed for use in handling compressed air, the valve has proved itself valuable in service with corrosive liquids. It can be economically supplied in special metals, glass lined or rubber lined.

BRANCH NEWS

Calgary Branch

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

The four million dollar water system for the city of Calgary is nearing completion and the opening meeting of the Branch was devoted to an address by the resident engineer, N. G. McDonald, A.M.E.I.C. About sixty-five members and friends assembled at the Board of Trade rooms on the 20th October and Lt.-Colonel F. M. Steel, M.E.I.C., presided.

The Glenmore Dam

At the outset the speaker referred to the necessity of ancient civilizations relying on spring water which had to be conveyed many miles by heavy aqueducts and tunnels. To-day it is possible and sometimes more economical to pump near-by surface supplies and avoid all risk of impurity by filtration.

The old works consisted of one gravity intake on the Elbow river and two pumping stations on the Bow river and their condition had made it most difficult for city engineers to maintain an adequate supply. In 1929 the firm of Gore, Naismith and Storrie were called in consultation to advise on the situation.

The central feature of the new system is a 60-foot dam on the Elbow river just above the city. Its primary purpose is to augment the low summer flow, but the head created affords power for pumping during the greater part of the year.

The dam is of solid concrete construction, surmounted by a handsome arched bridge, and the other works include a pumping station, purification plant, 48-inch trunk loop main for city distribution with booster pumps and high level tank for the North Hill district.

Photographs shown clearly illustrated the progress during construction and the views taken of a high flood in June, 1932, were of special interest. At this time the peak flow of the Elbow river reached 25,000 cubic feet per second as compared with a previous record of 15,000, but on account of temporary storage in the reservoir the flooding in Elbow Park, Calgary, was less severe than usual. The water rose to within a foot of the spillway and was then released to permit completion of the works.

Although the dam foundations involved some substantial extras, it is expected that the total construction cost will be within ½ per cent of the original estimate.

A hearty vote of thanks was accorded the speaker on the motion of R. C. Harris, M.E.I.C., and W. B. Trotter, A.M.E.I.C.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
G. Moes, A.M.E.I.C., Branch News Editor.

Visit to Hamilton Water Works

On Wednesday, October 19th, the members of the Hamilton Branch visited the new filtration plant which is in course of construction at Hamilton Beach and the new Depew street sewage disposal plant and incinerator.

In the evening a dinner was held in the Royal Connaught hotel at which W. L. McFaul, M.E.I.C., city engineer and manager of the waterworks, was the speaker.

An excellent student paper dealing with the application of oil electric engines, which had been submitted to the local Branch some time ago by E. C. Hay, S.E.I.C., a student engineer at the Canadian Westinghouse Company, was presented by the author.

Mr. McFaul stated during the introduction of his address, that the works consist of low lift pumping station, chemical building and mixing chambers, settling basins, filter building wash water tower, offices and laboratory, filtered water reservoir and connecting conduits. They comprise the filter plant proper and are for the purpose of conditioning or preparing the raw water as delivered from the lake by the intakes, conduits and screen chambers before delivery to the consumer as drinking water, by means of the existing high-lift pumps and the rest of the distribution system. The process of filtration is a method of treatment of water subject to pollution of various kinds in order to produce a clear sparkling liquid fit for any commercial use, and bacteriologically safe for human consumption.

The speaker explained that in 1927 a new 60-inch intake, conduits and screen house were designed and constructed. This work was in addition to the existing 48-inch intake and conduits, and at that time the old settling basin on the shore of the lake was abandoned. Provision was made at that time for the construction of the filter plant by providing two 60-inch diameter conduit connections past the screen house and a connection for the filtered water conduit to the high-lift pump suction conduit. The work of designing the filtration plant was undertaken by the city engineer's department in the spring of 1930 and the first contract was let in January, 1931.

Mr. McFaul then explained the new filtration plant in detail and its mode of operation.

Describing the low lift pumping station, he stated that in the main station there will be installed four horizontal centrifugal pumps, of 5½, 11, 22 and 33 million Imperial gallons per day capacity respectively. The operation of the pumps motors is controlled by push button stations on individual control pedestals located in the main pump room.

The speaker then explained the ensuing operations which take place in the chemical building and mixing chambers, settling basins, filter wash water tower, filtered water reservoir, chlorine house, connecting conduits, sewage system, etc., and in conclusion stated that the estimated cost of the work was $1,175,000 and the commitments to date were $1,169,967, to which must be added the loss on sale of debentures and interest owing to a delayed sale.

Annual Joint Meeting with Babcock-Wilcox and Goldie-McCulloch Engineering Society

The annual joint meeting of the Hamilton Branch and Babcock-Wilcox and Goldie-McCulloch Engineering Society was held in Galt on Tuesday, November 8th, 1932. Members of the Hamilton Branch always look forward to a Galt meeting, where friends, not frequently seen, meet again and general whole-hearted hospitality abounds.

The speaker for the evening, H. A. Lumsden, M.E.I.C., county engineer, county of Wentworth, and engineer, Hamilton Suburban Roads Commission, a Branch member, and therefore known to nearly all present, in speaking on "Highways of Ontario," had chosen a subject interesting to everyone.

In the absence of the Branch chairman, E. P. Muntz, M.E.I.C., the well-attended meeting was opened and the speaker introduced by Major G. H. Wilkes, chairman of the Babcock-Wilcox and Goldie-McCulloch Engineering Society.

Major Lumsden began with a historical review of roads in Ontario, the earliest ones being constructed in the latter part of the eighteenth century. He explained that the system of roads in Ontario is divided for economic purposes into the following classes: (1) King's Highways, (2) Kings' Suburban Highways, (3) County Roads, (4) Suburban Roads, (5) Township Roads.

All these roads come under the Department of Highways in some way or other, in the case of (1) entirely, both as to engineering and cost, while in the case of (2), (3), (4) and (5), the Department bears a share of the costs while the local governing bodies bear the remainder, and, in most cases, do their own planning and engineering.

The functions of different types of local public bodies controlling roads were explained by the speaker in detail.

Coming to the various types of road construction, Major Lumsden laid stress on the fact that the economic choice of type of road entirely depends on the traffic such a road will have to bear. The enormous increases of vehicular traffic on our highways in the last twenty years has necessitated road design and construction unthought of only a few decades ago.

There are two main classes of road construction: (1) concrete roads, used where traffic is heaviest, considered best, but also the most costly type of road; (2) bituminous roads of which the main classes are: (*a*) penetration roads, (*b*) retreated roads, (*c*) mix macadam or black base roads. The speaker explained in detail the method of construction of these types, their relative advantages, costs, and limitations.

After questions had been answered by the speaker, a hearty and sincere vote of thanks to Major Lumsden was proposed, seconded, and endorsed by all those present, for the most interesting and instructive evening. The meeting then adjourned.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
R. B. McKenzie, S.E.I.C., Branch News Editor.

The members of the Lethbridge Branch of The Institute met at 6.30 p.m. on October 29th in the Marquis hotel for the usual dinner meeting. A musical programme was enjoyed, after which the speaker of the evening, Mr. E. Ward Jones, superintendent of Animal and Agricultural Industry, C.P.R., Calgary, was introduced by P. M. Sauder, M.E.I.C.

Some Observations of Agriculture in Europe

Mr. Jones subject was "Some Observations of Agriculture in Europe." In his preliminary remarks he said that Canada could produce and maintain livestock equal to the best in the world. In support of this point he showed a number of pictures of stock raised in western Canada.

He then went on to speak of stock in England and mentioned that wealthy people there raised pure bred stock and thus much good stock could be found.

Mr. Jones next spoke of France and the enjoyable position occupied by agriculture in that country due to the tariffs against wheat. Italy was in a similar position and the tariffs were undoubtedly a good thing for those countries. Holland has several distinctive breeds of cattle, and he showed pictures of these and pointed out their characteristics. One feature that struck the eye was the absolute uniformity of markings and build in a given breed. He also mentioned that there is a cattle show in Holland only every ten years but that good cattle are inspected yearly and very complete records kept for comparison and other purposes.

Scotland was next mentioned and pictures of prize winning horses, sheep and cattle shown. Mr. Jones had several interesting stories to tell of the places he had visited and his experiences.

A hearty vote of thanks was moved to the speaker by Gavin N. Houston, M.E.I.C.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Junior Section

At a meeting of the Junior Section on November 2nd, L. A. Duchastel, S.E.I.C., was in the chair. As usual, two short papers were presented as follows:

1. "Public vs. Private Utilities," by J. R. Desloover, of the Power Corporation of Canada. In this the author gave some very interesting arguments for and against both public and private ownership, and a most active discussion took place.

2. "Wood Poles and their Preservation Treatment," by W. J. S. Dormer, Jr.E.I.C., of the Bell Telephone Company of Canada, Ltd. The author here gave an outline of the types of poles used and their strength and life, with reasons for decay and defects, followed by a description of preservation treatments and the method of applying same.

At a meeting held on November 16th, with S. Farquharson, A.M.E.I.C., in the chair, the following papers were presented:

1. "Reinforced Concrete Pipe," by E. A. Sherrard, of the Consolidated Pipe Company. The author described various types of concrete pipe and methods of manufacture. In the discussion following, some interesting features of the Bonna pipe recently ordered by the City of Montreal were explained.

2. "Features of the Rapide Blanc Development," by L. A. Duchastel, S.E.I.C., of the Power Engineering Corporation. Mr. Duchastel gave a very interesting paper, describing generally the development, and particularly the construction of the dam itself, stability, design, penstocks, gate openings, etc.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

Due to the kindness of the Canada Cement Company, the Branch enjoyed a very pleasant visit to the Port Colborne works on October 26th.

Rearrangements and extensions had recently changed the process from dry grinding to wet grinding and the improvement to the surrounding countryside and the cleanliness of the interior was quite noticeable. In fact, the final grinding and bagging rooms were the only places in which the visitors had to be careful of their clothes.

Manager L. M. McDonald and the staff officers guided groups through the various units, starting with the raw material at the rock crusher and explaining the various steps whereby the limestone and clay is mixed in exactly the correct proportions.

The large rotary kiln with the attached coolers and fuel system formed the chief item of interest. This machine is 412 feet long and about 11 feet in diameter with a slope of ½ inch to a foot and makes one revolution in 68 seconds. The slurry is fed into the upper end and immediately comes in contact with loose chains slung across the diameter of the kiln which assist the drying process and breaking up into particles, ready for calcining. At the lower end are ten cooling chambers, each 5 feet in diameter and 20 feet long, attached to the periphery of the kiln and revolving with it. The interior of each cooler is also fitted with numerous chains and the calcined product is further broken up and loses heat during the traverse. About 85 per cent of the air used in combustion is introduced to the kiln through these coolers and is thus preheated, the balance being blown in by the fan which handles the pulverized coal fuel. This chain system of transferring heat units is somewhat of an innovation, but appears to be working most satisfactorily. The fuel consumption has been reduced from 100 pounds of coal per barrel of cement, under the old dry-grinding process, to 78 pounds of coal per barrel.

The principal feature of the wet grinding process is a better control of materials resulting in a more uniform mixture going into the kiln and consequently little danger of some portions over-burning. The clinker has very few hard particles and the final grinding gives a product of which 92 per cent will pass through a 200 mesh screen, whereas, with the dry grinding process, 86 per cent was considered reasonable.

Calcining temperature in the kiln is kept at 2,700 degrees F. and the flue gasses are checked continuously for carbon monoxide and dioxide.

Refreshments were served at the main office and, after dinner at the Guild Hall, Mr. McDonald gave an illustrated address on cement manufacture and answered various questions as to the process.

Cement Manufacture

Mr. McDonald stated that in the Roman period hydraulic cement was made by combining lime with volcanic ash. In England the first record was in 1759, when John Smeaton experimented with clay and lime and achieved a good hydraulic cement which was used in the construction of the Eddystone lighthouse. James Parker, in 1796, mixed limestone with impure clays and by calcining at higher temperatures produced a cement which he named Roman cement. The name Portland cement did not come into use until the year 1824 when John Joseph Aspdin produced a quicklime by wet grinding rock and clay; this was then dried before calcining and the resulting concrete was seen to be quite similar to the local "Portland" rock.

In America the first record of hydraulic cement was that used for the construction of the Erie Canal in 1818, and in 1872 the first Portland cement was manufactured in Kalamazoo, Michigan. The first manufacture in Canada was at Thorold, Ontario, where a natural cement was produced in 1889 and at Napanee, Ontario, where a Portland cement was made. Natural cement rock is obtainable in the vicinity of Montreal and in the Lehigh Valley.

The per capita consumption of cement in America is about 1.4 barrels. The peak consumption in Canada was during the year 1930 when 9,500,000 barrels were produced. This has dropped to about four million barrels in the present year.

The kiln at the Port Colborne plant was designed for a capacity of 2,700 barrels a day, but might be overloaded to turn out as much as 3,200 barrels. The plant covers an area of 142 acres and uses 2,300 to 2,400 kilowatts of electricity. One hundred and forty men are employed and the storage bins have a capacity of 240,000 barrels. Local limestone and the overlying clay are the principal ingredients and the mix consists of 42 per cent lime with a silica ratio of 2.6. Nova Scotia gypsum to the amount of 3 or 4 per cent is added as a retarder. The slurry has a water content of 35 per cent and this is considered important because an extra one per cent of water will mean an extra pound of coal fuel per barrel.

In addition to the advantages of a finer ground and more uniform cement, the wet grinding process conserves about 6 per cent of the primary materials which was formerly wasted as dust. Also the plant maintenance and operating costs are materially reduced.

Mr. McDonald warned his audience however that, due principally to the finer grinding, storage methods would have to be watched very carefully. For periods of a month or longer in storage, he advised that sheds should have a floor and wall insulation, which would reduce the moisture content of the air to a minimum.

Chairman E. P. Murphy, A.M.E.I.C., presided at the meeting. Discussion was carried on by Messrs. Walters, A. J. Grant, M.E.I.C., G. F. Vollmer, M.E.I.C., and Councillor E. G. Cameron, A.M.E.I.C., moved the vote of thanks to Mr. McDonald and the Canada Cement Company.

Ottawa Branch

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

At the noon luncheon held at the Chateau Laurier on the 27th of October, O. M. Biggar, K.C., of the firm of Smart and Biggar, patent solicitors, Ottawa, was the speaker, his subject being "Inventions and their Protection." At the head table, in addition to the speaker and the chairman, C. McL. Pitts, A.M.E.I.C., there were the following: Col. F. H. Emra, M.E.I.C., A. E. MacRae, A.M.E.I.C., Col. H. Osborne, G. J. Desbarats, C.M.G., M.E.I.C., James VanWagenen, International Boundary Commissioner of Washington, N. Ogilvie, M.E.I.C., W. L. Scott, K.C., Group Captain J. L. Gordon, J. H. Campbell, W. I. Haskett, S. Bray, M.E.I.C., J. McLeish, M.E.I.C., and J. A. Wilson, A.M.E.I.C.

Inventions and Their Protection

At the commencement of his address, the speaker mentioned the difficulty in defining the word "invention," giving as his own definition "an exploratory incursion into realms of scientific knowledge not before explored."

Connected with the subject of inventions three points might be enumerated: first, the discovery of a new idea; second, improvements to an existing invention or device, and third, the creation of a new form. Patent laws in different countries treat these three aspects of the subject differently. About 80 per cent of inventions have been made by engineers. One of the most profitable inventions ever patented was a rubber band arrangement to put inside of dolls to make them say "Ma-ma" when squeezed.

The protection of inventions was considered a prerogative of the state as long ago as 1623. The protection of copyrights extends back some two hundred years and of trademarks much more recently. The underlying principle regarding the issue of a patent is that it is an arrangement whereby the state may protect a man's ideas for a definite length of time while he may utilize them to his own advantage. The practice relating to the granting of patents differs somewhat between England and the United States, with Canadian practice taking certain points from each. In England the fundamental principle is to stimulate industry, in the United States to stimulate inventions themselves.

In England, in line with the idea of stimulating industry, a patent might be given to a new method of manufacture introduced for the first time into that country, whether such method was devised by a resident of England or brought in from some other country. In Canada and the United States this is not the case. In England also, one cannot obtain a patent on anything in public use at the time of the application for patent. In the United States or Canada this is not the case and such use may extend over a period of as much as two years. Another point of difference is that in the United States there is no provision for the manufacture of an invention, after patent, whereas in England the patentee is required to carry on manufacture commencing within eighteen months of the date of the patent.

In England, the period of monopoly is computed from the date of the application for patent; in Canada and the United States the period is dated from the issue of the patent itself, which may be some considerable time, even years, after the date of the application.

A valuable feature of a government patent office is that it contains a public record of all inventions made from day to day. In England and in the United States the government patent offices are equally efficient, there being adequate subdivisions of the arts for reference purposes and complete printed copies of patent information available at small cost. In Canada, unfortunately, although a synoptic publication of the claims of patents is provided for, there is nothing corresponding to these, and one cannot obtain similar information without the payment of high fees and the loss of considerable time. For instance, information which may be obtained quite readily in England or the United States for a fee of, say, $10 might entail fees amounting to as much as $200 in Canada as well as a considerable delay in time.

In concluding his address, Mr. Biggar stated that the inventor should be very careful to properly define what it is he is inventing, for upon that definition the monopoly will be granted. Any other monopoly which had been intended but which was not defined could thereafter be awarded to anyone else.

Peterborough Branch

W. F. Auld, Jr.E.I.C., Secretary.
W. T. Fanjoy, Jr.E.I.C., Branch News Editor.

Annual Outing

The annual outing of the Peterborough Branch was held for the third year in succession at Kawartha Camp, Stoney Lake, on Saturday afternoon, September 24th. Attended by approximately forty, the day was successful from every standpoint.

The sports programme directed by D. V. Canning, Jr.E.I.C., included a softball game in which the single men defeated the married men 21 to 18, but the latter turned the tables in the tug o' war. The horseshoe pitching contest was won by J. Thornton and J. Cameron, S.E.I.C., beating R. L. Dobbin, M.E.I.C., and J. Turnbull 21-7.

The outing ended with an excellent meal in the club house prepared by the camp staff under the direction of Doug. Loomis.

Peterborough Gas Plant

The first regular meeting of the 1932-33 season took place at the Paragon hall, Thursday evening, October 13th, when some 37 members and friends gathered to hear E. F. Reid give an interesting address on the Peterborough gas plant. Mr. Reid has been connected with the local plant for some twenty-four years.

His remarks gave an insight into some of the city's early history, starting with the first gas by-law passed in 1857. Since that time the gas plant has grown until on September 10th to 17th, 1932, the second largest week's output was 17,260,000 cubic feet. The largest week's output of 17,750,000 cubic feet was made in 1923.

B. Ottewell, A.M.E.I.C., recently elected chairman of the Branch, presided at the meeting. Ross Dobbin, M.E.I.C., general manager of the Utilities Commission, introduced Mr. Reid.

Combustion in the Automobile Engine

An address of general interest on the subject "Combustion in the Automobile Engine and the Comparative Value of Various Fuels" was given by E. A. Allcut, M.Sc., M.E.I.C., Professor of Mechanical Engineering, University of Toronto, at the October 27th Branch meeting.

The speaker described the problems and advancements made in the high compression automobile engine and also the so-called Diesel engine. He pointed out that the trend in the gasoline automobile engine is toward higher compression and in the Diesel toward lower compression.

An interesting point brought out was that from the standpoint of calorific value the cheaper grades of standard gasoline varied but little from the more expensive. From an antiknock standpoint, however, specially treated fuels were superior.

At the close of the address the speaker was bombarded with a great number of questions, which revealed the interest with which the audience followed the subject. Among other things, the discussion brought out more clearly the fact that a lean mixture using 15 pounds of air to one pound of fuel eliminated carbon monoxide in the exhaust gases, and prevented the formation of carbon in the engine and gave a considerable increase in fuel economy.

Saguenay Branch

G. H. Kirby, A.M.E.I.C., Secretary-Treasurer.

The annual general meeting of the Saguenay Branch of The Engineering Institute of Canada was held at the Chicoutimi hotel on Monday, August 8th, 1932.

Preceding the meeting, lunch was served to the twenty-one members and friends present.

The minutes, annual report and financial statement were read by the Secretary, accepted as read by G. E. LaMothe, A.M.E.I.C., and seconded by H. R. Wake, A.M.E.I.C.

The Secretary's report included the results of the election of officers for the coming year, which were as follows:—

Chairman........................N. F. McCaghey, A.M.E.I.C.
Vice-Chairman...................A. W. Whitaker, Jr., A.M.E.I.C.
Executive Committee:
For one year term..........H. B. Pelletier, A.M.E.I.C.
F. W. Bradshaw, A.M.E.I.C.
For two year term..........S. J. Fisher, M.E.I.C.
A. Cunningham, A.M.E.I.C.

The retiring chairman, J. F. Grenon, A.M.E.I.C., then turned the meeting over to Mr. McCaghey who, in his opening address, gave a plan of what might be expected from the new executive in the line of meetings during the coming year. The chairman then called on Mr. Whitaker, who had promised to speak on aluminum, an abstract of which follows:—

Aluminum — Its Early History, Recent Development, and Future Possibilities

Aluminum is a comparatively recent metal and, while some of its compounds were known as early as the first century, the metal itself was not isolated until 1825, by H. C. Oerstedt, a Danish physicist and chemist, and in 1827 by Frederick Wohler. It was not until 1845 that Frederick Wohler isolated sufficient of the new silvery metal to study its properties.

Commercial development of aluminum was started by Henri St. Clair Deville in 1854, following his improved method of production. Deville's method was an improvement on Wohler's method, in that he substituted metallic sodium for potassium in the reduction of alumina, to form metallic aluminum. Even this process was very expensive, resulting in a very high price for aluminum, and, therefore, its very restricted use.

It was not until 1886 that Charles Martin Hall, in America, and Paul L. T. Heroult, in France, discovered a new process for the production of aluminum, a process in which the metal was electrolytically reduced from alumina in a fused bath of cryolite. Hall's discovery preceded Heroult's discovery by about two months, neither knowing of the work of the other. During the next ten years, between 1886 and 1896, development of the new process was carried forward under many hardships, both physical and economic, but by the latter date the industry had become well established, not only in America but in Europe, with the production measured in hundreds of tons instead of pounds, and cost in the order of cents instead of dollars. Thereafter, production and use of aluminum mounted rapidly until today approximately 500,000,000 pounds of aluminum are used annually.

A brief description was given of the life of Charles Martin Hall and also of the establishment and early struggles of the aluminum industry in the United States and Canada.

Aluminum is the most abundant of the metallic elements in the earth's crust. A brief picture was given of how it occurs in the various minerals, clays and rocks, together with descriptions of the more important ores from which it is derived. Bauxite, a hydrated oxide, is the most important source of aluminum today and is found largely in tropical and semi-tropical countries. As far as is known, there is no bauxite in Canada. The various methods of extracting aluminum from bauxite were described.

The major portion of the address dealt with aluminum and its alloys, outlining processes of production, fabrication, properties, and many of the more important uses. Aluminum alloys with practically all common metals, and even with many of the lesser known and rarer elements. Alloys of silicon, copper, manganese, magnesium and zinc are most common and constitute the bulk of aluminum alloys, however, in many varying combinations and proportions. As a rule aluminum alloys contain at least 85 per cent aluminum.

The physical and chemical properties of aluminum and its alloys were described, with especial emphasis on the more important physical properties in some of the well known strong and corrosion-resistant alloys.

It has been stated on good authority that aluminum and its alloys have a greater diversity of uses than any other metal. This seems most remarkable when consideration is given to the recent development of aluminum compared with the age old more common metals, such as iron, lead, copper and zinc, and certainly points to enormous future possibilities.

Many of the uses of aluminum and its alloys were outlined in detail, such as in cooking utensils, electrical transmission conductors (aluminum cable, bus bar, channel bus, etc.), automobile construction (such as pistons, connecting rods, crank cases, engine blocks, bodies, and many smaller parts), aluminum furniture, aluminum paint, structural aluminum shapes (such as I beams, channels, angles, etc., used in building, railway car, truck and autobus construction), castings for many uses where strength with light weight, beauty, permanence, resistance to corrosion, etc., were major factors. Aluminum in the past several years has passed the experimental stage in construction of many parts of railway cars, trucks, buses, railway and truck tank cars, equipment in the food and chemical industries, bridge cranes, booms of locomotive cranes, steam shovel dippers, and many other places where reduction in deadweight means increase in pay load, with corresponding ultimate economy.

Construction of the modern aeroplane and lighter than air rigid airships, such as the Akron, are outstanding examples of the use of aluminum and its alloys in fields of modern transportation.

Aluminum foil is another rapidly growing use. It has many uses, not only in plain and fancy embossed patterns, but in coloured printed patterns. It is used in the packaging of food products, tobacco products, and many other products where retention of moisture and quality as well as permanence, light weight and attractive appearance in packaging are desired. Aluminum foil is also rapidly coming forward as an important insulation material.

Construction of musical instruments, such as the violin and bass viol, are recent notable developments in the use of aluminum. The manufacture of collapsible tubes for cosmetics, dental and shaving cream, and of seals for all kinds of bottled food products are also important uses of aluminum.

Many more uses and forms in which aluminum and its alloys play a prominent part, were described. In order to emphasize and make more understandable many of these uses, the author displayed many interesting samples of forms in which aluminum is fabricated. The meeting took a keen interest in the display.

After the meeting the members present were the guests of the Chicoutimi Harbour Commission, who showed the party the points of interest in the construction of the Chicoutimi-St. Anne bridge.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. G. Clark, S.E.I.C., Branch News Editor.

Visit to the Coffer-Dam at West Saint John

On October 26th the flooding was commenced, preparatory to the removal of the coffer-dam, of the area on which the substructures of the new deep water terminal facilities have been built, at West Saint John, N.B.

The coffer-dam is 5,900 feet long and the area enclosed 43 acres. The range of spring tides is 28 feet and the bottom of the excavation, inside, is 35 feet below low water, so that a head of as much as 63 feet was supported by the dam. The maximum length of the sheeting was 85 feet.

On the above date, three openings, 12 inches by 24 inches, were cut about 15 feet above low water level, and during successive high tides water was admitted through these openings and a flume, 6 feet by 3 feet in cross-section. In a week's time, about 100 million gallons had flowed into the area, bringing the water level up to about 3 feet above low water level.

On November 2nd, the two control gates, 10 feet wide, which had been used during the construction, were opened. The sheeting here was cut out from 6 feet above low water level to the top of the dam. The water then flowed in sufficient volume so that the maximum head across the dam has not, since the opening of the gates, exceeded 4 feet.

The work of removing the coffer-dam fill is now being carried out and the sheeting is being withdrawn. The dredge "Leaconfield" is also at work excavating the approaches to the berths and the toe of the fill.

The works inside the coffer-dam, consisting of a pier 700 feet by 300 feet, the Navy Island quay wall 857 feet long, together with the head walls each about 300 feet long, of the two docks, are being built by the Atlas Construction Company, through whose kindness the visit of inspection of the Branch was made on September 2nd. The invitation was extended by A. Gray, M.E.I.C., general manager of the Saint John Harbour Commission, and the arrangements for the visit were carried out by the engineering staffs of the company and the Harbour Commission.

Saskatchewan Branch

Stewart Young, A.M.E.I.C., Secretary-Treasurer.

The first regular meeting of the Branch for the 1932-1933 season took the form of a dinner and smoker held jointly with the American Institute of Electrical Engineers, Saskatchewan Section, in the Grant Hall hotel, Moose Jaw, on Friday evening, October 21st, 1932.

Preceding the meeting, the members of both organizations paid a visit to the new Moose Jaw natatorium where they indulged in a swim in water that, except for its colour, approaches sea water, the pool, 40 feet by 75 feet, being fed at the rate of 75,000 gallons per day from two universalized springs, one at a temperature of 80 degrees F. and the other at 120 degrees F.

Following the dinner, at which there were about forty-five in attendance, the meeting adjourned to the Blue room where the balance of the evening was spent enjoyably in the form of a smoker, J. D. Peters, A.M.E.I.C., presiding.

Generation and Distribution of Power in Alberta

The regular meeting of the Saskatchewan Branch of The Institute was held in the Hotel Champlain, Regina, on Friday evening, November 13th, there being in attendance fifty-two members and guests.

Immediately following the dinner, J. D. Peters, A.M.E.I.C., chairman, introduced several new members, after which the meeting proceeded with the business of the evening.

The speaker was G. H. Thompson, A.M.E.I.C., chief engineer and manager, Calgary Power Company, who gave an excellent address covering the generation and distribution of power in Alberta by the Calgary Power Company.

After giving a brief outline of the power system in the province of Alberta as developed by the Calgary Power Company and associated companies, Mr. Thompson proceeded to a detailed account of the construction of the water power plant at the junction of the Ghost and Bow rivers, illustrating his address by numerous lantern slides.

The address was provocative of considerable discussion, and the meeting closed at 10.00 o'clock p.m. with a hearty vote of thanks to Mr. Thompson.

Sault Ste. Marie Branch

G. H. E. Dennison, A.M.E.I.C., Secretary-Treasurer.

Canada's Stake in Transportation

The speaker at the September meeting, held in the Windsor hotel on September 30th, was W. S. Wilson, A.M.E.I.C. Mr. Wilson spoke on "Canada's Stake in Transportation" and discussed the enormous financial investment of Canada in railways, harbours, canals, motor cars, highways, and other transportation facilities. He discussed the capacity of Canada's carrying systems, the movements of passengers and freights, the rates in effect on some commodities and the difficulties of securing two-way haulages. The competition of trucks, railways and lake carriers was also discussed, and the speaker concluded with a consideration of Canada's overdeveloped railway transportation and some of the factors which had contributed thereto. A hearty vote of thanks was tendered Mr. Wilson for his very interesting talk.

The Production of Lubricating Oil and its Application

The Sault Ste. Marie Branch of The Engineering Institute of Canada held their monthly dinner on Monday evening, October 31, at the Windsor hotel.

Mr. W. A. P. Schorman, chief consulting engineer for the British American Oil Company, was the speaker of the evening, and his subject, "The Production of Lubricating Oil and its Application."

Mr. Schorman discussed the origin of crude petroleum from organisms differing in structure and giving rise to the five grades now recovered—paraffins, semi-paraffins, asphaltic, semi-asphaltic, and naphthenic; the three series of molecular structure into which these five grades fall was next discussed and the fractional distillation of the paraffin series to obtain the different groups of molecules was described in some detail. The treatment of the fourth group of molecules, the wax distillates, obtained from the first fractional distillation, to obtain the viscous lubricating oils was also described in detail.

Mr. Schorman next discussed the tests by which oils are graded for their various applications, specific gravity, flash point, fire test, cold test, and viscosity and described the method and equipment used for these tests. Finally, the applications of lubricating oils was discussed: the theory of bearing lubrication, the severe duties to which lubricants are subjected in practice, the slight differences in method of application which have been shown to give widely differing effects in lubrication, and the absorption of oil by metallic surfaces.

A very interesting discussion followed completion of the paper, and a hearty vote of thanks was extended to the speaker on motion of K. G. Ross, M.E.I.C., and Wm. Seymour, M.E.I.C.

Vancouver Branch

W. O. Scott, A.M.E.I.C., Secretary-Treasurer.

Burrard Bridge

The "Burrard Bridge," Vancouver, B.C., was the subject of the paper presented to the Branch by Major J. R. Grant, M.E.I.C.

Major Grant was the designing and consulting engineer on this structure and presented an excellent paper, illustrated by lantern slides.

He outlined the history of the site and the difficulties encountered before the by-law authorizing its outlay was passed.

The paper gave complete detail of all the various phases of the construction of the project, including excavation, both on land and under water, sinking of caissons, pouring of concrete, steel erection, roadway, sidewalks, railings, electrical lighting, ornamental work, traffic studies and approaches and many other points.

Following the paper the meeting as usual was thrown open for discussion.

E. A. Cleveland, M.E.I.C., moved a vote of thanks to the speaker for the excellent paper and its illustrations, which was seconded by Chas. Brakenridge, M.E.I.C., city engineer, under whose office the project was fostered.

Attendance: members and visitors, 85.

The DeLaval Steam Turbine Company, Trenton, N.J., has developed a new type of rotary displacement pump known as the "DeLaval-IMO" which is available in capacities ranging from ½ to 700 gallons per minute, and for pressures up to 500 pounds per square inch. Pumps for higher pressures and capacities can be supplied. Power is applied to a central or power rotor, which meshes with one or more sealing rotors of such form that they are propelled largely by fluid pressure, with a minimum of mechanical contact. This action results from the ingenious shape of the threads, those of the power rotor being convex, while those of the idler rotor are concave. This tooth form, which is patented, accomplishes sealing so effectively that numerous turns of the thread around the rotor, as found in common screw pumps, are not required in order to keep slippage to a small value. Efficiencies of 80 to 90 per cent have, it is stated, been obtained on independent impartial tests. The velocity of the liquid through the pump is low and there is no trapping or cutting off of liquid in tooth pockets, and the pump operates successfully and quietly at the higher motor speeds and even at turbine speeds. A bulletin listing these pumps for oil service is available.

Preliminary Notice

of Applications for Admission and for Transfer

November 19th, 1932

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, 1933.

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

CHRISTIE—GEORGE WILLIAM, of Dartmouth, N.S., Born at Amherst, N.S., Feb. 17th, 1902; Educ., B.Sc. (Mech.), Nova Scotia Tech. Coll., 1924; 1924-25, dftsman., Stone & Webster Co., Philadelphia; 1925-26, dftsman., Philadelphia Electric Co., Philadelphia; 1926-28, field engr., Collins & Aikman Co., textile mfrs.; 1928 to date, asst. chief engr., Imperial Oil Limited, Dartmouth, N.S.

References: R. L. Dunsmore, C. Scrymgeour, J. S. Misener, F. R. Faulkner, J. L. Allan.

DARROCH—DAVID, of Calgary, Alta., Born at Barrow-in-Furness, England, June 10th, 1884; Educ., evening classes, Univ. of Wales; 1920-22, M.V.T.C., Univ. of Bristol; 1 year, Municipal Engrg. Academy, Liverpool; 1899-1904, ap'ticeship, boiler and pontoon constrn.; 1904 and 1909, training periods in Royal Navy; 1906-08, asst. foreman; 1909-10, automobile engrg.; 1912-13, foreman (supt.), boilermaker and pontoon bldr.; 1914, foreman engine fitter; 1917, instructor on internal combustion, H.M.S. Indus.; 1927-31, various positions, including engrg. (mech.) constrn., Pacific Paper Mills, Ocean Falls, B.C., installing diesel engines, generators, etc., in fishing vessels for Rose Engrg. Works, Steveston, B.C., and other plant installns.; April 1931 to date, elect'l. operator, City of Calgary, Alta.

References: F. M. Steel, P. J. Jennings, M. W. Jennings, G. H. Thompson, J. R. Wood, J. S. Tempest, W. H. Broughton, H. J. McLean, W. S. Fetherstonhaugh.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

PORTAS—JOHN, of New Glasgow, N.S., Born at Windsor, Berks., England, Dec. 17th, 1896; Educ., B.Sc., Engrg., London Univ., 1921; Military Service, 1915-22. Capt., Indian Army; 1922-23, struct'l. detailer, Ingalls Iron Works, Birmingham, Ala., U.S.A.; 1923-25, struct'l. designer, Canadian Vickers, Ltd., Montreal; 1925, misc. engrg. work, Montreal Engineering Company; 1925-27, estimator, design and checking details, Montreal Harbour Bridge, Monsarrat & Pratley, and from 1927 to 1931, with same firm, working on Montreal Harbour Bridge, Alexander Bridge, Detroit, Clifton Arch Bridge, Niagara Falls, Grand Mere Suspension bridge, property for cantilever and suspension bridges at Halifax and Vancouver, and other long span bridges, also C.N.R. Terminal, Montreal; 1931 to date, chief engr., J. W. Cumming Mfg. Co. Ltd., New Glasgow, N.S., manufacturers of struct'l. steel, castings, and machinery. (*A.M. 1927.*)

References: C. N. Monsarrat, P. L. Pratley, F. P. Shearwood, D. Stairs, J. W. Roland.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CRAWFORD—ROBERT ERIC, of 228 Percival Ave., Montreal West, Que., Born at Montreal, Aug. 15th, 1899; Educ., B.Sc. (Mech.), McGill Univ., 1922; 1918-19, C.P.R. Angus Shops; Summers, 1917, 1920 and 1921, machine shop work; 1922-23, production dept., and 1924-28, estimating, Dominion Engineering Works, Ltd.; 1922-28 and 1931 to date, instructor, senior evening classes in Mechanical Drawing, Montreal Technical Institute. Also at present, sales and advertising, Dominion Engineering Works, Limited, Montreal. (*S. 1919, Jr. 1925.*)

References: E. Brown, J. L. Busfield, H. S. VanPatter, H. Crombie, C. E. Herd, F. Newell.

SIMPKIN—DOUGLAS BENJAMIN, of Noranda, Que., Born at Maple Creek, Sask., August 16th, 1900; Educ., B.Sc. (C.E.), Univ. of Alta., 1922; Summers: 1918-19, surveyor's helper and transitman; 1920, leveller, 1921, field dftsman., Reclam. Service; 1922-23, steel detailer, Lackawanna Bridge Works; 1923, steel detailer, McClintic Marshall; 1923-25, struct'l. dftsman., Braden Copper Co.; 1925-28, chief dftsman., mech. dept., Anglo-Chilean Cons. Nitrate Corpn., Tocopilla, Chile, and from 1930-32 with same company as constrn. foreman (4 mos. steel erection, 6 mos. in charge of struct'l. shop, 6 mos repair foreman); 1929-30, and at present, designer, Noranda Mines, Noranda, Que. (*S. 1919, Jr. 1927.*)

References: R. S. L. Wilson, H. R. Webb, N. A. Pearson, H. B. LeBourveau, R. Barnecut, T. R. Cooil.

STEWART—DONALD, of 5258 Queen Mary Rd., Montreal, Que., Born at Inverness, Scotland, Oct. 30th, 1899; Educ., B.Sc. (E.E.), McGill Univ., 1926; 1923 (summer), dftsman., Northern Electric Co. Ltd.; 1924 (summer), electrn's. helper, Shawinigan Engrg. Co.; 1925 to date, with the Bell Telephone Company of Canada as follows: 1925-26, C.O. repairman; 1926-29, engrg. asst., dial equipment; 1930 to date, divn. equipment engr., Montreal Divn., Montreal, Que. (*S. 1924, Jr. 1927.*)

References: G. S. Ridout, A. M. Mackenzie, E. Baty, F. S. Howes, G. A. Wallace.

FOR TRANSFER FROM THE CLASS OF STUDENT

DUCHASTEL de MONTROUGE, LEON ALEXANDRE, of 640 Dunlop Avenue, Outremont, Que., Born at Westmount, Que., July 22nd, 1905; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1927; Summers: 1922-23, surveys, Quebec Streams Commn.; 1924, Quebec Highway Dept.; 1926, Welland Ship Canal; 1927-29, mech'l. dfting., and from 1929, study of proposed power sites on Upper St. Maurice Rivers. Hydraulic, reinforced concrete, and struct'l. steel design for the Power Engineering Company, Montreal, Que. (*S. 1925.*)

References: S. Svenningson, J. A. McCrory, A. L. Patterson, O. O. Lefebvre, A. E. Dubuc, R. E. Heartz.

RUTHERFORD—JAMES FOREST, of 5549 Queen Mary Rd., Montreal, Que., Born at Montreal, Aug. 2nd, 1905; Educ., B.Sc. (E.E.), McGill Univ., 1926; Summers: 1923, dftsman., Routex Corpn.; 1924, recount recorder, Bell Telephone Company; 1925, elect'l. helper, Quebec Constrn. Co.; 1926-27, student ap'tice, Canadian Westinghouse Co.; 1927-28, grinder room foreman, 1928-30, mtce.engr., Laurentide Co.; 1930-32, engr. in charge of sales and service on Hoffman bearings, Lyman Tube & Supply Co.; at present, sales engr., Pollock International Corpn. Ltd., Montreal. (*S. 1924.*)

References: C. V. Christie, W. B. Scott, H. O. Keay, S. F. Rutherford, E. B. Wardle, J. Palmer, H. G. Timmis.

YEOMANS—RICHARD HENRY, of 55 Wolseley Ave., Montreal West, Que., Born Buffalo, N.Y., Sept. 17th, 1905; Educ., B.Sc., McGill Univ., 1930; with the manufacturing dept., Northern Electric Co. Ltd., Montreal, as follows: 1922-24, 1924-26, and summers 1927-28-29, work including inspection engrg. work, check inspection work, etc., and from 1930 to date, inspection engrg. work, including quality studies, testing of carrier telephone, telegraph and repeater equipment and testing of manual and automatic telephone equipment. (*S. 1928.*)

References: A. J. Lawrence N. L. Dann, H. Miller, W. H. Jarand, B. H. Steeves, H. J. Vennes.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and 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

All notices intended for publication must be received not later than the 17th of the month for the E.I.C. News and the 25th of the month for The Journal.

Situations Vacant

INDUSTRIAL ENGINEER, university graduate, preferably between the ages of 30 to 36. Experience in paper mill and time study work desirable, the former not altogether essential. Must be able to handle employees and be tactful. Apply to Box No. 892-V.

Civil Service

22408. Six Junior Trade Commissioners (Male), in the Department of Trade and Commerce, at Ottawa, at a salary of $1,920 per annum. By legislation this salary is subject to a deduction of 10% for the fiscal year beginning April 1, 1932.

Duties: To engage in a course of instruction in foreign commerce under the Director, Commercial Intelligence Service, for the purpose of becoming qualified to fill the position of Assistant Trade Commissioner; in the course of this instruction to perform clerical and correspondence work as required; to compile statistical and other reports dealing with the industries and resources of Canada.

Qualifications: Education equivalent to graduation from a university of recognized standing or graduation from the Royal Military College, Kingston, full course; preferably graduation from a university with the degree of Bachelor of Commerce, or with specialization in political economy; preferably some knowledge of French, German, Italian or Spanish.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, *not later than January 3, 1933.* Application forms may be obtained from the offices of the Employment Service of Canada, from the Secretary of the Civil Service Commission, or the Secretary of The Engineering Institute of Canada.

Situations Wanted

YOUNG ENGINEER, B.A., B.Sc., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill 1919, A.M.E.I.C., P.E.Q., 12 years experience oil refinery and power plant design, factory maintenance, steam generation and distribution problems, heating and ventilation, etc. Available at once. Location immaterial. Apply to Box No. 265-W.

ELECTRICAL ENGINEER, B.Sc., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co.; telephone engineering and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Sales or industrial engineering desirable. Apply to Box No. 266-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C., Jr.A.S.C.E., age 28, married. Experience: construction, design, cost estimating on hydro-electric and storage work, also railway. Desires work in engineering, industrial or commercial fields. Available at once. Apply to Box No. 447-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Located in Toronto. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL ENGINEER, A.M.E.I.C., University graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at once. Apply to Box No. 564-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, graduate of McGill University, B.Sc. '30, seeks position in any capacity. Fluent French and English. Apply to Box No. 599-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL ENGINEER, B.Sc., '29, Jr.E.I.C. Age 26. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

YOUNG ENGINEER, B.A.Sc. (Univ. Toronto '27), Jr.E.I.C. Four years practical experience, buildings, bridges, roadways, as inspector and instrumentman. Available at once. Present location, Montreal. Apply to Box No. 714-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Born in Canada. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '31, S.E.I.C. Age 25. Nine months experience on installation of power and lighting equipment. Eight months on extensive survey layouts. Two summers installing telephone equipment. Specialized in radio servicing and merchandising. Available at once. Location immaterial. Apply to Box No. 740-W.

SALES ENGINEER, B.Sc., McGill 1923, A.M.E.I.C. Age 33 Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York State. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

MECHANICAL ENGINEER, graduate, '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Age 25. Married. Available at once. Apply to Box No. 767-W.

WORKS ENGINEER, A.M.E.I.C. Twenty-four years experience, responsible for the design and building of extensions to mill buildings, specifying and installing of equipment and maintenance of plant of large manufacturing company. Good references. Will take position abroad. Apply to Box No. 768-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box No. 770-W.

ELECTRICAL ENGINEER, Queen's Univ. '24, Jr.E.I.C., age 32, married. Experience includes, student Test Course, Can. Gen. Elec. Co., four years dial system telephone engineering with large manufacturing company. Available at once. Apply to Box No. 772-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

SALES ENGINEER, Grad. McGill Univ. in E.E. '26. Canadian, married, age 27. Two and a half years General Electric Co., U.S.A., including two years on Doherty's Advanced Course in engineering. Experience also includes sales work with automobile manufacturers, and general merchandising work with building trades. Available on short notice. Apply to Box No. 782-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

CIVIL ENGINEER, B.Sc., '32. Two years experience in municipal engineering. Two summers experience in highway engineering. In charge of survey party last summer. Available at once. Location immaterial. Apply to Box No. 800-W.

STRUCTURAL ENGINEER, B.Sc., Jr.E.I.C., with extensive experience in design and construction of industrial buildings and tall office buildings. Fully experienced in latest developments, in steel and reinforced concrete frames for above buildings. At present located in Chicago. Available at about one to two weeks notice. Apply to Box No. 802-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C. B.Sc. (Queen's '32), age 21. Three summers surveying in Northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

Situations Wanted

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

SALES ENGINEER, M.E.I.C., graduate civil engineer with twenty years experience in the structural, sales, and municipal engineering fields, and as manager of engineering sales office. Available at once. Apply to Box No. 830-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

AERONAUTICAL ENGINEER, B.Sc. (McGill,) M.Sc. (Mass. Inst. Tech.). Canadian. Age 26, recent graduate. Capable of aeroplane design and stress analysis. Apply to Box No. 838-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. Toronto '22), age 32, married, Jr.E.I.C., Jr.A.S.M.E., P.E. (Ont.). Experience includes executive power plant, plant layout, maintenance, development, research, consultation, testing, inspection, laboratory instruction and lecturing. Available immediately for any location. At present in Toronto. Apply to Box No. 842-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience, B.O.T. certificate, thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ENGINEER, McGill Sci. '21-'25, S.E.I.C., Aerial mapping, stereoscopic contour work; lumber classification; highway, railway and transmission line locations; estimates; water storage investigations, etc. Five years ground surveys; three years aerial mapping. Bilingual. Available on short notice. Apply to Box No. 872-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of bldgs., etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting. requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Dept. checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial At present in Toronto. Apply to Box No. 899-W.

ENGINEER, Jr.E.I.C., specializing in reconnaissance and preliminary surveys in connection with hydro-electric and storage projects. Expert on location and construction of transmission lines, railways and highways. Capable of taking charge. Location immaterial. Apply to Box No. 901-W.

MECHANICAL ENGINEER, Canadian, age 25, B.Sc. (Queen's '32). Since graduation on supervision of large building construction. Undergraduate experience in electrical, plumbing and heating, and locomotive trades. Available at once. Apply to Box No. 903-W