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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Hydro-Electric Development on the Seguin River

Municipally-Owned Plant Now Being Constructed for the Town of Parry Sound, Ont., To Generate From 2,200 to 2,900 H.P.—Gravity Type Concrete Power Dam—Concrete Storage Dam at Mill Lake—Initial Expenditure, Approximately $150,000

TWO new concrete dams on the Seguin river, and a new power house with an ultimate capacity of from 2,200 to 2,900 electrical horse-power are being built for the town of Parry Sound, Ont., as a municipally owned public utility.

Parry Sound, located on the east shore of Georgian Bay, has the advantages of water transportation and service by three railways: Grand Trunk, Canadian Pacific and Canadian National. It is a county seat and the centre of an enterprising community. The population according to the last census (1911) was 3,429, but has since increased considerably, and during the war reached nearly 7,500, largely due to the great industrial activity in the neighboring town of Nobel, where plants of Canadian Explosives, Ltd., and British Cordite Co. were located. Since the armistice, business in Parry Sound has been reduced in volume and the town's officials decided that steps must be taken to ensure an adequate supply of power, so that new industries can be attracted to the town and its prosperity maintained.

The firm of C. H. and P. H. Mitchell, consulting engineers, Toronto, was asked to report upon the cost of an increased power supply, and a by-law was submitted to the citizens, who decided by a very large majority to adopt the scheme suggested by the engineers and to begin construction immediately.

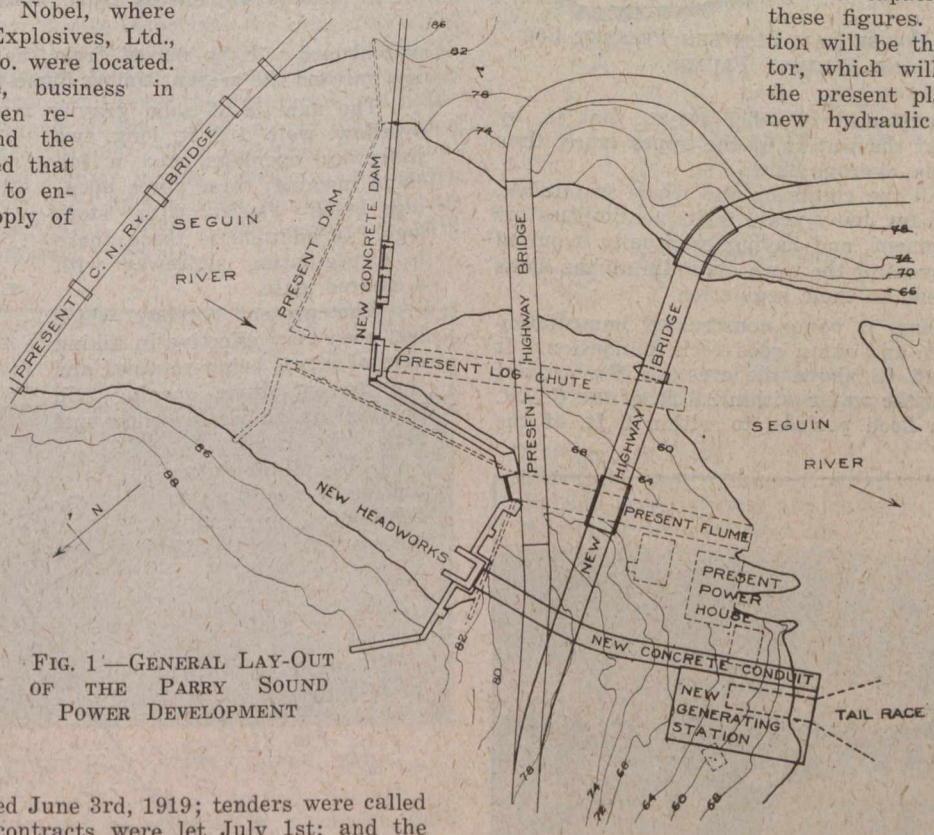


FIG. 1.—GENERAL LAY-OUT OF THE PARRY SOUND POWER DEVELOPMENT

The vote was polled June 3rd, 1919; tenders were called to be in June 20th; contracts were let July 1st; and the power dam is now nearing completion.

For many years past the town has owned a small hydro-electric power plant, located very near the site of the plant now under construction. The old plant was rebuilt in 1905 and equipped with a Jenckes hydraulic turbine and an Allis-Chalmers-Bullock generator of 425 k.w. capacity. A concrete dam on the Seguin River was built at the same time, and also a timber storage dam at the outlet of Mill Lake. The town's power requirements are exceeding the capacity of this plant; moreover, the officials dislike being dependent upon a single unit; so, for these reasons, and also those outlined above, it was decided to build the new plant.

The Seguin river watershed, with an area of 425 square miles, includes at least twelve lakes well suited for storage purposes. Conservatively estimating the flow at one cubic foot of water per second for each square mile, with a gross head of 32 ft., 1,200 h.p. (24-hr. power) would be available. Assuming that the load factor of the system would not exceed 50%, the plant would produce 2,400 h.p. on peak, or about 2,250 h.p. of saleable electrical power, and upon these figures the design was based.

The engineers point out that a more complete study of the watershed, with its excellent storage possibilities, may show a capacity much in excess of these figures. The initial installation will be the old 600 h.p. generator, which will be transferred from the present plant and coupled to a new hydraulic turbine, and a new 800 h.p. unit, or a total of 1,400 h.p. By the time the third unit is required, more accurate run-off data will be available, and the third unit, instead of being 800 h.p., may be 1,000 or even 1,500 h.p.

The present plans, however, are for an ultimate installation of at least 2,200 h.p., of which 60 h.p. will be required for the operation of the motor-driven exciters, leaving a net saleable output of 2,140 h.p. This is not taking into account the generator overload capacity of 400 h.p. With the initial installation of 1,400 h.p., allowing 40 h.p. for exciters, the net saleable output will be 1,360 h.p., not including the generator overload capacity of 200 h.p. The generator station provides room for the installation of a third unit of any probable required capacity.

Between Mill Lake and the head water, there is 5 ft. difference in level. At the new development there will be a gross head of 32 ft. The difference in level between the new tailrace and Parry Sound, which is an arm of Georgian Bay, is 8 ft. It may be mentioned that there is a power development, owned by the Parry Sound Lumber Co., on the Seguin River between Georgian Bay and the town's plant.

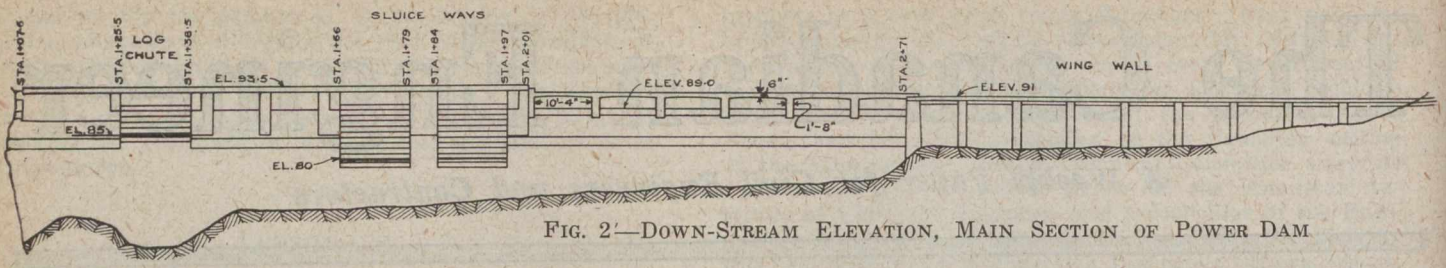


FIG. 2—DOWN-STREAM ELEVATION, MAIN SECTION OF POWER DAM

The engineers considered the possibility of building a higher power dam and thus obviating the necessity of a new dam at Mill Lake, and also increasing the working head. By raising the dam another 5 ft., a head of 37 ft. could have been obtained, but there would then have been a greater area under flood below Mill Lake. It was estimated that the land damages, including the necessary removal of the C.N.R. tracks, would cost more than the value of the additional power that would be obtained as a result of the higher head. It was thought that a much smaller sum would give as much

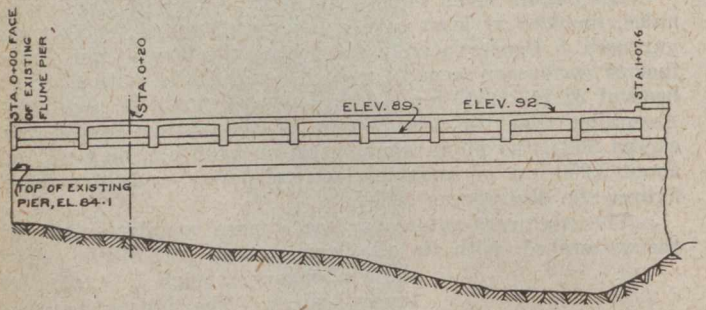


FIG. 3—SECTION OF POWER DAM BETWEEN PRESENT LOG CHUTE AND PRESENT FLUME

additional power if expended in other ways; that is, by stricter conservation of the waters of the upper lakes, thus increasing the possible average flow.

The town owns all the rights on the whole watershed, having looked forward for many years to its possibilities for greater power development, and having eventually acquired entire control. Employees of the town maintain all the dams on the lakes, and attend to their regulation.

The new power dam is being constructed immediately below the present dam, and has a good rock foundation. It will raise the water 6 ft. above the crest of the present dam. This will bring the water within 2.8 ft. of the C.N.R. bridge girders, or, in flood periods, to within 2 ft. of the

FIG. 4—OLD DAM AND HIGHWAY BRIDGE, LOOKING DOWN-STREAM

girders. It was hoped that the old dam might be utilized in the construction of the new works, but upon examination it was found that its condition did not warrant further use, and it has been entirely abandoned. The new dam is so placed that the present plant need not be shut down until the new plant is ready to be operated. The entire works will be constructed, ready for operation, before the final gap in the new power dam will be closed, shutting off the supply to the present flume. This is shown by Fig. 1. After the new unit is in operation, the old generator, exciter and

FIG. 5—NEW POWER DAM, LOOKING UP-STREAM

switchboard will be moved from the present plant to the new one and the present timber flume will be dismantled.

The dam is of solid gravity type. The crest has an overflow weir 160 ft. long, two sluiceway openings, and a log chute opening, these three openings being closed with stop-logs. In addition to these, there is a regulating sluiceway with a geared gate.

The present forebay, which has been very effective in taking care of ice, is being retained and the present flume opening will be used as an ice overflow and sluiceway.

With all the sluices and weirs, floods up to 5,000 c.f.s. can readily be passed, and this

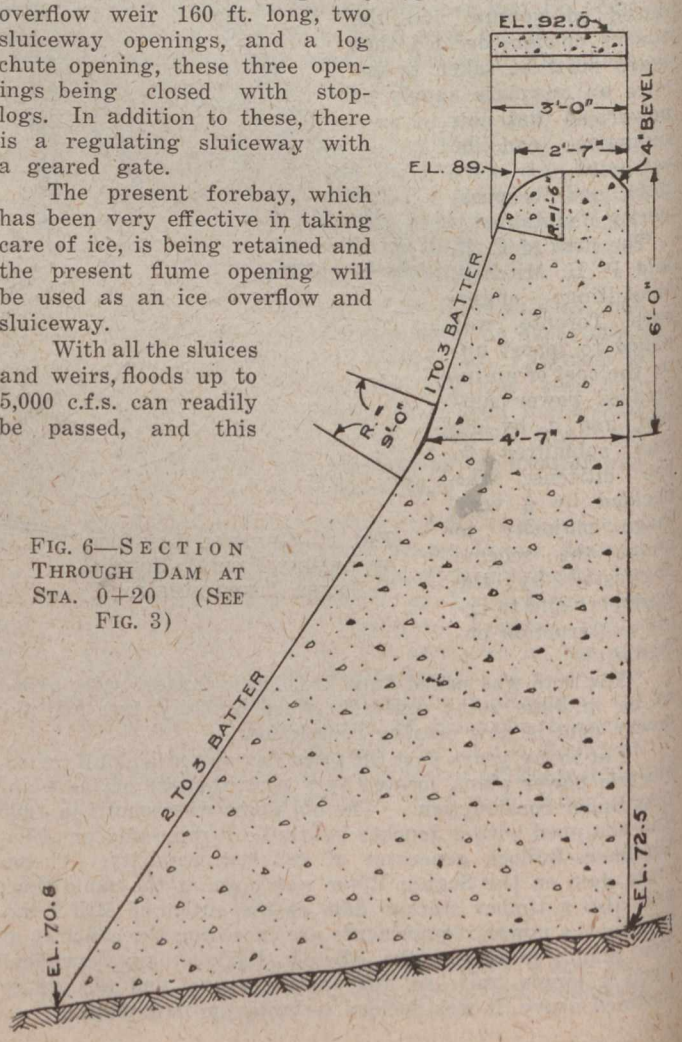


FIG. 6—SECTION THROUGH DAM AT STA. 0+20 (SEE FIG. 3)

flood capacity is said to be in excess of any flood likely to occur after the Mill Lake dam has been rebuilt and other storage dams have been put in place.

The headworks intake leads to a reinforced concrete conduit, box section, 9½ by 10 ft., through which the water flows to the power house. The intake is being equipped with gates, racks, ice and debris outlet, etc., and is housed.

The turbines will be set in open concrete flumes and will be of standard horizontal type, equipped with Lombard oil

FIG. 7—VIEW ACROSS OLD POWER DAM, SHOWING HEADWATER AT RIGHT AND LOG CHUTE

pressure governors. The generator aisle will be used only for the three generators. The switchboard gallery is raised 21 ins. above the floor and projects into the generator aisle, so that the operator will have a clear view of all equipment. The exciters are adjacent to the switchboard gallery. An overhead travelling crane will serve the generators and hoisting gear will be arranged for the flumes and for the erection and adjustment of the turbines. The switchboard will consist of generator and exciter panels, feeder panels, series street lighting panels, etc., and will be equipped with an automatic voltage regulator. The power house and gate house will be of reinforced concrete.

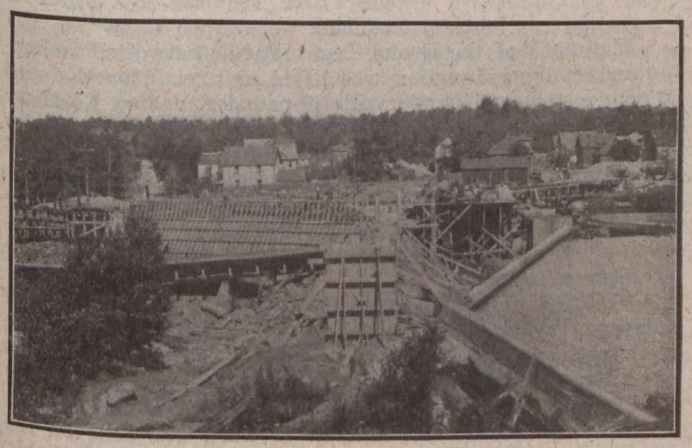


FIG. 8—NEW POWER DAM UNDER CONSTRUCTION

The Mill Lake dam will be replaced by a concrete dam of the same height, containing log chute, overflow weir, sluiceways and a submerged gate.

The road en route to Mill Lake will be flooded at one place as a result of the higher power dam, and this will require 6 ft. of fill for a length of 400 ft., and the construction of a culvert.

As can be seen from Fig. 1, there is at present an old highway bridge across the river just below the power dam. While the necessary new bridge could be carried on the power dam, that would entail considerable detour and steep grades. Bearing in mind proper town planning requirements, eliminating such detours and grades, it has been decided to build a new bridge, costing $15,500, below the present one.

Following are the costs as estimated by the consulting engineers, and it may be stated that all the contracts have been awarded within the estimates:—

Power dam, including sluice gates, etc., and cofferdams	$ 18,500
Head works, north wing wall, conduit, intake and water metering equipment	14,500
Generating station, flumes, gates and tailrace	32,800
Crane and hoist	2,500
Removal of flume, resetting log chute, etc.	750
Two turbines, one 1,050 h.p. for new generator, and one 650 h.p. for present generator, with governors, installed	19,200
Generator, 600 kw., installed	11,000
Resetting present generator and exciter	300
Motor generator exciter set	2,000
Switchboard, including rebuilding of present switchboard, wiring, etc.	6,750

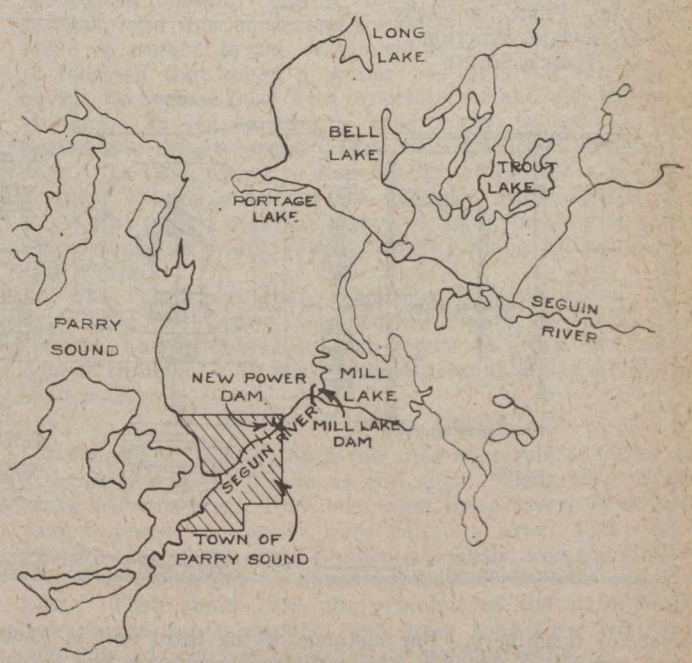


FIG. 9—MAP OF THE PARRY SOUND DISTRICT, SHOWING COURSE OF THE SEGUIN RIVER AND LOCATION OF NEW DEVELOPMENT

Voltage regulator	1,700
Mill Lake dam	6,500
Raising level of road and culvert	1,000
Allowance for contingencies	6,500
Engineering	7,000
Interest during construction	4,000
Land damages above power dam	15,000
Debenture issue	$150,000

(Six per cent. bonds sold at 101.75)

Annual Generating Charges

Following are the estimated annual charges:—

Annual charge on debenture issue	$ 11,250
Annual charge on balance outstanding ($30,000) on old debentures issued in connection with present power plant	2,225
Maintenance and repairs	3,000
Supplies, oils, etc.	500
Operation	3,600
Insurance	400
Annual generating plant charges	$ 20,975

With an output of 1,360 h.p. (neglecting the overload capacity) this would mean an annual power cost on the switchboard of $15.50 per h.p.

If the third unit be identical with the initial new unit, the cost on this installation will be, at present prices:—

Turbine with governor	$ 11,500
Generator	11,500
Switchboard and wiring	2,000
Total	$ 25,000

The additional storage capacity required throughout the watershed for supplying the three units, together with attendant land damages, is estimated at $25,000, or total cost of $50,000 for an additional saleable output of 780 h.p. (neglecting overload capacity). On this, annual cost would be $4,450; or for the 2,140 h.p., the total annual cost would be $25,425, or $12 per h.p. It is confidently expected by the engineers, however, that with extensive storage on the watershed, a greater power capacity would be available, and that the third unit could be larger without appreciable additional cost for machinery. For instance, if the third unit is 1,500 h.p. instead of 800 h.p., the additional cost over the above figures would be $20,000, on which the annual charges would be $1,600. This would yield 2,830 h.p. at a total annual cost of $27,025, or somewhat less than $10 per h.p. at the switchboard.

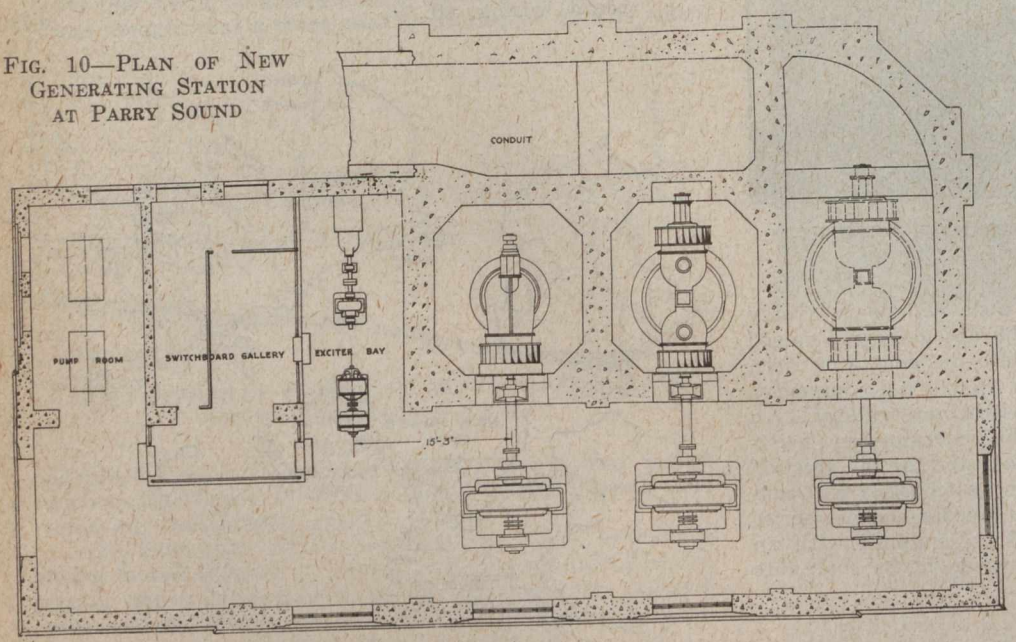


FIG. 10—PLAN OF NEW GENERATING STATION AT PARRY SOUND

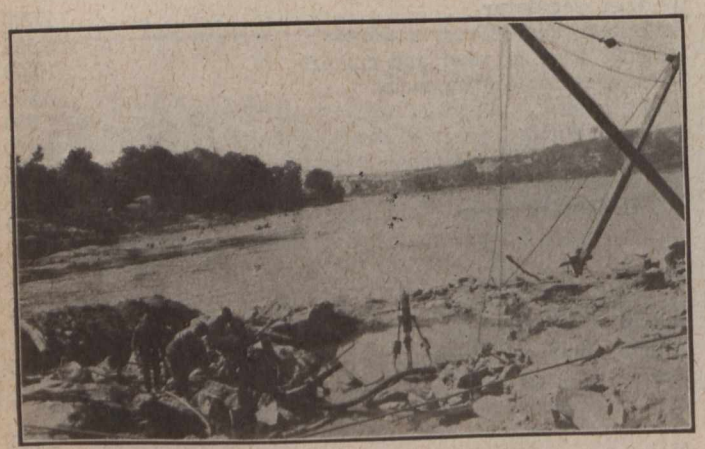


FIG. 11—EXCAVATION FOR TAILRACE AT GENERATING STATION SITE

R. W. Harris is the resident engineer for C. H. and P. H. Mitchell, who are supervising the construction of the plant. Geo. Groves is superintendent of the Parry Sound Electric Light and Power System. The general contractors are W. M. Fletcher & Co., of Toronto; the contractors for the electrical equipment are the Canadian Westinghouse Co., Ltd., of Hamilton; for the hydraulic equipment, the Boving Hydraulic & Engineering Co., Ltd., of Lindsay.

TRACK LIFTED FOR MILITARY USE

OVER 23,000 tons of steel were lifted from the roadbeds in Canada during the war and shipped overseas, according to the report presented to the Dominion government by Alex. Ferguson, engineer in charge of lifting rails for war purposes. Mr. Ferguson's report follows:—

On the 21st of May, 1917, instructions were given to proceed with the work of lifting track from the roadbeds of the Grand Trunk Pacific and Canadian Northern railways, between Imrie and Resplendent, Alta., in order to provide steel rails for the use of His Majesty's armies in France. An organization was immediately created, and the work of lifting track and of transforming the two lines into one commenced.

The Grand Trunk Pacific track, between Imrie and Leaman Junction, 13.6 miles; between Obed and Pocahontas, 42.25 miles; and between Geikie and Resplendent, 34.8 miles, was lifted, and the rails and angle bars shipped to Three Rivers for shipment to France.

The Canadian Northern track between Leaman Junction and Obed, 79.9 miles, and between Snaring Junction and Geikie, 22.05 miles, was lifted and the rails relaid on the Grand Trunk Pacific roadbed, between Leaman Junction and Obed, and between Snaring Junction and Geikie, thus releasing the Grand Trunk Pacific rails and fastenings for war purposes as required by order-in-council.

The track of the Grand Trunk Pacific between Pocahontas and Snaring Junction was lifted and relaid partly with 60-pound steel and partly with 80-pound Canadian Northern steel in order to release the Grand Trunk Pacific steel for shipment to France, and at the same time preserve rail connection with the coal mines at Pocahontas. This portion of the Grand Trunk Pacific line is being operated as a spur and is, as yet, considered merely temporary. A rearrangement of the main lines may be found necessary in the interests of economy.

The first shipment of steel rails for Three Rivers left Edmonton on the 17th of June, 1917, and the last on the 26th of October, 1917. The total shipments amounted to 23,408 gross tons of rails and 1,110 gross tons of angle bars.

During the months of October, November and December, 1917, a considerable amount of work was done on the construction of highways between Otley and Carrot Creek, and between Peers and Fulstow, in order to give the settlers access to the Grand Trunk Pacific line. Before the close of the fiscal year arrangements were made for the completion of these roads and for the construction of a roadway from Rosevear, on the Grand Trunk Pacific, to Horner.

The tenders which were received last Monday by the Department of Public Highways, Province of Ontario, for the construction of about 65 miles of bituminous roads, have been opened and the contracts awarded, but the department states that it will be impossible to give out any information regarding the list of bidders, prices or names of successful contractors until the provincial cabinet has approved of the awards suggested by the department.

Water Power Policies of the Quebec Government

Goodwill of Ontario and Federal Officials Needed to Solve Some Difficult Problems—Emphyteutic Leases from 9 to 99 Years — Many Undeveloped Powers in the Province—Address at the Annual Meeting of the Union of Canadian Municipalities

By ARTHUR AMOS
Chief of the Hydraulic Service, Province of Quebec

CANADA'S water-powers! Quebec's water-powers! What alluring words, to a great many promoters; what promises, to a great many prospectors! One might almost think that a waterfall is as valuable as a gold mine. I might state immediately that such is not my opinion. Once a gentleman very much interested in water-powers and who had obtained a valuable grant from the government, came to my office and said: "I think that a power concession is merely an authorisation to spend a lot of money."

I do not agree with that statement either, although I do believe that a person wishing to obtain a water-power grant must be well organized financially and gifted with an energetic character and much perseverance in order to be able to realize a development. Anyone who has tried to acquire flooding rights will no doubt agree with that statement.

In my province there are still, of course, a great many undeveloped power-sites, both in the populated districts and northward in the great uninhabited New-Quebec.

Recently the Hydraulic Service was called upon to make a statement regarding the assets of Quebec in this regard, and it was thought proper to consider separately the power-sites that might be useful to the present generation and those that would only benefit our grandsons. This division line was fixed along the 50th parallel, so a glance at the map will show that we have practically admitted that more than two-thirds of the powers of the province are out of reach for the time being.

Incidentally, I was not quite right in doing so, for we have actually issued a lease for a water-fall near the 57th degree of latitude, about as far north as the middle of Hudson Bay!

Nevertheless, we have roughly estimated the energy of the water-falls below the 50th parallel to represent, in round figures, 5,000,000 h.p. If we assume that the remainder of the province is equally well provided with water-falls, it would then have some 10,000,000 h.p. scattered in the wilds of the Labrador and Ungava districts; but these figures are merely hypothetical, and personally I do not attach great importance to them; I believe rather that we had better concentrate our thoughts and abilities on the sites that are at our very doors and waiting on our initiative to supply us with all the commodities that their energy represents.

Two Classes of Rivers

To that end, the concurrent goodwill and best brains of our governments, at Ottawa and at the provincial capitals, must unite in order to find the means of solving the many difficult problems that are involved.

As you know, rivers are of two classes, the navigable ones and the non-navigable. Although this division is simple enough, yet innumerable disputes have from time to time arisen owing to the difficulty of getting a correct definition of what is a navigable stream. For instance, I may mention the case of the Ottawa river, which was declared navigable near Ottawa, at Table Rock, only by three judges against two, in the Appeal Court. If a river be navigable, then its bed is vested in the provincial government, notwithstanding the fact that the federal government controls the works that may be built thereon.

Consequently, any applicant for power on the St. Lawrence, the Ottawa or the Saguenay, for examples, must negotiate with at least two governments. In the case of the Ottawa river, the third government, that of Ontario intervenes, as this river is the interprovincial boundary.

It may therefore be seen that it would be desirable that as regards such rivers, a uniform policy should prevail, and that similar conditions by the three authorities would be of great advantage to prospective users. Possibly, however, it would be better not to discuss difficult cases but preferable to state what is done regarding other rivers where only one government has charge.

I have stated that the rivers are divided into two classes, navigable and non-navigable. The beds of non-navigable rivers are either private property or form part of the public domain. Before 1884, the Quebec government granted land lots bordering rivers without any special reserve in regard to the water rights adjoining these lots. It followed that when a settler had obtained his letters-patent, he became *ipso facto* proprietor of half the adjoining stream. In consequence a good many water-falls thus passed into private property and were developed at an early date. In 1884, owing to disputes for water rights, the government became aware of the value of water-powers, and a law was passed creating a reserve, in favor of the Crown, three chains in width (about 200 ft.) along all non-navigable rivers.

The result was that, remaining riparian owner since that date, the Crown retained all rights in the bed of streams, and its leases on such rivers do away with many former troubles. To give a short account of these government leases:—

History of Quebec Leases

Originally (about 1867) the sites were sold outright for practically a nominal sum as mill sites. Then, some thirty years later, or about 1897, somewhat more severe conditions were imposed and prices were raised a great deal. Such was the case of the great Shawinigan Falls, sold for $60,000 with the obligation of spending $3,000,000 within a few years. Then about 1909, the principle of the emphyteutic lease began to be applied, and since that time has been generally adopted almost to the exclusion of sales.

I do not know whether emphyteusis is well known outside of the province of Quebec, so I will explain what it means in a few words. It is a contract by which the proprietor of an immovable, conveys it to another for a time which cannot be shorter than 9 years nor longer than 99 years, the lessee binding himself to make improvements, to pay the lessor an annual rental, and to pay such other charges as many be agreed upon. This sort of lease differs from other leases by the fact that the lessee (provided he fulfills his obligations) becomes the real proprietor of the object conveyed, to all intents and purposes; he can sell or mortgage the property, and make any improvements he wishes. At the end of the lease the lessor takes back the property, as well as the buildings thereon, and may then enjoy all the improvements made unless he wishes to renew his contract. I shall not further discuss emphyteusis, as full details may be found in the civil code.

Such has been the policy adopted by the Quebec government for the last ten years and the public seems to like it. Rentals from those leases have been growing from year to year. In 1914, they amounted to $10,000; they reached $72,000 in the last fiscal year.

There is also another important source of revenue derived from rivers; it is the so-called stored water. There are several regulating reservoirs in the province. The first ones were built by the Public Works Department in the upper Ottawa, at the foot of Lake Temiskaming, at the foot of Lake des Quinze, and at the two outlets of Lake Kipawa. The others were built by the Quebec Streams Commission at the headwaters of the St. Maurice, at the outlet of Lake St. Francois, and a smaller one on the Ste. Anne de Beaupré River.

The St. Maurice River reservoir, which has lately been named the Gouin reservoir, is by far the largest of all. In fact it stores more water than is held by the Assuan dam built by the Imperial government on the Nile. So far it has permitted the commission to double the minimum flow of the St. Maurice, in accordance with its contract with the mill owners; and I have reason to believe that it will be possible to increase substantially this proportion.

The project cost about $2,500,000, including various accessory works such as a hydro-electric plant capable of developing 1,000 h.p., a railroad 20 miles in length, etc. This reservoir is at present yielding a revenue of $191,000 per annum just from the three companies now using it.

Storage Profitable for Province

After subtracting interest on the capital and an annuity for a sinking fund to redeem our bonds in 30 years, we had this year a net profit of about $25,000. Bearing in mind that there are still many rapids and falls available on the river, and that several of them will likely be developed in the course of the next 10 to 15 years, it may be seen that the proposition is a good one both for the government and for the users of the water.

The method adopted to collect the revenue was based, after mature consideration, on the horse-power-year. This expression needs a word of explanation. The minimum flow occurs in the fall and again in the winter months. The reservoir is consequently closed some months in the year and only opened in times of drought. The water given out in those dry months is calculated as though it was evenly distributed throughout the year; by a simple calculation it may then be converted into horse-power according to the head at each power-house. Such is at present the policy of the government as regard water-power and storage reservoirs.

I have not referred at any length to the undeveloped water-powers of Quebec for the reason that I have treated the subject already in a little booklet entitled, "Water-Powers of the Province of Quebec," which was printed in 1917, by the Department of Lands and Forests of the Province of Quebec, and which will be mailed free to anybody applying for it.

Permit me to sum up the situation by saying that the province of Quebec is well provided with water-powers, as is well known, but that most of its falls are not of great height.

It should be especially observed that the sites where considerable energy (over 50,000 h.p.) can be produced, and which are still in a natural state, are remarkably situated for supplying the wants of the principal cities. Thus, for the vicinity of the city of Ottawa, we find the Chats Falls and other rapids of the Ottawa River; for Montreal, besides the sources of energy now in use, the rapids of the St. Lawrence at Coteau, Les Cèdres, and also the Sault-Saint-Louis, commonly called Lachine Rapids; for Trois-Rivières and Quebec, the water-powers of the River St. Maurice, regulated by the largest reservoir in Canada; for the Saguenay and Chicoutimi region, the rapids of the Grand-Décharge, the outlet of Lake St. John; and lastly, for Lower St. Lawrence, the falls of the Manicouagan and of the River Aux Outardes.

Wonderful Opportunities at Lake St. John

The south shore of the St. Lawrence is not so well provided, but it may be said that for the more densely populated regions, that is to say the Eastern Townships, the St. Francois River, which is regulated, will suffice for the demand for a good many years.

The advantages of the Lake St. John region and, particularly, those of the Grande-Décharge, should be especially emphasized. The national conditions there are remarkable; the available undeveloped power is enormous; ocean navigation is possible almost as far as the site where the works would be erected; there is no lack of labor and a railway, as well as a steamer line, connects the district with Quebec and Montreal.

The Quebec Streams Commission, acting under the jurisdiction of the provincial government, has taken in hand the improving of the regimen of rivers on which industries are established. Great advantages are anticipated from this policy, and everything tends to show that within the next decade the work of this body will produce all the good results expected from it.

The question of public ownership is very much to the fore these days. I do not think, however, that it is within my jurisdiction to discuss this matter here, although I may say that the Quebec government has already made grants to a certain municipality on the general policies outlined above So far as I know, this has been found satisfactory to the people of the town concerned, and no other special favor has been asked. I would be pleased to furnish anyone privately with any further details that might be desired, concerning the water-power situation in the province of Quebec.

Letter to the Editor

PROF. BLANCHARD'S APPOINTMENT

Sir,—I wish to advise your readers of the action of the Board of Regents of the University of Michigan in the matter of reorganization of the work in highway engineering at Michigan University.

At the last meeting of the board, the professorship of highway engineering was created and filled by the appointment of Prof. Arthur H. Blanchard, late of Columbia University. Prof. Blanchard is so widely known as a teacher and engineer in matters of highways and highway transport, that I need say nothing as to his qualifications.

Funds were also provided for the appointment of an assistant professor of highway engineering who will have charge of the highway laboratory and courses in design, laboratory and field work. This position will be filled by the appointment of John H. Bateman, a graduate of the University of Michigan, and for the past four years assistant engineer and engineer of the Michigan State Highway Commission.

The regents have made liberal appropriations for equipment, current expense and for the salaries of clerical and laboratory assistants.

The University of Michigan four years ago commenced to develop work in highway engineering, and the work in the university and the laboratories has been built up to a good state of efficiency under Prof. John J. Cox, who recently resigned to devote his whole time to construction work.

A large program of work under Prof. Blanchard will include the continuation of all work formerly given undergraduate students in highway engineering, together with one or two new courses, the addition of courses in highway transport and highway economics, the development of graduate work during the regular collegiate year, and the continuation of the highway short course which has been given at Michigan University for the past five years.

In addition to this work, special courses for graduate practicising engineers, leading to the master of science degree in engineering, will be given during the winter months. These courses will be given intensively so that engineers who can only take a few months away from their practice may take the work and secure credit towards the degree.

It is the intention and desire of the authorities of the University of Michigan to give the most ample support to the work in highway engineering as being a subject which demands attention at the present time.

HENRY E. RIGGS,
Professor of Civil Engineering,
University of Michigan

Ann Arbor, Mich., August 13th, 1919.

The Rust Engineering Co., of Pittsburgh, Pa., have been awarded contract for a radial brick chimney for the Ames-Holden Tire Co.'s plant at Kitchener, Ont.; also contract for four chimneys for the Imperial Oil Co.'s refinery at Dartmouth, N.S.

HORSEPOWER REQUIREMENTS OF CENTRIFUGAL PUMPS

THE water horsepower requirements of a centrifugal pump may be easily determined when the quantity to be pumped and the total head are known. However, it is necessary to have some idea of the efficiency of different sizes and kinds of pumps before the actual horsepower for the driving motor can be specified. Useful information on this subject is given by T. M. Heermans, mechanical engineer, centrifugal pump department, Allis-Chalmers Manufacturing Co., in a recent issue of "Power," from which the matter following has been taken.

The efficiencies in the accompanying table are conservative and can be used in estimating the horsepower required for well-designed pumps operating at suitable speeds against moderate heads.

The usual practice in fitting motors to centrifugal pumps is to allow 10% leeway over the horsepower that it is figured will be required.

Starting Requirements

Besides knowing the size of motor to put on a pump, it is necessary also to know something about the starting requirements of centrifugal pumps and how they affect the selection of the type of motor and also the starting apparatus to be used. Centrifugal pumps are started up quite easily and are generally considered "light starting duty for a motor." Consequently, squirrel-cage motors, and even synchronous motors that do not have much starting torque, can be used to drive centrifugal pumps, but this statement needs a little explanation. The curves of Fig. 1 are typical of the performance characteristics of three different types of centrifugal-pump runners. Chart A is for a standard single-stage centrifugal pump fitted with a runner having a rising horsepower characteristic. By slightly changing the runner design, this pump can be made to have a horsepower curve that is practically flat after the point of maximum efficiency. Chart B is representative of the ordinary type of multistage pump with diffusion vanes, and chart C shows the characteristics of a single-stage pump with a so-called Francis type runner which is particularly designed so that relatively high pump rotative speeds can be employed for low heads. These curves have been reproduced to show in particular the "shutoff horsepower" of different kinds of pump runners. This is the power required to rotate the pump runner at rated speed in the pump casing when full of water but when no water is allowed to be discharged, as would be the case when the pump is started up with the valve in the discharge from the pump closed. The shutoff horsepower has been indicated as a certain percentage of the horsepower required at the highest point of the curve, which has been taken as 100%.

CONSERVATIVE EFFICIENCIES FOR PUMPS OF VARIOUS CAPACITIES

Size of pump In.	Normal capacity, G.P.M.	Efficiency single-stage heads up to 150 ft. Per cent	Efficiency multi-stage heads above 150 ft. Per cent
2	100- 150	50	45
3	200- 350	55	50
4	400- 600	60	56
5	650- 900	65	62
6	950-1,300	70	68
8	1,500-1,800	72	70
10	2,000-3,000	75	72
12	3,500-4,500	76	73
14	5,000-6,500	77	74
16 and over		78	75

Slip-ring or shunt-wound direct-current motors will start pumps having the characteristics shown by all three curves, and squirrel-cage motors also have been found capable of starting these pumps, although in the larger sizes and sometimes for pumps having the characteristics shown by chart C, squirrel-cage motors will take too much current in starting to be used. Standard synchronous motors will ordinarily start pumps having the characteristics of chart A, and develop the necessary torque to pull into synchronism when up to speed, but will have to have specially constructed motors to develop the 50% of rated horsepower required to pull pumps having the characteristics of chart B into synchronism, and cannot be used at all, except by making special arrangements, to start pumps having the characteristics shown in chart C.

The special arrangement just mentioned is to equip a pump so it can be started up empty and then primed after being brought up to synchronous speed. What is done is to provide some means of lubricating the close clearances in the pump until it can be primed, when the water will provide the lubrication. The necessary arrangements can be made easily on single-stage pumps, but it is rather difficult to fix up the multistage type. For this reason they are seldom started up empty, although clutches are sometimes employed.

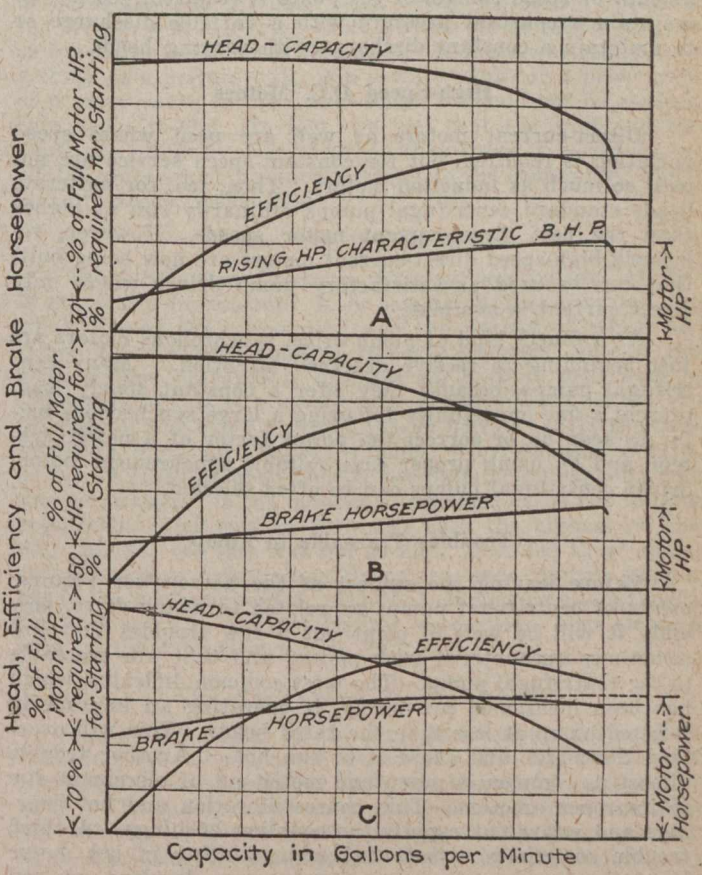


FIG. 1—PUMP CHARACTERISTIC CURVES

All the previous remarks apply to pumps that are started up with a closed valve in the discharge. As a general rule this should be figured on, as otherwise starting conditions will be much worse. It is necessary only to refer to the curves again to see that where no discharge valve is provided, the motor in coming up to speed has also to come up to full horsepower and be thrown on the line at full rating instead of at a fraction of full horsepower. This is not good practice and is bad for the motor even if undue disturbances will not be caused in the line. Instances have been known where the heavy surges of current to start squirrel-cage motors attached to centrifugal pumps without any valve in the discharge have in time loosened up the motor coils.

Kinds of Motors Used

Having considered the power required to start and operate centrifugal pumps, brief reference will be made to the kinds of motor used for pump drive. This is a large subject in itself and should be taken up in detail in separate articles. Probably the motor most commonly used to drive centrifugal pumps is of the squirrel-cage induction type. This motor,

on account of its simplicity and also because the starting duty of a centrifugal pump is not heavy, is used to drive the majority of small and moderate-sized pumps.

In sizes over 150 h.p. and in many cases less, the slip-ring induction motor is used instead of the squirrel-cage type, because it takes less current from the line in starting. Also power companies often fix the maximum size of squirrel-cage motor they will allow to be connected to their lines. In still other cases where a system does not have much capacity, throwing a large squirrel-cage motor on the line would cause serious disturbances and possibly a voltage drop that would be enough to prevent the motors coming up to synchronous speed. These cases call for the use of slip-ring motors. This type is used sometimes when a moderate amount of speed control of the pump is required, possibly to maintain a constant pressure with a variable discharge or to maintain a constant discharge with varying heads.

High-Speed D.C. Motors

Direct-current motors as well are used where speed variation is required, but for constant-speed service are not used so much as induction motors. Then, too, for moderate heads standard centrifugal pumps ordinarily run at higher than the best direct-current motor speeds. However, relatively high-speed direct-current motors are now being built that can be used as satisfactory pump drives where only direct current is available.

As a fourth kind of pump drive, synchronous motors are just beginning to receive deserved attention. Many centrifugal pumps, because they offer a constant steady load, present a fine opportunity for using a large synchronous motor to keep up or correct the power factor of a power system, and by using proper care suitable synchronous motor-driven centrifugal pumps can be often selected.

Troubles Traceable to Pump

Before leaving the subject of the horsepower requirements of centrifugal pumps as related to motor drive, possibly it will be well to point out a few troubles that are sometimes encountered with motors and that are traceable to the centrifugal pump. The most common difficulty, which has been mentioned previously, is operating an improperly selected pump at less than the rated head. This will overload the motor and cause it to run hot. Another trouble almost as common is pump and motor out of alignment due to improper erection. This causes vibration and hot bearings and wears out rapidly the coupling bushings. A third trouble sometimes experienced and resulting in hot motor bearings, is when the centrifugal pump develops an end thrust, causing collars on the shaft to rub on the ends of the bearings. End thrust may develop in a single-stage double-suction pump on account of one side of the runner becoming partly obstructed or an obstruction lodging in the suction passage on one side, which unbalances the runner. Unequal wear of the runner wearing rings on opposite sides of a double-suction runner or displacement of the runner slightly to one side of the centre line of the casing also will cause thrust. In multistage pumps thrust is generally caused by failure or partial failure of the arrangements provided to balance the end thrust. Two pumps taking their suction from the same suction pipe or discharging into the same discharge line, if they are not properly arranged and do not have the right kind of characteristics, can cause trouble by dividing the work unequally, but this and similar questions are outside the scope of this article.

Unit Considered in Entirety

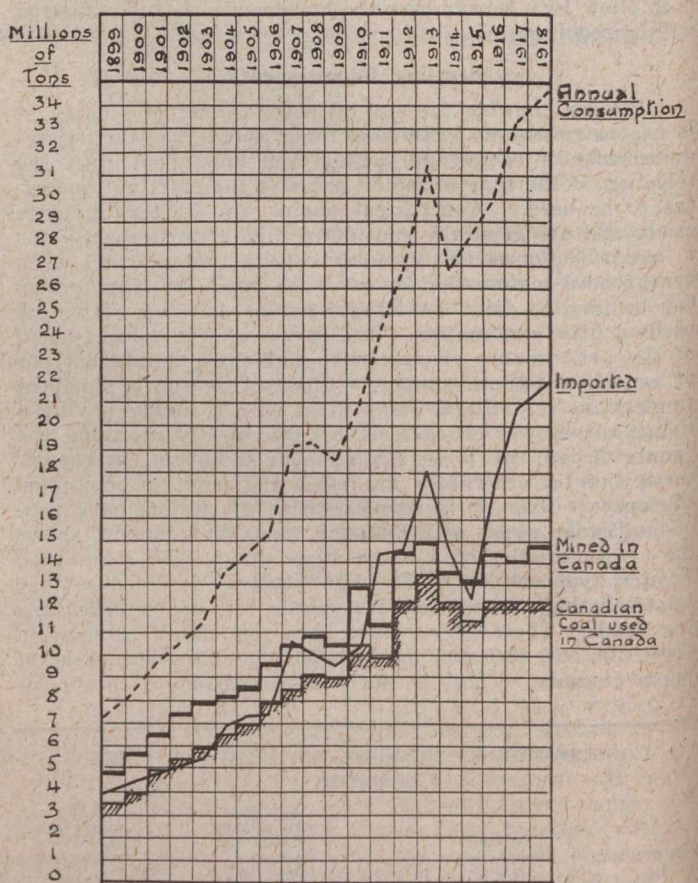
It can be safely stated that a pump should not be bought merely as a pump of a certain size without any reference to the work it will have to do. In conjunction with the driving motor it should be selected to do certain definite work to the best advantage. It is therefore preferable to buy pumps that have been tested carefully and their characteristics determined, with motors of suitable size to run the pumps under all the conditions that will be met with in service. That is, a pump and the drive should be considered as a unit and selected accordingly.

PRODUCTION OF COAL IN CANADA*

By F. D. Gray

THE accompanying graph was compiled from Department of Mines statistics. It shows that up to about 1912 the Dominion was able to furnish from its own coal-seams a little better than half the tonnage of coal consumed for all purposes in Canada. Actually, however, this was not the case, as a certain amount of coal was exported, chiefly from the Cape Breton mines to Boston, Mass.

During the period 1886 to 1899, the coal imported into Canada averaged a little over 54% of the total coal consumption of the country. During the period of 1899 and 1918, included in the graph, the same percentage was maintained, but during the war period the percentage of coal imports was greatly increased. At the present time the imports have risen to 63% of Canadian consumption of coal.



Production and Consumption of Coal in Canada

The coal consumed in Canada during 1918 is estimated at 34,840,000 tons, the highest figure recorded in Canadian statistics, and most closely approached by 1913, when 31,582,545 tons of coal were consumed.

The consumption per capita shows a steadily rising figure, and this is encouraging as showing Canada's progress in the industrial arts and in the conveniences of civilized life, but the discouraging feature disclosed by a study of the statistics is that the Dominion is rapidly increasing its importations of coal, at higher prices than have ever prevailed in the past, and at the same time the home production of coal shows a stationary and even a declining tendency. Any form of production in Canada that is stationary is unsatisfactory and is equivalent to a declining production when viewed in relation to the general growth of population.

There is a difference between the jump in coal consumption that marked 1913, and the peak figure of 1918, namely that in 1913 Canadian coal-mines were increasing their outputs coincidentally with the increase in coal im-

(Concluded on page 247)

*From "Iron and Steel of Canada."

GENERATOR FIRES*

ONE of the side issues brought into existence by the sustained overloads carried during the war service, is the question of fires, their origin and the best means of handling them, and in view of this, a questionaire was circulated by the sub-committee of the N.E.L.A., early this year, giving the following results:—

Some 30 companies reported 81 fires in the past five years; 21 fires equally divided between 60 and 25 cycle units, were specifically described occurring in units ranging from 3,300 to 35,000 kw., and from 2,300 to 13,200 volts.

About an equal number of fires appeared to have started within the insulation and external to the insulation. The greater proportion of fires external to the insulation seems to have occurred on 3-phase systems operating without a grounded neutral. Other causes are many, principally short circuits and grounds, with the remainder from mechanical causes, eddy currents, moisture, etc.

The consensus of opinion is that more frequent inspection and cleaning of the generators is very desirable and has a direct bearing on the liability to fires from sources external to the windings. Too many companies appear to trust the air washing devices for this work, but even with the best possible apparatus, air and grease creep in, fluff and dirt accumulate and conditions for potential fires exist. Good practice, therefore, would indicate periodical cleaning.

Grounding of the Neutral

The grounding of the neutral of 3-phase systems solidly or through resistance, is rapidly becoming standard practice on both 25 and 60 cycle throughout the country.

Twenty-one of the 30 companies replying favor this method of operation; five operating with solid ground system prefer to operate through resistance; three companies oppose the grounding of the neutral. The consensus of opinion seems to be that grounding is very desirable and, in addition to other advantages, has a considerable effect in the reduction of generator fires occurring external to the insulation of the conductors.

It is also rapidly becoming standard practice, particularly on large units, for the manufacturer to bring out both ends of each phase winding to the generator terminal board so as to permit the installation of current transformers between the terminals of phase windings and the neutral of the coils. The current transformers can be connected differentially with respect to the instrument current transformers in the leads between main oil switch and generator, so that in the event of a fault in the generator or its leads, the balanced relay will immediately open the main oil switch, the neutral switch if closed, and, after slight delay, the field switch.

Twenty-four of the 30 companies reporting approve the installation of balanced relay protection and have adopted it as standard practice on all new generator installations and on older generators where the expense involved is not too great.

Fires in Turbo-Generators

The modern type of turbo-generator is usually completely enclosed and the blower action of the ventilation is such that fires are apt to become serious and very difficult to extinguish. As in the case of most fires the time element is the main factor in control. It is especially important to apply the extinguishing medium as promptly as possible, and as close to the seat of trouble as can be done without permanent injury.

This leads to the question of ways and means of fire fighting. Water, steam and carbon-tetrachloride are looked upon with favor, the standard ways of applying being to pipe these mediums up to the end bells.

*Excerpt from annual report of the Canadian Electrical Association's Committee on Electrical Apparatus. Members of the committee: J. F. Neild (chairman), W. H. McIntyre, C. J. Porter, M. D. Schwegler and J. S. H. Wurtle.

PRIVATE WELLS AND PRIVY VAULTS*

By Robert E. Tracy
Director, Bureau of Governmental Research, Chamber of Commerce, Indianapolis, Ind.

IT is a far cry from the privy council to the privy vault, and still they are both Anglo-Saxon institutions dating from time immemorial, and both, as institutions, are very much alive and kicking in the 20th century. It would appear, however, that in England, the home of the privy council, that the privy vault was, comparatively speaking, very much eliminated or reduced to a state of innocuous desuetude by good sanitary methods. By the time we reach England's death rate from typhoid fever we can very well say the same of ourselves, but not until then. Why we should speak of the private well and privy vault, strikes me as rather strange so far as the adjective is concerned. If there was really such a thing as a private well, or a private vault, or a privy well, or a privy vault, in the literal sense, I should not be reading this paper to-day. In fact, we find that the well and the vault are often so close together that there is a certain ineffable unity which produces a result to the community which is, so to speak, ineluctable.

Disease Not Private Matter

The fact is that disease is not a private matter. Health is not a private matter. It is something that concerns the whole life of the community, and the neglect of which becomes a community liability, if not a scourge. One of the most serious preventable diseases we have to deal with is typhoid fever. It is a purely preventable disease, as the experience of our army on the Mexican border and in the cantonments, has shown beyond a doubt. Nevertheless, in 1916, in the 29 cities of over 200,000 population, Indianapolis was the worst sinner, in the number of reported cases per 100,000 population. Our rate in 1916 was 26.6, the highest on the list. In 1915 the rate was not so high, 12.3, and three cities, Columbus, New Orleans and Baltimore, were slightly higher, but in the five-year period, 1911-15, Indianapolis had an average rate of 20.5. Only two cities were worse, New Orleans with 20.9 and Baltimore with 23.7.

City Government Survey Report

The survey report of the city government, prepared in 1917 for the Chamber of Commerce, by the Bureau of Municipal Research of New York, has this to say on the subject: "The main causes of this condition are undoubtedly the pollution of the stream by sewage and the large number of yard privies. It is understood that a sanitary commission has been appointed to deal with the former nuisance. Two other sources of danger, namely, water and milk infection, are being eliminated by chlorination and filtration of city water and pasteurization of milk. The health department has not the power to compel householders to make sewer connections, even if sewers exist, or to prescribe a sanitary privy.

"It can, however, keep its information as to cesspools and unsanitary privies in a readily comprehensible form by carding this information and filing the cards by streets. It can also constantly agitate the question and insist that an ordinance be enacted making house connections with existing sewers compulsory upon orders from the board of health and requiring that in any future extension of sewers through built-up sections the sewer connections be made by the city and the cost be assessed upon the property owner and paid for by instalments, as other assessments are paid."

Typhoid Statistics

In 1917 there were 161 typhoid cases reported and 28 deaths; in 1918 there were 86 cases reported and 19 deaths. These statistics are not as accurate as they might be, even as to deaths for occasionally the case might develop into terminal pneumonia and death might be ascribed to this cause. It is fairly safe to say that there are ten times as

*Excerpts from a paper read before the American Water Works Association.

many cases as there are deaths, which would make 280 cases in 1917, as against 161 reported, and 190 cases in 1918 as against 86 reported.

The Privy Vault Menace

It it unnecessary for me to go into the causes of typhoid; they are perfectly well known. The existence of the disease in any strength, indicates that there are a number of human hogs about. Human filth transported from its place of deposit into the food of healthy people means typhoid.

It is estimated that there are 10,000 to 15,000 privy vaults in existence in the city of Indianapolis; many of these are on unsewered streets and the best that can be done is to see that they are screened and constructed in such a way as not to be accessible to flies, and not to be accessible to surface drainage, which causes soil pollution.

We are not the only city with such sources of public infection. St. Louis, in 1915, still had 20,000 privies, or privy sinks, 80 per cent. of which were on sewered streets. Philadelphia had 20,000, of which 10,000 had sewers accessible; Minneapolis had 17,000, Cincinnati 27,000. Toronto abolished 12,291 privy vaults in two years up to December, 1914; Philadelphia abolished 16,661 in two years. Worcester, Richmond, Buffalo and Erie report no vaults, but they are the great exceptions.

One of the objections to the elimination of these obnoxious places is the expense involved either to connect them with sewers or to place proper facilities in the interior of houses. This could be unquestionably worked out and installed just as gas or electric ranges are installed, in this case at the expense of the city, which would be repaid by the landlord over a period of months or years, as the case might be. We, in Indiana, have the Barrett Law, which furnishes us with the analogy for the carrying out of this health preventive campaign.

Deaths From Preventable Causes

About a million and a half persons die annually in the United States; probably 25 per cent. to 33 per cent. die from preventable causes. From 35,000 to 50,000 die annually of typhoid fever; from 400,000 to 500,000 are prostrated by this dread disease. Let us compare this with the figures of other countries:—

	Deaths	Sick
France	10,000	100,000
England	8,000	80,000
Germany	5,000	50,000

This comparison shows very plainly where we stand in the matter of public cleanliness. Bridgeport, in 1910, was the only American city having a death rate from typhoid of less than 5 per 100,000. Can we afford, as a nation, to permit the economic loss from sickness which runs from $1,500,000,000 to $2,000,000,000 a year, to continue? In 1908 Dr. Ditman wrote, "The cost of typhoid fever each year in sickness and death throughout America amounts to many million dollars. The sickness and death from this cause in this city and in Philadelphia, Scranton and Pittsburgh, during a single year, represent an economic loss to those cities of $3,750,000; such epidemics with their resulting losses, are startling in an age which considers itself enlightened."

Typhoid Disease of Uncivilization

Typhoid is the disease of uncivilization. As Sedgwick says, "Defective sanitation is but another name for defective civilization." The average rate from typhoid throughout the United States per 100,000 is 22. In Indiana as a whole, it is 40. The average for a ten-year period is far greater.

With 30,000 deaths per year from typhoid, the yearly loss is easily $150,000,000. It is just as stupid for us to permit this loss to continue as it is to permit our tremendous fire losses to continue, but just so long as ignorance and indifference create this disease politic, we shall continue to have it. According to Dr. Morgan, of the city board of health, the number of private wells is 308 and of privy vaults 664 within the mile square in this city (Indianapolis). You will probably be startled to ascertain the number of each, but this is based on a sanitary survey recently made and shows conclusively that we are sitting on a volcano so far as typhoid is concerned. As Lawrence Veiller, secretary of the National Housing Association, says, "How profitless is it for a city to spend vast sums of money to insure a supply of pure water to its inhabitants, and at the same time to allow barbarous privy vaults, sinks of iniquity, to drain their contents into private wells, still used by 'conservative citizens', who cling to them with startling tenacity."

When you stop to consider that during the epidemic of 1916, at the rate of $300 as an average cost of medical care per case, it cost the citizens of Indianapolis in the vicinity of $250,000. Without attempting to estimate the economic loss to industry, one can readily grasp the financial significance of further temporarizing with middle-age sanitary facilities.

Proper Ordinance Needed

This condition can be eliminated by the right kind of an ordinance, which, once backed by an enlightened public opinion, will go through without any difficulty. "There never was a reform in administration in this world," says Elihu Root, "which did not have to make its way against the strong feeling of good, honest men concerned in existing methods of administration, and who saw nothing wrong. It is no impeachment of a man's honesty, his integrity, that he thinks the methods that he is familiar with and in which he is engaged are all right. But you cannot make any improvement in this world without over-riding the satisfaction that men have in things as they are, and of which they are a contented and successful part." Mr. Root here states admirably the position of those who want to stand pat in health matters, and want to stand pat in this matter of privy vaults, because it involves a few of their dollars.

Have we not learned among other things, in this war that human lives come before dollars, that we are spiritual beings first and human beings second? We must become as interested in the conservation of human life, at least as interested as we are in the conservation of animal life, and surely in a great agricultural state like this, we do not neglect our stock. Human life seems so cheap after a great war when 7,000,000 men fell that others may live in freedom. Surely after this tremendous drain on the world's stock of humanity we can leave no stones unturned to preserve what the war has left intact, and fortunately we, in the United States, suffered almost no loss as compared to our annual loss from preventable disease. Our total deaths in this war was only twice our annual loss from typhoid.

New Spirit in Industry

In closing, let me quote from a statement of the Minneapolis Civic and Commerce Association, substituting the word Indianapolis for Minneapolis:

"A new spirit is developing in industry, a spirit of a realization that all industry suffers through the misfortune of any factor. The employer fails to prosper as his men fail to prosper. Bad housing for the workmen means bad business for the one who hires. In the light of this spirit, the primary question is not 'What can the tenant afford?' It is, 'What can Indianapolis afford?' If we are to develop in Indianapolis the highest type of civilization, if industry is to thrive permanently, if art and music are to serve their highest purpose, we must first recognize as an essential prerequisite to the realization of these high ideals, the providing of a home life for every family, rich or poor, that shall insure to them their inalienable right to sanitation, safety, ventilation, privacy, sunlight, space and beauty."

Official announcement is likely to be made at an early date of the appointment by the Dominion government of an Honorary Advisory Highway Board which will assist the Department of Railways and Canals in formulating its good roads policy for the enactment of the legislation, recently passed by parliament, appropriating $20,000,000 for federal aid for highways. Daily newspapers report that there are rumors in Ottaws that C. A. McGrath, chairman of the Canadian section of the International Joint Commission, will be a member of the board, and that Home Smith, of Toronto, and J. P. Mullarky, of Montreal, may be appointed.

PROGRESS IN WATER-TURBINE DESIGN

Excerpt from Annual Report of Canadian Electrical Association's Committee on Prime Movers, Signed by S. Svenningson (Chairman), A. H. Wilson and A. J. McDougall

DURING the four or five years period prior to the war the manufacturers of hydraulic turbines made great strides in developing units of high efficiency and simple designs. This was primarily obtained through the introduction of the high specific speed single runner units. During this period a great number of low head plants were built using single runner units of larger size than anything previously attempted. During the last four years, however, the activities in hydro-electric developments were greatly lessened and few new features in design have come out, although a certain amount of research work has been carried out the benefit of which should be realized in the near future.

Efficiencies of 92 to 93% for runners have already been obtained in several plants and we may assume that this is very near the maximum efficiency that can be expected; but, in order to obtain a maximum overall efficiency of plants, hydraulic turbine engineers are now carefully looking into the design of all passageways from headrace to tailrace. Particular attention is being paid to the design and efficiency of draft tubes for high specific speed runners. The tendency is towards the use of deeper draft tubes with the idea of making the turn from the vertical to the horizontal direction at lower velocities than was previous practice.

It is also generally realized that improvements can be made in the design of intakes, especially for low head plants.

There seems to be a difference of opinion as to the number and size of units to be installed in a projected plant; the tendency has been to look upon the water turbine as an almost fool-proof piece of machinery; consequently, plants have been equipped with as few and as large units as possible, thereby making considerable saving in first cost as well as operating expense. Considering, however, that the reliability of a unit does not only depend upon the water turbine but also on the generator and auxiliaries, some designers of power plants incline towards comparatively small units with less chance of shortage of power in case of breakdowns. The question as to size and number of wheels to be installed in a plant must, of course, also be decided upon with regard to the transmission system and importance of continuous service.

Runners

The single runner vertical shaft units for low and medium head plants have proven to be of such a success that practically all new plants under this category are now being equipped with this type of units.

Turbine manufacturers are constantly experimenting with higher specific speed runners in order to meet the demand from customers for large units operating under low heads. While a few years ago a specific speed of 100 was considered high, manufacturers claim to-day to be able to build low head units with a specific speed of 170.

Thrust Bearings

With the increase in size of large vertical water wheels and the consequent increase in weight of the rotating parts, the importance of satisfactory thrust bearings cannot be exaggerated and a great deal of progress has been made in recent years.

The General Electric Company, Schenectady, N.Y., have developed a spring-supported thrust bearing in an effort to overcome certain difficulties experienced in the operation of thrust bearings on this character of service. The main features of the spring supported thrust bearing is that it automatically adjusts itself to unequal loading due to inaccurcies in workmanship or in alignment. A distinctive feature of this bearing is that it will automatically adjust itself while in operation if there is a loss of alignment due to settling of the foundation or to other causes.

The bearing is not affected by wobbling of the shaft. The rubbing surfaces are in a bath of oil and the quantity of oil circulated from an outside source depends on the losses and the cooling conditions. Water cooling coils may be installed in the bearing housing which will reduce the amount of oil and in certain sizes of bearings at low speed, no circulation of oil from a source outside the bearing housing is required.

The salient features of the G. E. spring-supported thrust bearing are:—

A thrust collar keyed to the shaft which transmits the weight of the revolving parts to the rotating ring of the bearings. This rotating ring has a smooth rubbing surface and is so designed that a rapid circulation of oil is maintained.

There is also a stationary ring, the upper surface of which is the stationary rubbing surface of the bearing. This ring rests on springs and to insure flexibility it is made thin and has a radical saw cut through one side.

Sufficient springs are provided so that the stress is only about one half that usually used and the deflection under load is about 0.1 in.

Cooling coils are used to carry off a part of all the heat generated between the rubbing surfaces of the bearing. Centre pins hold the springs in position. An oil tube is provided which forms the inside annular wall of the oil chamber and is welded to its supporting ring. Vowel pins keep the stationary ring from revolving.

G. E. Bearings at Cedars

Two of these bearings have recently been installed in the Cedars Rapids plant of the Montreal Light, Heat & Power Consld., in connection with the last two 10,800 h.p. units, and have now been in operation for some months and have given entire satisfaction.

These bearings are designed to sustain a load of 550,000 pounds during continuous operation of the generating units at a normal speed of 55.6 r.p.m. A good grade of lubricating oil well filtered and free from water or entrained air and at a temperature not greater than 43 deg. C. maintained at a level above the sliding surfaces is used and under these conditions bearings can carry 600,000 lbs. without injury.

The cooling coils are placed within the bearing housing beneath the surface of the oil and are of such length, number and size as will keep the temperature of the oil within the bearing housing under 45 deg. C. when supplied with water at 25 deg. C. under all conditions of normal operation. The bearings are capable of operating at a maximum runaway speed of the unit, not exceeding 111.2 revolutions per minute of the shaft, for the space of one hour, and the temperature of the oil not exceeding 55 deg. C. The bearings are also capable of starting from rest and stopping as often as may be required by service conditions.

Bearings are designed to suffer no injury due to interruptions of water circulation for space of one-half hour under otherwise normal conditions or for a space of 20 min. not exceeding 50% above normal speed.

The general construction of these bearings is such as will allow the bearing in all its parts to be removed from the bearing housing without disturbing the generator or waterwheel except by supporting the turbine shaft and generator by independent means provided, and removing the thrust block keyed to the top of the shaft.

These bearings are the first ones of this size to be equipped with water cooling coils for circulation of cooling water instead of using oil circulation.

Kingsbury Bearings at Queenston

The Kingsbury thrust bearing has already been described to a great extent in many engineering periodicals and shall not again be treated in this report. It may be of interest, however, that this type of bearing has been adopted by the Hydro-Electric Power Commission of Ontario for the Westinghouse generators on the Chippawa-Queenston development. They are designed to carry a load of 900,000 lbs. at 187½ r.p.m.

Governors

No radical departure from standard designs of governers, mechanical or hydraulic, have taken place recently. The tendency has been in the past to specify quick acting governors in order to maintain a constant voltage. This tendency may lead to serious troubles, particularly where the

turbines are connected to long penstocks which are not protected by relief valves or surge tanks.

Designers are aware of this danger and considerable attention is now paid to this problem.

Troubles encountered in governor systems, such as corrosion of pipe lines and governor parts, where water is used as operating fluid, are being met by the introduction of soluable oil barium hydrate and potasium bichromate into the operating fluid.

There still seems to be a difference of opinion among designers as to the advisability of using individual governor systems or having all governors receive the operating fluid from a central pumping system. The latter system is, as a rule, the cheapest and when the necessary care is taken laying out pumps, pipe lines, etc., very satisfactory from an operating point of view.

A noticeable improvement has taken place in recent designs of water turbines with regard to accessibility, thorough lubrication and easy cleaning of turbine parts. One of the important features of the single runner vertical unit is the easy removal of gate mechanism for inspection, as well as the easy adjustment of guide vanes.

SCREEN WHEEL FOR REMOVAL OF ALGAE IN IRRIGATION CANAL*

By E. Court Eaton
Superintendent Lindsay-Strathmore Irrigation District; Formerly Assistant Irrigation Engineer, C.P.R.

A GOOD deal of trouble was experienced by the Lindsay-Strathmore Irrigation District of Lindsay, Cal., during the season of 1918 with algae or "moss" in an open lined canal. To prevent the particles of this growth from entering the distributing pipes of the system, removable screens were first placed in the canal, and these were taken out and washed with a hose as required. It was found, however, that these screens required the continued presence of a man day and night, as they needed cleaning every 15 minutes. To do away with this expense, a revolving screen wheel was designed.

Driven by Paddle Wheel

The canal has a bottom width of 6.3 ft. and a total depth of 3.5 ft. A rotary drum, made of two circular sections of 3-in. lumber was made up and suitably braced. This was covered with a galvanized screen having a ¼-in. mesh; four vanes, or paddles, were placed inside this, it being the intention to have the wheel rotated by the velocity of the water in the canal.

It was soon found, however, that this had a tendency to roll the streamers of algae under the wheel, and thus allow a large percentage to pass the wheels. Accordingly, the paddles were removed and a separate paddle-wheel built in upstream, connected by a crossed belt of cable to the screen wheel, and by this means the wheel was rotated in a direction against the flow of the water. To assist in picking up the larger particles, six rows of nails were driven into the circumference, parallel with the axis.

Washed at Every Revolution

The screen wheel is supported by, and rotates on, a length of 4-in. wrought iron pipe as a shaft, and this pipe is perforated with a row of 3/16-in. holes. One end of this pipe is connected to one of the pressure mains from the pumps, thus washing off the collection of moss at each revolution, which is caught in a trough and run to waste.

The wheel has been successful, and would be improved if built up of steel, allowing smaller clearances between the bottom and sides of the canal and the rotating wheel. A good deal of water is necessary to clean the screens, this depending, of course, on the quantity of material to be removed.

*From "Engineering and Contracting," Chicago.

COST AND LIFE OF NEW YORK STATE HIGHWAY PAVEMENTS*

ON January 1st, 1918, we had in New York State 6,912 miles of pavement, of which 5,820 miles were non-permanent types and 1,092 miles permanent types, of the latter all but 129 miles being of brick or concrete.

Water-bound Macadam.—This pavement is best adapted to the needs of light traffic, but has no place on any through route. It costs to-day about $23,000 per mile for a 16-26-ft. pavement 9 in. thick (3-in. top on 6-in. sub-base). Low construction cost has been the greatest advantage. Its greatest disadvantage now is its high cost of maintenance, which in 1917 amounted to $970 per mile. The average life of this type of pavement is seven years for a traffic of under 1,000 tons a day. Many waterbound roads have worn out in from one to three years when called upon to carry a heavier tonnage.

Bituminous Macadam Penetration Method.—This type is also adapted to light traffic generally, and is advantageous in many localities where the only stone available is non-binding. Among its disadvantages is its tendency to creep under traffic. It is slippery when wet; has a fairly high cost of maintenance—$412 per mile during 1917; and a construction cost of $28,500 per mile for a 16-26-ft. pavement 9 in. thick (3-in. top course and 6-in. sub-base bottom course). The average life of this type is two years more than that for waterbound macadam under similar traffic conditions.

The determination given for average life of the above types was made in 1917. The much heavier traffic tonnage of to-day would shorten it considerably.

Concrete.—Has the disadvantage of a glare. It has the advantage of low first cost, $31,200 per mile to-day for a 16-26-ft. pavement 6 in. average thickness. The maintenance on it in 1917 was $112 per mile. Its average life so far can only be estimated, but, judging from the condition of 5 to 9-year-old pavements of this type with which I am familiar, we can say at least 15 years.

Brick Pavements, Semi-monolithic.—This type differs from the original brick pavement in that there is no sand cushion, but the bricks are laid in a cement sand bed and grouted with cement grout to form an integral part of the pavement. This type has the advantage of developing beam strength as in concrete pavement, and eliminates the shifting of and depressions in the brick. Its cost under present conditions would be about $50,600 per mile for a 3-in. brick on a 4-in. concrete foundation. I have no maintenance figures for this type, as we have been building it only a little over a year.

Brick Pavements, Monolithic Type.—It differs from the semi-monolithic type in that the brick are set in a green concrete and grouted with a cement grout, forming an integral part of the pavement. This type develops the full beam strength, and has even greater advantages, so far as strength is concerned, than the semi-monolithic type. It is more difficult, however, to get as smooth a surface as with the semi-monolithic type.

Asphaltic Concrete.—In order to insure a nearly smooth pavement, a smooth concrete foundation should be provided. These pavements have the disadvantage of pushing under traffic from future consolidation if the aggregate is not properly sized and proportioned, or carries too much bituminous material. However, if too little bituminous material is used, the pavement becomes dry and soon disintegrates. The ideal mix is one in which the motor oil dropped from cars renews the volatile oils lost. These pavements cost about $40,000 per mile, depending upon the type, with a 2-in. top and a 5-in. concrete foundation. Their maintenance cost in 1917 was $245 per mile.

There are many patent types of pavement which come under the classification of permanent types, and which are good.

*From a paper presented before the New York Chapter of the American Society of Civil Engineers by H. E. Breed, formerly Deputy Highway Commissioner of New York State.

CANADA'S CANAL SYSTEM*

By W. A. Bowden
Chief Engineer, Department of Railways and Canals

THE through water route between Montreal, at the head of ocean navigation, and Fort William and Port Arthur, on the west shore of Lake Superior, comprises 74 miles of canal, with 48 locks and 1,155 miles of river and lake waters, or a total of 1,229 miles.

The minimum depth of water on this route is 14 feet. From Montreal to Duluth, on the south-west end of Lake Superior, the total distance is 1,354 miles, and to Chicago 1,286 miles.

Connection is made with the Canadian Pacific Railway from points west and south at Fort William and Port Arthur, six miles apart. From Fort William connection with the main transcontinental line of the Canadian Government Railways is made by the branch line originally constructed by the Grand Trunk Pacific Railway, but now leased to and operated by the Canadian Government Railways.

On this through route the approaches to the canals and the channels of the intermediate river reaches are well defined, and are lighted with gas buoys under the control of the Department of Marine and Fisheries, admitting of safe navigation in the hands of competent pilots both by day and by night. The Lachine, Soulanges, Cornwall, Welland, and Sault Ste. Marie canals are lighted throughout by electricity and electrically operated. The Farran's Point canal is lighted by acetylene gas.

Of the minor systems, the Murray, Trent, Rideau, and Ottawa River canals may be considered geographically as branches of the through east and west route. In operation, however, these canals serve a distinct traffic of more local nature. Isolated from the systems just mentioned, the navigation of the Richelieu River, from its junction with the St. Lawrence at Sorel to Lake Champlain, is effected by means of the St. Ours Lock and the Chambly Canal; while in the extreme east the St. Peter's Canal provides communication between the Bras d'Or Lakes of Cape Breton Island and the Atlantic Ocean.

*From the annual report of the Department of Railways and Canals.

SUPER-POWER PLANTS**

By L. G. Denis
Hydro-Electric Engineer, Commission of Conservation

THE recent decision to proceed with the super-power station scheme for electric supply in Great Britain, calls to our notice what should be done along these lines on a more modest scale in certain portions of Canada.

The British plan to improve the supply of electricity throughout Britain contemplates the replacement of the numerous small stations now in operation by fewer but much larger stations supplying extensive districts through high-tension transmission works. There will be a gain both in economy and fuel conservation, and, in many cases, the quality of service will be much improved. This national electric supply operates under the supervision of five commissioners appointed by the Board of Trade; these, in turn, appoint district boards, which include representatives of electric undertakings, of large consumers and of labor.

Lancashire is to be one of the first areas dealt with, the county being divided into three districts. Some of the smaller stations will probably be shut down immediately, the energy transmitted from larger existing stations being substituted. Following the building of the new super-power plants, the commissioners will eliminate the remaining small stations and also the moderate-sized plants.

**From "Conservation," the official bulletin of the Commission of Conservation, Ottawa.

A similar situation, however, does not occur in Canada, as by far the larger portion of the capacity of our hydro-electric stations is to be found in what may be called "super-power" stations; many of them are also interconnected to allow more efficient operation.

There is, however, a portion of Canada where the abscence of water power makes it necessary to supply power from steam or other fuel agencies. This area, which comprises southern Saskatchewan and adjacent portions of Manitoba and Alberta, is becoming of much importance through its rapid agricultural expansion, and its future needs should be anticipated so far as possible.

As pointed out in a report on "Electric Generation and Distribution in Canada," recently pubilshed by the Commission of Conservation, adequate supply of electric energy in this section is confined to a few large centres. The smaller municipalities have installed small electric plants, which are usually very expensive to operate and only give a night service. The rates which have consequently to be charged and the limited service prevent the full benefit which should otherwise be enjoyed from the various uses of electric energy. All these small plants through concerted action could be replaced by a few large and more efficient ones, each supplying a fairly extensive district by means of electric transmission lines. The cost of production would be reduced to about one-third and a better service supplied.

The example given in the above-mentioned report illustrates the possibilities in the Estevan district. A central power plant at Estevan would supply transmission lines radiating in various directions, covering a total length of 150 miles. The estimated demand, based on the requirements of the near future, shows a total of some 600 h.p. outside of Estevan. As the lines would only carry a light load, they could be built cheaply with light conductors and at a cost possibly not exceeding $2,500 per mile. If we allow a load factor of 40 per cent., the cost of transmission would average 2½ cents per k.w.h. The cost of production in the central plant would be from 2½ cents to 3 cents per k.w.h., so that the electricity could be delivered for an average of from 5 cents to 5½ cents per k.w.h. at the various small centres supplied. With a small plant, the present cost runs as high as from 15 cents to 19 cents per k.w.h. Numerous other districts, if treated in the same way, would probably show advantageous results.

BALDWIN'S CANADIAN STEEL CORPORATION

ANNOUNCEMENT is made that the British Forgings plant at Toronto, which was recently bought by Baldwin's, Ltd., of Swansea, Wales, will be operated as Baldwin's Canadian Steel Corporation, Ltd. The new firm will be capitalized at $10,000,000, it is said, and will employ 2,300 men within a year.

E. L. Cousins, chief engineer of the Toronto Harbor Commission, who negotiated with the company on behalf of the city and the harbor commission, states that A. M. Russel, of Hugh Russel & Sons, Ltd., Montreal, was largely instrumental in persuading Baldwin's to establish a plant in Canada. Mr. Russel went to Wales for the purpose of interesting his principals, with the result that J. C. Davies, managing director of Baldwin's, Ltd., came to Canada, accompanied by D. E. Roberts, consulting engineer of the company, and the deal was consummated soon afterwards. Mr. Russel will be president of the new Canadian corporation.

Within a few months the new firm will begin the manufacture of tin plates, black sheet and galvanized sheet. The British Forgings plant, located in the Toronto Harbor Commission's eastern harbour terminal, is 127 acres in extent, with 1,600 lineal feet of 24-ft. dockage. The new company also holds an option on 79 acres of additional land. A detailed description of the British Forgings plant was published in the March 27th, 1919, issue of *The Canadian Engineer*.

DRAFTSMEN'S ASSOCIATION ORGANIZED

FOLLOWING a series of meetings attended by a number of Toronto draftsmen, an association was recently organized under the name of the Draftsmen's Association. The address of the association is given as P.O. Box 453, Toronto, but the letterhead does not state the names of the officers of the society. A circular letter, also anonymous, has been mailed to draftsmen throughout Canada. This circular, which states that it was drafted by the association and approved by the executive committee, is as follows:—

"Following a series of meetings attended by a great number of draftsmen of all branches, the above association was duly formed, and the officials elected by secret ballot on the date set above. What were the salient reasons that prompted the draftsmen of the different professions or branches connected with the arts and science of building, construction, engineering and marine to become the pioneers of such a movement?

"1.—To promote more professional etiqutte of the various branches of arts and science similar to that of the physician, lawyer, etc.

"2.—To ensure that all work be carried out by men of specific qualifications.

"3.—That the branches of arts and science shall know each other closer in relation to their work and eliminate professional jealousy.

"4.—That by means of lectures and classes to be given by advanced members of the association, a broader knowledge be imparted to the younger element of all branches.

"5.—To act habitually through the associations of architects, engineers and draftsmen and their chapters; in other words, to act as a compact, professional body, and not as individuals.

"6.—To convince the employers of the different branches that the maintenance of ethical standards is the only right road to business success.

"7.—To make the employers believe in us because we believe in ourselves.

"8.—To promote such interest and participation in public and quasi-public affairs that will show the draftsmen to be men of general ability and civic pride, and not merely self-interested individuals.

"9.—To create a more equable relation between employers and employees.

"10.—That the employers who purchase the brains of the different services financially realize the value thereof.

"11.—Last, and not least, that by inspiration and thoroughness in the training of the junior draftsmen, this association aspires to do what the societies of architects and engineers have failed to do, namely, a more sound training in every branch of the arts and science, and ensure better recognition of the draftsman as a co-ordinate to the architect or engineer."

The explosion in the grain elevator at Port Colborne, Ont., was caused through the ignition of wheat dust, states the tentative report of the commission of engineers appointed by the Dominion government to investigate the accident. It is thought that the "leg" used for loading the boats jammed, causing excessive friction between pulley and belt. When the "leg" fell, raising a cloud of dust, the latter was ignited from the heat generated by the pulley.

Announcement was made in last week's issue that Jones & Attwood, Ltd., of Stourbridge, Eng., who are the owners of the patents on the activated sludge method of sewags disposal, were transferring that department of their business to a newly-formed firm, Activated Sludge, Ltd., of Stourbridge. Later reports from England state that while the new company has been registered, final arrangements have not yet been completed, and in the meantime all activated sludge business is being handled as in the past by Jones & Attwood, Ltd.

THE ORGANIZATION OF EFFICIENT CONCRETE ROAD CONSTRUCTION GANGS*

By Halbert P. Gillette

THIS question is often asked of the man who has made an enviable financial record: "What is the secret of your success?" If he is not a man given to analyzing his methods, he is apt to reply with some generalization that is too broad to be serviceable to others, such as "Hard work is the secret," or "Strict honesty," or "Attention to details," and the like.

The fact is that there is no single "secret" of success, whether it be winning battles or building roads. Success is usually a simple result, but it is never attained by a single "open sesame." It is the outcome of the judicious application of many separate factors. So, in discussing how to organize construction gangs with which to build roads economically, we must dismiss at once the idea that there is any one way that is invariably successful in accomplishing the desired minimum cost.

"Tricks of the Trade"

On the other hand, although different organizations are needed for different conditions, there are a few general principles of organization applicable under any condition; and there are many subsidiary principles of organization applicable under more specific conditions. In addition to such principles, there is an almost limitless number of "tricks of the trade" that can be profitably applied only under very specific conditions.

To illustrate, it is a good general rule of organization that each construction gang should be composed of men of the same nationality. This broad rule may be broadened to read: Other factors being equal, the best construction gang is one composed of individuals having similar temperament and habits. Experience has taught us that this is a sound rule of very broad application. It holds as true of sewer work as of road work, of military units as of a squad of religious revivalists.

There are, however, "secrets" of organization success that are of somewhat narrower application. Thus it is a good rule to make one of a gang of shovelers the leader or pace maker, that is, a sort of "working foreman." Such a man should be more ambitious than the rest, and close mouthed enough not to state his weekly bonus to his fellows. If paid a bonus of $5 to $10 a week above the average wage, a good "working foreman" will set a pace that will decidedly increase the output of a shoveling gang. This principal of employing "working foremen" is one that was formerly more commonly applied than at present. It has lost none of its efficacy.

"Spotting" and Regulating Loads

As an example of a minor "trick of the trade," or economic method of limited application, the following is offered. Let it be the duty of one man to "spot" every load of stone (or gravel) and sand, instructing the driver exactly where to dump it. This man may also have other functions to perform, such as setting the side-boards or "rules," trimming subgrade, or what not. But even if he were to do nothing else than place the aggregates properly, he would save more than his wages. It is not uncommon to see piles of stone or gravel shoveled off the roadbed onto the shoulders, because loads of aggregate were dumped too close together. It is equally common to see loads too far apart, resulting in long hauls for wheel-barrows and the subsequent bringing in of extra wagon loads of materials under adverse hauling conditions.

Closely allied to this "trick" of having a man "spot" each load, is having a man regulate the size of loads at the point of loading. The size of wagon or truck loads may vary 5 to 10% unless it is some one's duty to watch the loading. Standard loading is highly desirable, as a little consideration will show. But by standard loading, I do not mean an unvarying size of load throughout an entire job. I mean a standard size for given hauling conditions. If the earth over which the load is hauled is hard, and if the grades

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*From the "Concrete Highway Magazine."

are easy, the standard load should be large. Under more difficult hauling conditions, it should be smaller. But in every case, the standard load for given conditions should be adhered to rigorously. This can be accomplished only by making it the special duty of some one to watch the loading of wagons or trucks.

Reviewing the three examples just given, we have (1) the broad principle of selecting similar individuals for each gang; (2) the narrower principle of having a "working foreman" for shoveling gangs; and (3) the still narrower construction methods of "spotting wagons" and of "standard sizing of loads."

In this connection it may be well to point out that men of college education are apt to be unduly impressed by what are called "general principles." Let a "law of nature" be announced and most college men are prepared to kowtow; but let a "trick of the trade" or a "construction method" be announced and they may not deign to lift an eyebrow. I am convinced that this false attitude toward the humble "tricks of the trade" accounts largely for the failure of many a college engineer to make a good superintendent of construction. However, engineering colleges are rapidly improving and fewer students are being graduated under the false impression that a knowledge of "tricks of the trade" is less important than a knowledge of broad principles.

The only difference between the worth of a broad principle and of a special economic method, or "trick," lies in the number of cases to which each is applicable. Hence it may happen that it is worth more to a road-builder to know that it pays to "spot" wagon loads than to know Newton's laws of gravitation.

A manager of concrete road gangs should be acquainted not only with the general principles of scientific management but with a great many specific methods of transporting, mixing, placing and surfacing concrete. The larger his store of knowledge of methods, the more likely it is that he will select an economic combination of methods for any given job. Hence the importance of storing the mind with published methods and hints relating to road work. This seems perfectly self-evident, yet it is a fact that the majority of construction managers add very little to their knowledge except through personal observation.

Contractors Must Study Work

It also seems self-evident that gangs should be so organized that all the workmen will be kept uniformly busy. Yet it is very common to see a large percentage of time wasted because of poor co-ordination. This is attributable to the fact that the manager does not know what constitutes a fair day's work for a man engaged in each of the separate processes or duties. Thus, if the manager does not know how many cubic yards of sand a workman should load per hour into barrows, and how many cubic yards he should be able to wheel a distance of 100 ft. per hour, he cannot accurately assign the right number of sand loaders and wheelers to a mixer having a given hourly capacity of concrete.

For the most accurate studies of gang organization, it may be desirable to time every single process and every minute delay, using a stop watch for the purpose. Such great refinement is not ordinarily needed on construction work. But it is desirable to know the average hourly output of good workmen on each class of work under any given conditions. To do this, any given class of work should be analyzed into two general parts, namely (1) the parts that do not vary materially on different jobs, and (2) the parts that vary on different jobs. Thus, in hauling sand with wagons, the team time lost in loading and dumping each load is quite uniform, but the time spent in hauling depends on the length of the haul. Hence the time can be expressed as a constant number of minutes (say 10 minutes) per load plus a minute per 100 ft. of distance between the loading and the dumping points. With such a rule in his head, a manager is able to assign the proper number of teams to the hauling of sand. Similarly for wheelbarrow work, or for any other kind of hauling.

Having thus scientifically selected the proper number of men and teams for each duty, the manager should watch them carefully to ascertain whether there is any "soldiering" or unnecessarily lost time, either because too many or too few men have been assigned to a given task. If too many men have been assigned, say, to loading sand, the manager can usually ascertain the fact by watching them for half an hour. If too few men have been assigned to sand handling, the other men will be delayed, and this can be readily ascertained by observing the other men. So an experienced manager need not necessarily know the average time required to perform each operation, but, by a "cut and try" method, he can distribute his men with considerable accuracy. Nevertheless, even an experienced manager will effect a better organization of his forces if he knows what to expect of a man on each kind of work under given conditions.

I have found, as have other road builders, that the timing of each separate operation and each cause of "lost time" is one of the most effective means of improving the organization of men. Lost time is the greatest source of lost profits on road work. On most concrete road jobs the average daily progress of a mixer gang for a month is about half what it is during a day when everything runs smoothly. Extra parts and duplicate machines would do away with most of this lost time. But managers usually do not keep a detail record of all lost time and the causes. Hence they usually fail to realize the true economy of having spare parts, spare pumps, duplicate pipe lines, etc. For the same reason, they usually fail to realize that it pays to have spare men—men able to fill a gap or ready to attend to a breakdown or to shift a plant with expedition. A small emergency gang of "Jacks of all trades" will usually earn their wages many times over by reducing delays from breakdowns, plant shifting, short-handed crews, etc.

Keep a Note-Book

The average workman likes to do only one class of work. If his job is to finish a concrete surface, he resents being required to load a wheelbarrow. This is easy to understand where a skilled man is required to do unskilled work. Why a common laborer should resent being shifted from one class of unskilled work to another class is not so clear, but it is a fact. A wheelbarrow man dislikes turning his hand to pick and shovel work, for example. But there are a few men who seem to enjoy frequent changes, and will gladly do anything from grubbing roots to shoeing a horse, provided they are not kept at one thing very long. This is the type of man for an emergency gang. Every large road job should have such a gang.

In a brief article on a big subject it is impracticable to do more than throw out a few suggestions. Of the few here offered, there is one, however, that will prove profitable to every manager of road gangs. It is this: Keep a note book in which you enter a memorandum of every "trick of the trade" that you see, hear, or read. Number each of these "hints" serially. Read them over at intervals. You will ultimately have nearly every one of several hundred "hints" committed to memory. And as your stock of memorized "hints" grows, you will find it progressively easier to remember new "hints." Most men make the mistake of regarding the brain as a store house of limited capacity for memorized facts. Its capacity is practically limitless; and, curiously enough, the greater the number of facts of a given class that a man memorizes, the stronger does his memory grow for facts of that class. College trained engineers are particularly prone to avoid memorizing details. They argue that they need remember only general principles and that they can look up published details when necessary. In practice, however, they seldom look up published details in a thorough-going manner, partly because they haven't the sources of reference at hand, and partly because published indexes are wholly unsatisfactory for the purpose of finding such details.

In reading biographies and sketches of famous men, it is worth noting that such men are so frequently credited with having an astonishing command of memorized data relating to their specialty. James J. Hill, "the empire builder," had a memory for details of railway operating and construction costs that was amazing. He was a genius as an organizer and promoter. Certainly, his feats of memory were not merely incidental to his success, but, in large measure, accounted for it. If we cannot all be prodigies like Jim Hill, at least we can profit by using his methods.

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PRINCIPAL CONTENTS

CONSULTING ENGINEERING ETHICS

IS it ethical for consulting engineers to quote less than 5% (of the cost of the work) for plans, specifications and supervision of erection of buildings, bridges, power plants or any other engineering undertakings? and what, if anything, should be supplied for that amount, other than the plans, specifications and personal supervision?

These questions are being actively debated among the consulting engineers of Toronto, due to recent keen competition for appointment in connection with an important bridge. One firm offered to do the work for 4%; all the other engineers asked 5%, but after their letters had been read in council meeting, and it was published that an offer of 4% had been received, one of the engineers who had bid 5%, reduced his figure to 4%, and subsequently one other 4% offer was received from a firm that had not previously tendered its services in formal manner. The work was awarded to the engineer who cut his price from 5% to 4% after he saw that another engineer had bid 4%.

Which of these two engineers, if either of them, was guilty of unethical conduct?

The man whose original bid was 4% states that 4% is his regular fee for certain classes of work, and that no engineer should have altered his price after it had been tendered. He says that he considered his services on such work worth 4%; and that if another engineer considered his own services worth 5%, he should not have entered into a price-cutting competition, but should have allowed the owners of the proposed bridge to determine whether the one man's services would be worth more than the other's services.

This man, therefore, thinks that the "cutting" from 5% to 4% was unethical, but that he was fully justified in quoting 4%. On the other hand, the engineer who "cut" is of the opinion that he was justified in so doing in order to meet unethical competition; in other words, that it was not ethical for any engineer or engineering firm to quote less than 5% at any time for plans, specifications and supervision.

Webster defines ethics, as applied to professions, as follows: "Any body of principles or rules concerning moral obligation, whether true or false, that is intended to regulate practise in any particular sphere of activity."

Are there any "principles or rules" that were violated by either of these engineers? The code of ethics of the Engineering Institute of Canada contains no reference to fees or price-cutting. The code of ethics of the American Society of Civil Engineers says: "It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member . . . to compete with another engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another." The code of ethics of the American Institute of Consulting Engineers contains a clause almost identical to that in the A.S.C.E. code.

Obviously, however, there was no intention of *underbidding* on the part of the engineer who cut his price, but merely of *meeting* the other man's lower bid. The clause quoted above does not seem to prohibit such a reduction. It would, however, prohibit a bid of 4% if a firm's regular fee were 5% and if the reduction were made knowing that another engineer had quoted 5%. In this case, the engineer whose original bid was 4% states that 4% is his regular price on work of that amount and character. Moreover, his bid was the first one received by the owners and antedated all others by at least four days.

The only civil or consulting engineering society that has adopted a schedule of fees is the American Institute of Consulting Engineers, which stipulates 5% or more for preliminary examinations, surveys, plans and specifications, final working drawings, and consultation and general advice during construction. This is much less than the two Canadian engineers above referred to, offered to do for the same or smaller percentage. The firm that originally bid 4% offered "to place a resident engineer experienced in concrete bridge work on the job and do all necessary testing of materials entering into the construction of the bridge. In addition to the above, this fee would include the regular supervision of the work by members of this firm and preparation of monthly estimates, etc."

The engineer who reduced his bid from 5% to 4%, and who was appointed, agreed to "supervise, either by himself or by skillful, qualified persons that he may substitute, the erection and construction of the said bridge by the contractors and all work that may be incidental and necessary to properly carry out the work required for the completion, construction and erection of the said bridge . . . and that he will make proper and sufficient plans, specifications and estimates and inspections."

Toronto consulting engineers are therefore debating the advisability of adoption, by the Engineering Institute of Canada, of a schedule of minimum fees, but the majority are opposed to such action until after the American Society of Civil Engineers has adopted a similar schedule, fearing that American engineers may quote lower rates and take much work away from the Canadian engineers. Should the Engineering Institute be successful obtaining legislation closing the profession in Canada, the Canadian engineers could successfully establish a schedule regardless of what American engineers might charge; because then, in order to do work in Canada, the American engineers would have to belong to the Engineering Institute and consequently would be amenable to its regulations regarding fees in Canada.

There are times when an engineer might desire for personal reasons to become associated with some big job almost regardless of remuneration. To be forced to charge as much as men who were not actuated by the same motives, but who were bidding on the work as a purely commercial proposition, might then seem to him to be a hardship and a violation of his personal liberty. But we have all learned during the past few years that one's purely personal rights

matter but little when they are in conflict with the welfare of society as a whole, and there is no doubt but that a minimum fee, strictly observed, would certainly be beneficial to engineering as a profession and to the entire community of engineers.

Another point upon which there has been discussion, is the interpretation of the words "usual charges" in the American Society's code. What determines "his usual charges?" Must he publish or announce a personal schedule of fees? If so, could he ever lower those fees? Suppose that two engineers are being considered for certain work. Both have published schedules calling for 5%. If one of them were to submit a tender of 4%, would he not be cutting with real intention of underbidding the other man, even though the other engineer had not yet quoted on that particular work?

Moreover, just what services should a consulting engineer perform for any fixed percentage that might be adopted? The American Institute of Consulting Engineers requires its members to charge at least 10% when, in addition to preparing all the plans and specifications, they are called upon to test materials, to inspect the work and to be responsible for the organization, management and completion of the construction.

DEATH OF ANDREW CARNEGIE

ANDREW CARNEGIE'S death, August 11th, at Lenox, Mass., brought to a close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the Bessemer process for the production of steel, and by the establishment and development of steel plants which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction.

In the successful conduct of many industrial enterprises, he amassed great wealth, the possession of which he came to regard with deep seriousness as a public trusteeship. While yet in full possession of his faculties, he devoted himself to the distribution of large portions of his fortune to projects for the benefit of mankind.

Mr. Carnegie distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of homes for engineering societies, a number of which had elected him as an honorary member.

PRODUCTION OF COAL IN CANADA

(Continued from page 238)

ports, but in 1918 the imports of coal increased without precedent, while domestic coal outputs are declining with no immediate prospect of manifesting an opposite tendency.

It appears equally desirable and feasible that Canadian coal producers should strive to lessen the recently developed inequality in the ratio of imported coal to coal mined in Canada. Admitted that a certain tonnage of anthracite coal is probably required for domestic use because of its greater cleanliness, there is yet a large market for bituminous coal in Canada that is being filled to-day from United States sources.

Apart from the fact that raw materials obtained from outside sources provide employment in that outside source and not in the country where they are used—at least not in the same proportion—there is the further consideration that we are to-day paying for imports with a depreciated currency.

In a lecture recently delivered to the staff of Barclay's Bank, in London, Prof. Nicholson says with reference to conditions in Great Britain:—

"We are suffering in the first place from over-importation. During the war a great part of this over-importation was of the greatest national benefit. The imports from America were necessary for the conduct of the war. But an increasing part of the aggregate money value of these imports was due to the inflation of the currency and the associated rise in prices. This part was not a blessing—quite the contrary."

While a wholesale application of Prof. Nicholson's statement is not justified, yet in relation to the coal consumption of Canada, the statement is one of fitting exactitude. In brief, we are importing altogether too much coal and we are purchasing it at an increasing disadvantage.

PERSONALS

D. A. R. McCANNELL, who was recently appointed city engineer of Regina, Sask., was born in 1890, in Bruce County, Ont. His parents moved to Regina in 1893, his father being one of the first settlers who located there in 1882, before the municipality of Regina was formed. Mr. McCannell acquired his public and high school education in Regina, subsequently graduating in civil engineering at Queen's University. Commencing practice as a rodman with the engineering staff of the city of Regina in the summer of 1911, he was engaged on pavement construction until 1915, when he was appointed assistant to the city engineer. This position he held until 1917, when he became acting city engineer, and recently the city council decided to drop the word "acting" from his title.

M. L. CANTELL, of St. Boniface, Man., who is on the engineering staff of the Manitoba government, has been elected a member of the Royal Society of London, Eng.

J. LEBLANC has been appointed by the city commissioners of Montreal, as supervising engineer in charge of that city's contract work, in place of W. Matheson, resigned.

GORDON KRIBS, assistant engineer on the staff of the Hydro-Electric Power Commission of Ontario, has resigned in order to accept a position as manager of the Hespeler Manufacturing Co., Hespeler, Ont. Mr. Kribs is a graduate of the University of Toronto, Faculty of Applied Science and Engineering, class of 1905. For several years Mr. Kribs was in Texas as engineer for the Texas Power & Light Co.

ARTHUR H. BLANCHARD, consulting highway engineer, New York City, who is well known among Canadian engineers, has been appointed professor of highway engineering at the University of Michigan, Ann Harbor, Mich., the appointment to be effective commencing September 15th. This is a new chair at the University of Michigan, having been created at the last meeting of the board of regents. In addition to his consulting practice, Prof. Blanchard has been associated for some years past with the highway engineering department of Columbia University. He has given numerous lectures to Canadian audiences on various phases of highway work. Prof. Blanchard is best known as the chief editor of the "American Highway Engineer's Handbook." He is the author also of several other well-known books on highway engineering.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

PLACE OF WORK..	TENDERS CLOSE	ISSUE OF	PAGE
Alderson, Alta., school	Aug. 21.	Aug. 14.	44
Bridgeville, N.S., school	Aug. 30.	July 31.	41
Halifax, N.S., transit sheds, Nos. 21 and 22	Aug. 23.	Aug. 14	46
Halifax, N.S., schools	Aug. 30.	July 31.	41
Oshawa, Ont., warehouse	Aug. 22.	Aug. 14.	46
Ottawa, Ont., pumps, engines, etc.	Aug. 30.	July 31.	44
Parkside, Sask., school	Aug. 22.	Aug. 14.	46
Peterborough, Ont., public school	Sept. 1.	Aug. 7.	48
Pointe Pizeau, Que., repairs to wharf	Aug. 28.	Aug. 14.	48
Saskatoon, Sask., turbo-generator	Sept. 23.	July 24.	44
Ste. Martine, Chateauguay, Que., pavement	Aug. 30.	Aug. 14.	42
Sydney, N.S., church	Aug. 25.	Aug. 14.	46
Toronto, Ont., additions to school	Aug. 27.	Aug. 7.	48
Webbwood, Ont., concrete walks	Aug. 23.	Aug. 14.	42
Winnipeg, Man., water recorder	Sept. 1.	July 31.	46
Toronto, Ont., addition to school, Keele	Aug. 27.	Aug. 14.	46
Toronto, Ont., addition to school, Earl Grey	Aug. 27.	Aug. 14.	46
Toronto, Ont., addition to school, Duke of Connaught.	Aug. 27.	Aug. 14.	46
Toronto, Ont., 200,000 railway ties	Aug. 25.	Aug. 14.	48
Toronto, Ont., 1,375,000 railway ties	Aug. 25.	July 31.	46
Toronto, Ont., 1,400,000 railway ties	Aug. 25.	Aug. 7.	50
Toronto, Ont., 3,525,000 railway ties	Aug. 25.	Aug. 7.	50

BRIDGES, ROADS AND STREETS

Amherstburg, Ont.—Tenders will be received by the town council, until 8 p.m., August 25th, for a concrete pavement on Murray and Dalhousie Sts. W. A. McCormick, town clerk, Box 161, Amherstburg.

Amherstburg, Ont.—Tenders will be received by W. A. McCormick, town clerk, Box 161, Amherstburg, up to 8 o'clock p.m., Monday, August 25th, 1919, for a concrete pavement on Murray and Dalhouise Sts., according to plans and specifications which may be seen in the office of the town clerk.

Brantford, Ont.—Construction has commenced on the Brantford-Hamilton highway. Curves are being eliminated as far as possible and the road widened. Pavement to be laid, bitumin. Estimated expenditure for 1919, $100,000.

Brantford, Ont.—Contract has been awarded by the city council, for construction of asphalt concrete pavements on Chatham and George St., $2.00 per sq. yd., and on Dufferin Ave., $1.85 per sq. yd. Contractor, Standard Paving Co., Ottawa.

Brantford, Ont.—Scarfe and Co., contemplates extensions to their varnish factory.

Brantford, Ont.—The highway between Hamilton and Brantford will be constructed on macadam specifications similar to such roads in England, etc. Hon. F. G. Macdairmid, minister of public works, Ontario.

Brockville, Ont.—The town council contemplate paving Pearl St., estimate of cost, $44,092, and Pine St., estimate of cost, $12,094. W. A. Lewis, mayor.

Cobourg, Ont.—Contract awarded to M. Jex and Co. for the construction of a new curling rink for the Waverly Curling Club. Work has commenced.

Creston, B.C.—Contract has been awarded by the department of public works to G. Hunt, Kitchener, B.C., for construction of 1.5 miles of new road between Goatfell and Creston. Wm. Ramsay, district engineer.

Edmonton, Alta.—Sidewalks planned include both sides of 107th St., from Jasper Ave. to 100th Ave. Cinder walks to be built on the south side, 2 mls., west end, 2 mls., east end, 2 mls. Cost, $7,000. City engineer Haddow.

Edmonton, Alta.—The city council will consider construction of a new concrete sidewalk on Grierson St. A. W. Haddow, city engineer.

Fort William, Ont.—City council will construct sidewalks on Vicker's and Harold Sts.

Fort William, Ont.—Tenders will be received until August 30th, by the municipality of Paipoonge, for construction of a timber bridge and a culvert. W. A. Dyke, clerk, 115 St. May St., Fort William.

Fort William, Ont.—Tenders will be received until noon, August 29th, by the city engineer, for construction of approximately 1,550 lin. ft. of curb and gutter, 4,300 sq. yds. asphalt, asphalt concrete, or bitulithic pavement on 6-in. concrete base. C. B. Symes, city engineer. (Official advertisement in this issue).

Galt, Ont.—The board of works will undertake temporary repairs to the Main St. bridge this fall. It is expected that a new single span bridge will be constructed in the spring.

Golden, B.C.—Tenders will be received until noon, August 25th, by the department of public works, Victoria, for construction of a bridge over the Blaeberry river. Plans, etc., at offices of assistant district engineer, Golden, B.C., and district engineer's office, Vancouver. A. E. Foreman, chief engineer, Victoria, B.C.

Guelph, Ont.—The International Malleable Iron Co., will erect a new reinforced concrete and brick factory extension. Estimated cost $33,000. W. A. Maloney, architect.

Halifax, N.S.—Tenders will be received until noon, August 27th, by the C.N. Ry., for construction of dock marginal and other paved and macadamized roads and streets at the Halifax Ocean Terminals. Plans, etc., at offices of chief engineer, Moncton, N.B.; superintending engineer, Halifax Ocean Terminals; division engineer, C.N. Ry. Tunnel Station, Montreal. F. P. Brady, general manager, Montreal, Que.

Hamilton, Ont.—An experimental pavement is being laid on MacNab St., between Main and Jackson Sts. If successful, similar pavements may be laid on steep grades near the mountain. E. R. Gray, city engineer.

Hamilton, Ont.—Bulk and separate tenders will be received by R. L. Foster, secretary of the board of education, up to 5 p.m., Monday, August 25th, for the erection of a 12-room school on Hunter St. W. Plans and specifications may be received at the office of F. W. Warren, architect, Bank of Hamilton Building.