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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Hydro-Electric Power Development and Pulp Manufacturing Plant at Smooth Rock Falls

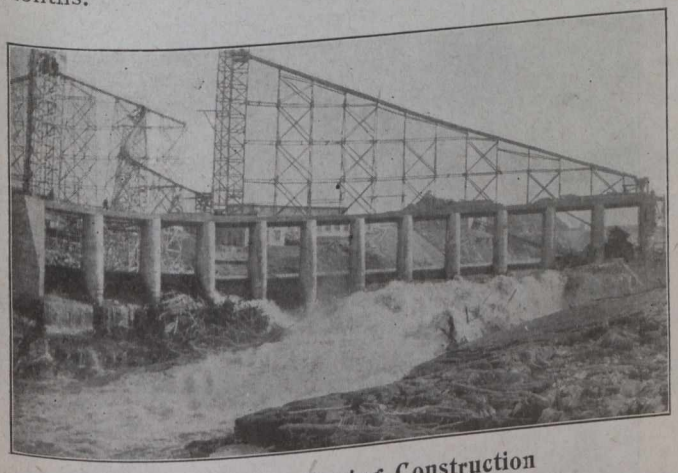
Establishing A New Town—Erection of Eight Concrete Mill Buildings, Dam, Power House, Pumping Station and Filter Plant—Construction Carried on During Severe Winter Weather

By JAMES DICK, A.M.Can.Soc.C.E.

Resident Engineer for the Contractor

THE plant of the Mattagami Pulp and Paper Co., comprising a sulphite pulp mill, power house and dam, is located at Smooth Rock Falls, on the Mattagami River, thirty-two miles west of Cochrane, Ont. This work, recently completed, has been under construction for the past year and a half.

The site of the plant is about three miles north of the National Transcontinental Railway. Before building construction work could be proceeded with it was necessary to construct a three and a half mile standard railway spur from the main line. This was undertaken and completed during the summer of 1916. In addition to this, about one square mile of land was cleared to provide for the establishing of the mill and town site, also to obtain adequate protection from bush fire, which in the northern part of Ontario is a serious menace during the summer months.



View of Dam During Construction

Construction work consisted of the erection of a pulp mill comprising a group of eight concrete buildings, a concrete dam, power house, pumping station and filter plant. The general layout of the various structures is shown on page 487.

Dam and Power House

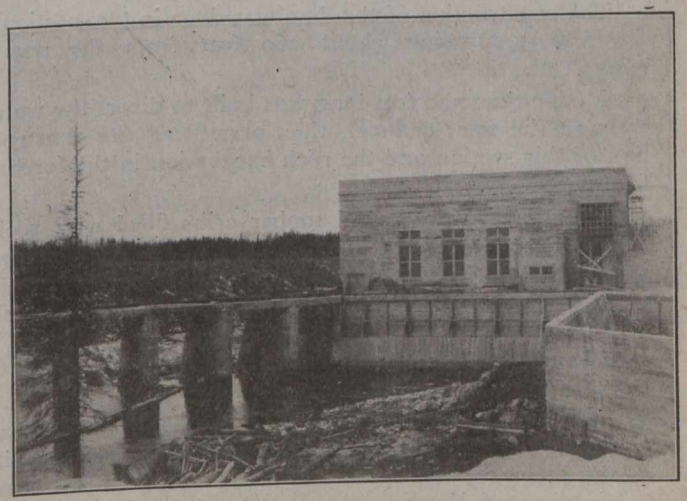
The Mattagami River at this point had a fall of about 25 feet in a distance of 180 feet before construction was begun.

At low water, this fall was through two narrow gorges, the river being divided by a rocky island, a feature which proved of value during the construction period, as it was possible to build a considerable portion of the dam before the unwatering was wholly complete.

The dam, which is of the stop-log type, is constructed to permit of raising the water 30 feet above the lowest water level, giving a maximum head of 45 feet. In plan

Lower Cofferdam

it is curved, the curve at the up-stream side having a radius of 333 feet with a total length of 448 feet. Below the stop-log sill level it is of mass construction, sloping both ways from that point to a maximum width of 40 feet



Power House

6 inches. Above this it comprises 18 piers covered with a deck 25 feet wide terminating at the abutments at each end of the dam.

The piers are spaced 21 feet centre to centre at the stop-log guides and are on radial lines. The maximum width is 5 feet, tapering towards the down-stream end to about 3 feet 3 inches in order to give a minimum spillway of 16 feet between the piers.

The discharge is controlled by the stop-logs of which there are two sets placed about 2 feet 6 inches apart.

Installation of Draft Tube Forms

These are of 12-in. x 12-in. timber bolted in pairs and are handled from the deck by an electrically driven lifting machine which operates on a track throughout the length of the dam.

The construction of the dam was done in two sections, the first comprising about 260 feet from the power house end.

A cofferdam 320 feet long was built to divert the water through the west channel, thus permitting the construction of this section and the rock excavation in the forebay to proceed.

Cofferdams were round timber cribs filled with rock. These were constructed in sections, floated into place and sunk, additional courses of logs being placed to bring the work up to the required height, then sheeted with two ply of 2-inch plank.

Divers were employed to place the sheeting and fit it to the river bed, which at this point is of bare rock.

The drawing on the opposite page will give an idea as to the procedure with regard to the unwatering of the site of the second section of the dam, the water in this case being diverted through the completed portion after the first cofferdam had been demolished.

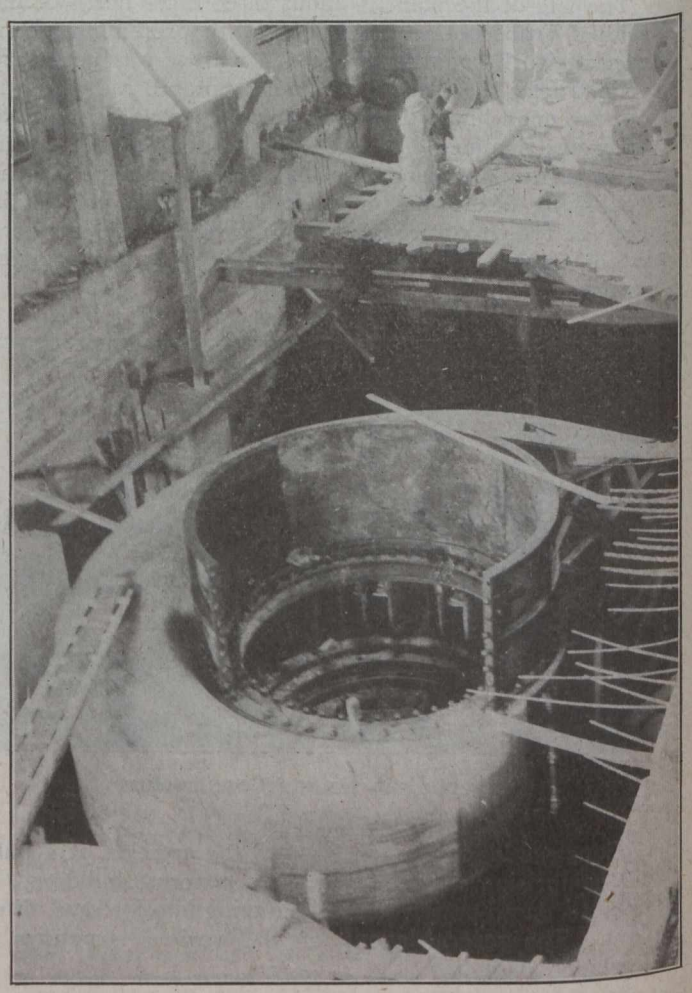
No pumping was necessary to keep the site of the work free of water as the seepage through the cofferdams was very slight and was taken care of by a pipe through the foundation of the dam. This was sealed with grout as soon as concrete reached the sill level.

The power house is 74 ft. x 98 ft. in plan and is constructed entirely of concrete, heavily reinforced. Structural steel was used for all roof and floor supports and wherever possible is encased in concrete.

On page 490 there is a plan of the power house, and on page 488 the first drawing shows a section through that part of the structure taken up by the main development, comprising about 66 feet of the length of the building. The remaining 32 feet at the east end is utilized for switchboard galleries, etc., details of which are not shown in the accompanying figures.

The lowest floor of this section is occupied by a 200-kw. alternating generator supplying current for such machinery as is required on Sundays. This is belt-driven by a 250-h.p. horizontal turbine, the intake for same being underneath the small gate house at the breast wall. The water is conveyed inside the building by a steel penstock 54 inches in diameter.

There are two floors above this, covering about half the width of the building. The lower one contains the switchboard apparatus and the upper level the control board from which all power distribution to the pulp mill



Scroll Case Form Work

and the operation of the power house is electrically controlled.

The installation for the main development consists of two vertical turbines, each having a manufacturers' rating at a 45-foot head of 4,500 h.p. and 112.5 r.p.m. Each unit is direct connected to a 3,125-k.v.a., 3-phase, 60-cycle, 575-volt generator.

A 60-kw. motor generator is provided as an auxiliary exciter to those direct connected to large units.

A complete lubricating system is installed, comprising three direct connected motor-driven pumps and pressure, drain and filter tanks. A motor-driven oil compressor supplies air for oil pressure and power for operating brakes.

The turbines were supplied by the I. P. Morris Co., of Philadelphia, Pa.; generators and switchboard by the Canadian General Electric Co., of Peterborough, Ont.

The water is controlled at each intake by a steel gate provided with roller bearings. Each gate is connected to a worm gear lifting apparatus which is operated by a motor.

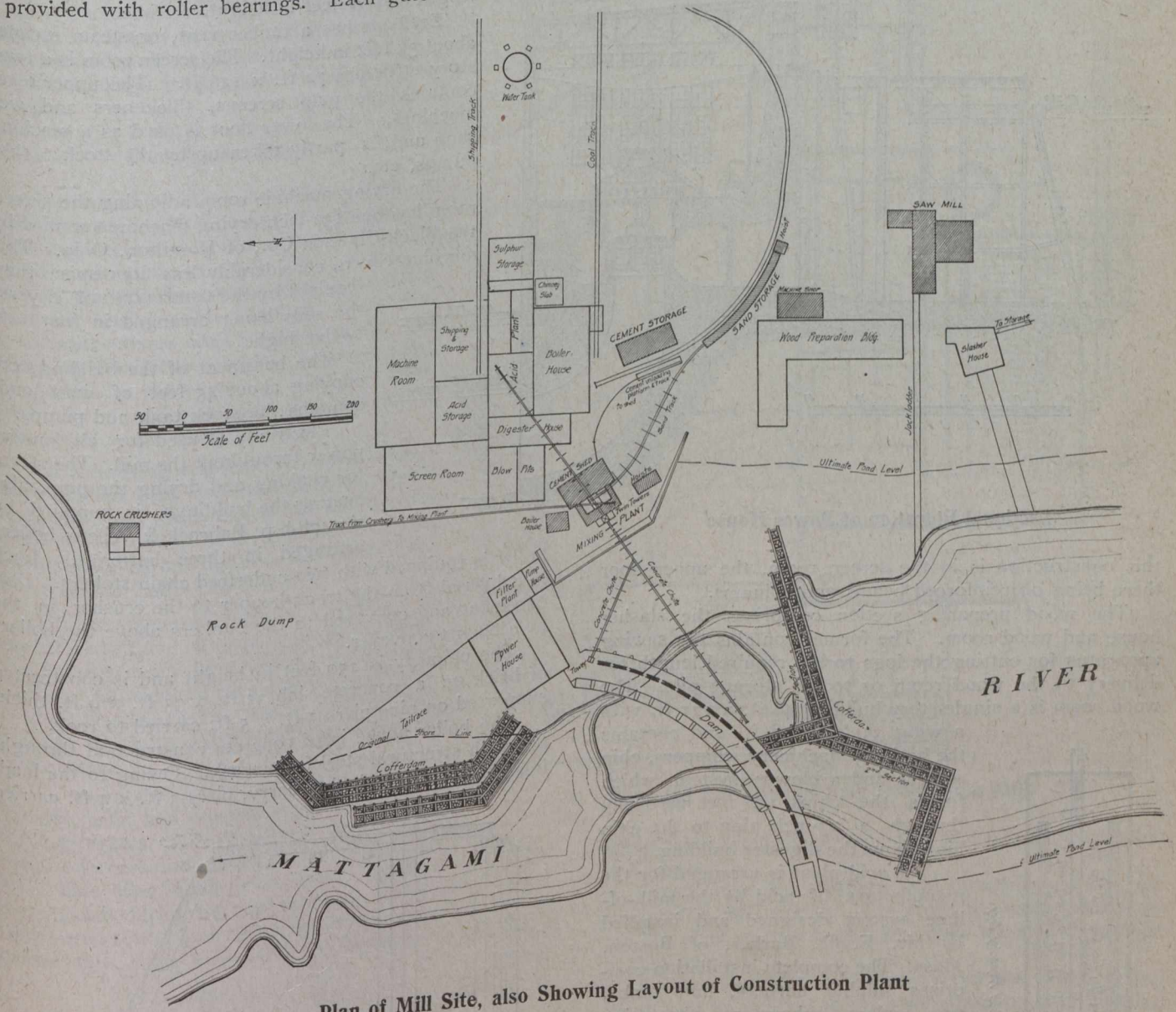
The drive shaft is so arranged that gates can be handled singly or together.

The intakes are fitted with two sets of steel racks, also emergency stop-log guides. Outside of the headworks a structural steel framework supports the outer racks and the deck in front of the building.

Before building construction could proceed it was necessary to excavate about 20,000 cubic yards of rock to provide sufficient depth for the installation of draft tubes and for forebay and tailrace. As the excavation for the power house and tailrace had to be carried below the water level a cofferdam was constructed around the site. This was similar in type to the one built to unwater above the falls.

Owing to the very irregular nature of the rock bottom, depth and swiftness of the water, the cribs were placed with considerable difficulty. Soundings showed 45 feet of water at the outside of the structure, at which depth the divers had much difficulty in placing the sheeting, being handicapped by the current and darkness.

In order to protect the sheeting from the force of the current and logs, a second cribwork was constructed outside to act as a breakwater. A space of 6 or 7 feet left between it and the cofferdam was used to contain clay puddle. To complete the unwatering two centrifugal pumps were installed to pump out the site of the excavation.



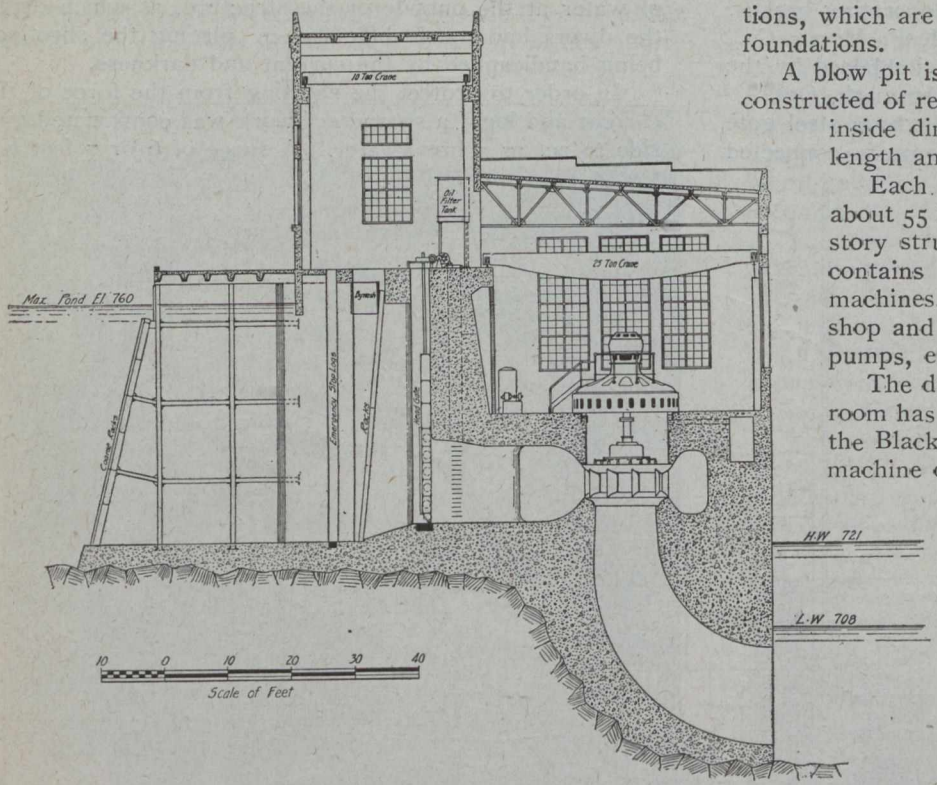
Plan of Mill Site, also Showing Layout of Construction Plant

Pulp Mill

The present capacity of the mill is 100 tons of dried pulp every twenty-four hours, the ultimate capacity being 150 tons, which will be attained by the installation of another digester and blow pit.

The group of buildings comprising the plant consist of a wood preparing department, acid plant, digester building, blow pits, screen room, drying machine room and boiler house.

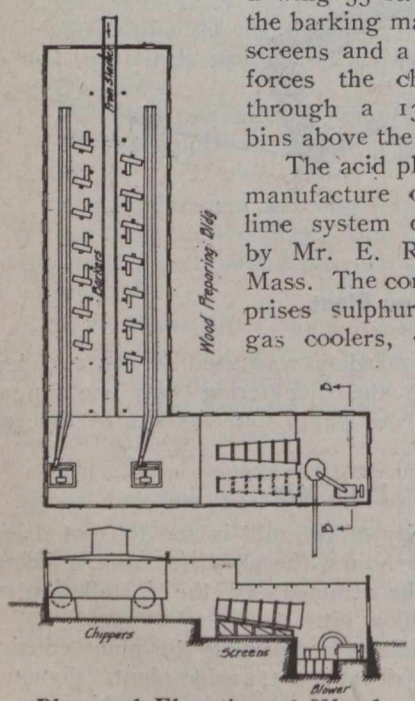
Concrete construction is used throughout except for some of the roofs which are of timber. All floors above the ground floor are supported by structural steel, all of which is encased in concrete. The only departure from



Sectional Elevation of Power House

this construction is in the screen room, the upper floor there being on reinforced beams and columns.

The wood preparing section comprises the slasher house and wood room. The former contains the sawing apparatus for cutting the logs to the required length for delivery to the wood room or to the storage pile. The wood room is a single-story building 48 ft. x 171 ft. with a wing 33 ft. x 78 ft. and contains the barking machinery, chippers, chip screens and a blower system which forces the chips 150 feet vertically through a 13-inch pipe to the chip bins above the digester building.



Plan and Elevation of Wood Preparing Building

The acid plant is arranged for the manufacture of acid by the milk-of-lime system designed and installed by Mr. E. R. Barker, of Boston, Mass. The complete installation comprises sulphur burners, lime tanks, gas coolers, exhausters, absorption towers, acid coolers, storage and reclaiming tanks.

The digesters, said to be the largest on the continent, are 19 feet in diameter and 65 feet in height, producing 50 tons of pulp each per day. Two are at present installed with provision made for the placing of a third. A steel chip bin is located over each digester and has a capacity for chips enough for one charging of the digester.

The chip bins are supported on columns resting on steel beams carried by the walls. The latter vary in thickness from 20 inches at the roof to 36 inches at the foundations, which are carried to rock, as also are the digester foundations.

A blow pit is provided for each digester. These are constructed of reinforced concrete and are wood-lined, the inside dimensions being 28 feet wide, 62 feet in length and 22 feet in height.

Each pit has a timber vent, or steam escape, about 55 feet in height. The screen room is a two-story structure 72 ft. x 126 ft. The upper level contains the pulp screens, thickeners and wet machines. The lower floor is used as a machine shop and is partly taken up by the stock tanks, pumps, etc.

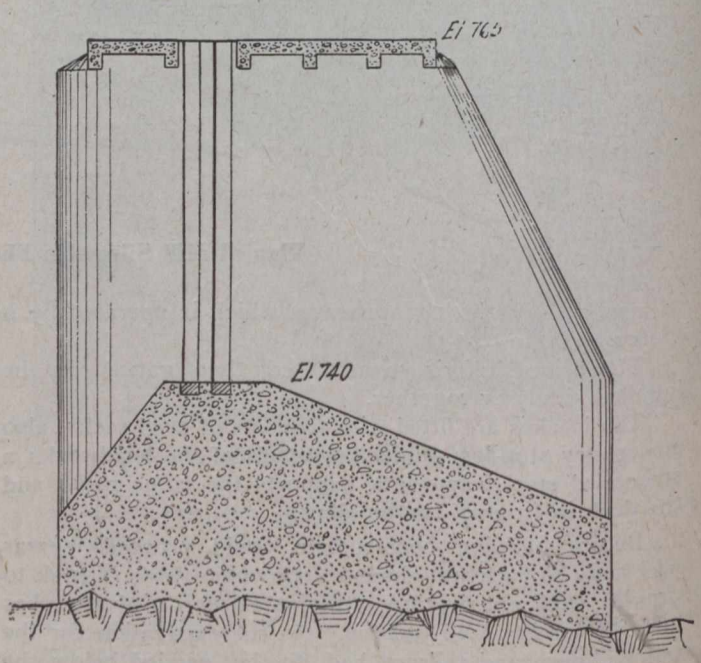
The drying machine room adjoining the screen room has one 132-inch drying machine supplied by the Black-Clawson Co., of Hamilton, Ohio. This machine covers considerably less floor space than required by the usual type of dryers, the rolls being arranged in four sets twelve high.

The basement of the building, occupying about 45 feet of west end, contains the stock tank and pumps.

Electricity is used for all motive power throughout the mill. The steam for cooking and drying the pulp, also heating the buildings, is supplied by six 478-h.p. Babcock & Wilcox boilers arranged in three batteries. Each boiler is equipped with two underfeed chain stokers. Coal is delivered from the track hopper to the crusher in the basement and conveyed to the bunkers above the boilers by a bucket conveyer.

The chimney is 250 feet in height and is constructed of brick on a concrete slab 35 ft. x 35 ft. x 9 ft. thick, supported on nine piers 5 ft. x 5 ft. carried to rock.

The boiler house is of concrete construction throughout with structural steel framework. Owing to the loading which columns had to carry, piers 3 ft. x 4 ft. carried



Typical Section of Dam

to ledge rock were placed under the foundation at all columns.

A filtered water supply is provided by two direct connected motor-driven pumps, each having a capacity of 2,500 gallons per minute, and eight pressure filters. The latter are located in a building adjoining the power house.

A complete hydrant system is installed with two underwriters' duplex fire pumps each having a capacity of 1,000 gallons, the storage consisting of a 150,000-gallon steel tank.

All buildings are provided with a sprinkler system.

Construction Plant

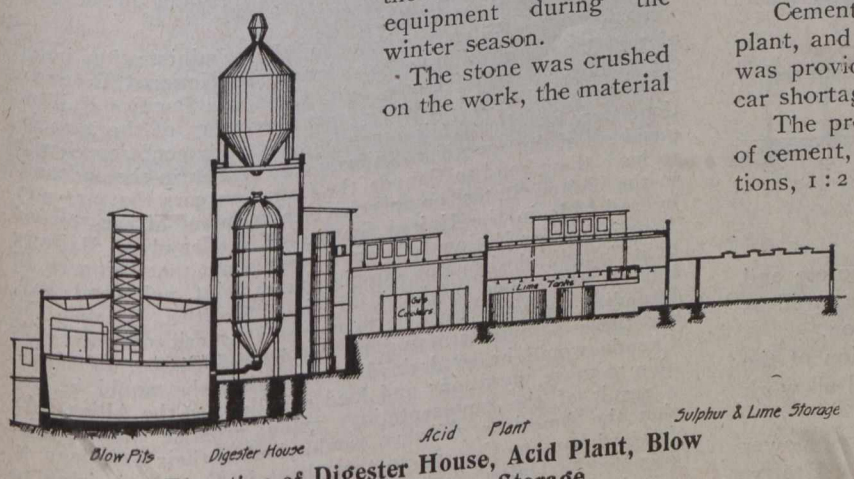
The layout of the construction plant is shown on page 487. The concrete mixing and handling section was laid out with the idea of distributing the concrete from a central mixing plant to the various parts of the work with the least possible handling. Two No. 2½ Smith mixers were installed under the charging floor, the charging hoppers being connected by chutes to the sand and stone bins above. The cement shed was at the same level as the charging floor.

Twin hoisting towers, 125 feet in height, were erected with two main concrete chutes radiating from them, one to the mill and the other to the power house and dam. These were supported on light timber trestle construction and had a fall of 1 in 4.

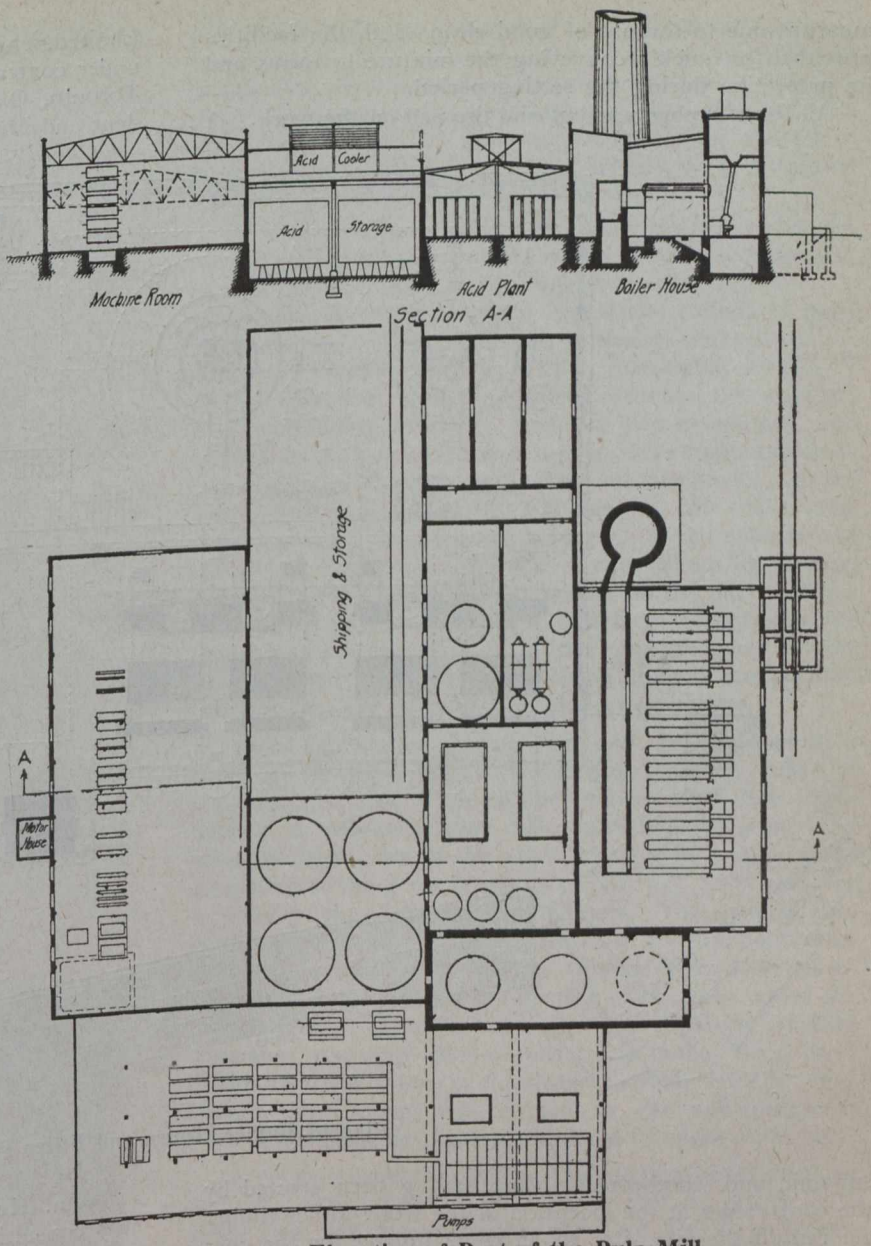
This arrangement, with the addition of branch chutes and sub-hoisting towers, facilitated the placing of concrete shortly after mixing. Outside the radius of the chutes the mixture was handled in buggies, the distance wheeled in all cases having been reduced to a minimum.

As no suitable gravel was to be had in the vicinity, sand and crushed stone were used for aggregates. The sand was delivered at the site in cars and unloaded into a storage bin. This was fitted with steam pipes to keep the material hot during the cold weather. From there it was transferred to the bins above the mixing plant only as required, thus doing away with the necessity of providing these bins with a heating equipment during the winter season.

The stone was crushed on the work, the material being taken from the power house and tailrace excavation spoil bank.



Elevation of Digester House, Acid Plant, Blow Pits and Sulphur Storage



Plan and Elevation of Part of the Pulp Mill

Two Climax jaw crushers were installed over bins adjoining the rock supply. The stone was conveyed to the mixing plant in cars hauled by cable operated by a hoist at that point.

Cement was delivered on cars very close to the mixing plant, and in addition to the shed adjoining it, a building was provided for storage of a reserve supply in case of car shortage, etc.

The proportions used in the concrete mixture were 1 of cement, 3 of sand and 6 of crushed stone for all foundations, 1 : 2 : 4 respectively being used in the superstructure of all buildings, also headworks of power house and piers of the dam.

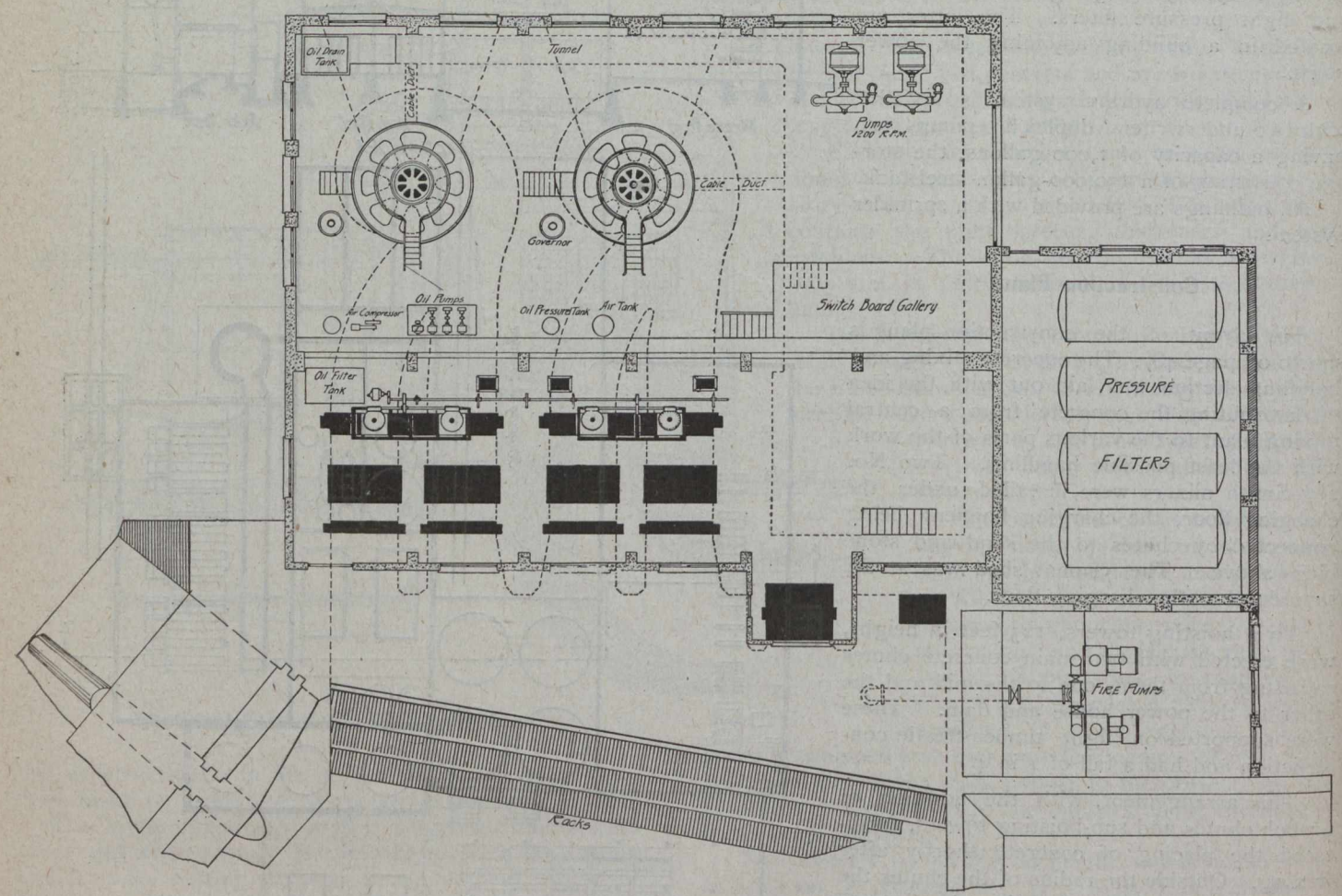
As the bulk of the concrete was placed during very severe winter weather, the sand and water used in it were heated to a temperature which would insure the mixture reaching the forms in good condition. The concrete in the completed structures shows no indication of having been affected by frost, the results obtained being in a great

measure due to the use of good clean sand, the facilities provided for quickly conveying the mixture to forms and its protection during the setting period.

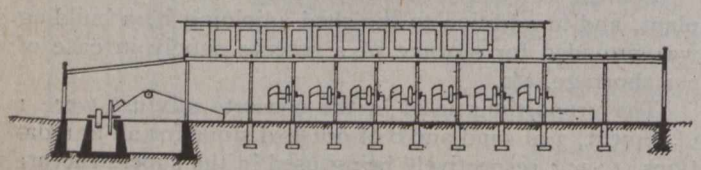
All form lumber was cut and dressed on the work. A saw-mill and woodworking shop having been erected by the contractors at the inception of the work to cut timber cleared off the site, also to provide lumber for the construction of camps, etc.

A well-equipped machine shop handled all machinery repairs with a great saving of time owing to the distance from facilities for doing such work. This building also contained an electric plant which provided lighting for camps, etc.

The whole work involved the excavation of about 21,000 cubic yards of rock, 57,000 cubic yards of other materials, placing of 34,000 cubic yards of concrete and 1,000 tons of steel, structural and reinforcing, as well as other material incidental to building construction.



Plan of Power House and Filter Plant



Section Through Barker Room

Construction work started with the completion of the spur line about the end of September, 1916, and all work was completed on October 31st, 1917.

The construction of the spur, mill buildings, power house and dam was performed by Morrow & Beatty, Limited, engineering contractors of Peterborough, Ont., under contract from the Mattagami Pulp and Paper Co., Toronto, Ont., of which Mr. Duncan Chisholm is president and Mr. S. R. Armstrong general manager.

Wm. Kennedy, Jr., M.Can.Soc.C.E., of Montreal, was consulting engineer on the hydraulic development and was represented by Mr. E. Loignon.

On Thursday, December 13, before the Ottawa Branch of the Canadian Society of Civil Engineers, Mr. F. Elcock, works superintendent of the Ottawa Gas Company, will read a paper on "Coal Gas." He will explain the design and operation of coal gas generating plants.

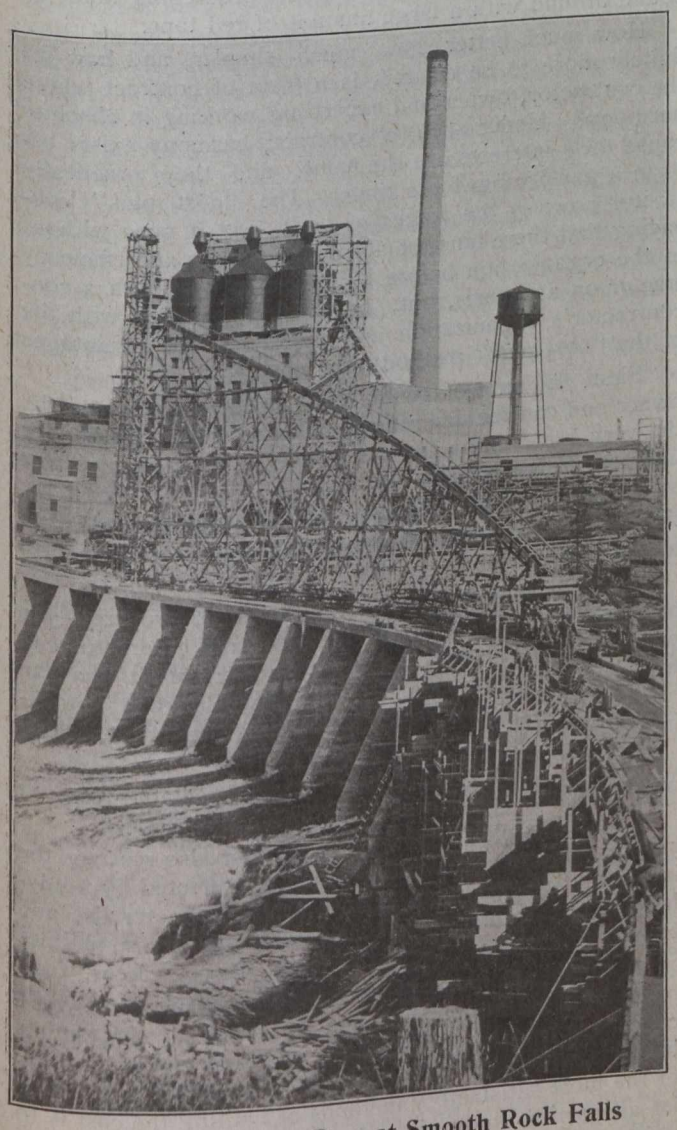
Mr. U. E. Gillen, chairman of the administration board of the Canadian Railway Association for National Defence; Sir George Bury, vice-president Canadian Pacific Railway Company, and W. M. Neal, general secretary of the association, were in New York recently to have a conference with members of the American Railway Association in the endeavor to have them send to Canada the Canadian cars that are now in the United States, or an equivalent number of cars owned by railroads in the United States. The Canadian Railway Association for National Defence pointed out that shippers all over Canada, desirous of shipping news print, pulpwood, hay, lumber and other products, are in difficulties, because the Canadian railways are able to use only American-owned cars for these shipments going to the United States, otherwise Canada would be so drained of cars that she would be unable to move munitions and food supplies for the Allies. As a result of the representations made, promise was secured that the American railways would double their exertions to forward cars to Canada so that those in Canada desiring to ship to the United States might be insured a reasonable car supply.

"LUMP SUM" VS. "COST PLUS" CONTRACTS*

By Fred. A. Jones

UNLESS a close analysis, based on actual experience, is made, the old-style "lump sum" or "spotter" method of contracting, apparently has a great many advantages.

It is generally thought that the "lump sum" contract is a protection against graft, and especially in public work, due to the publicity given to the lettings, and because of the stringent clauses in the contract or specifications by which the architect or engineer becomes a representative of the owner, and closely watches to see that the contract is performed in all respects. Another supposed advantage is in the idea that the exact cost can be determined better in advance than by estimating, and



Building the Concrete Dam at Smooth Rock Falls (See Preceding Article)

further, the "lump sum" form of contracting enables the owner to avoid the embarrassment of selecting one contractor from among several, which at times, due to friendships or business reasons, might be awkward.

From the contractor's viewpoint there is a general feeling that more money can be made out of "lump sum" work than under the "cost plus" method, and the average contractor likes the gamble, because all savings that can be effected are his, adding just that much to his profits, whether these savings are effected by actual economy in operation, change of the market condition, change of plans (which usually brings added profits), or by obtaining especially good treatment from the inspectors.

The objections to the "lump sum" contract from the contractor's point of view, are not as commonly supposed, due to hazards, because the hazards can be reduced to a minimum, if the contractor has ample capital, a good organization, and never submits proposals without having a double-checked estimate, with a reasonable margin of profit. I mean by a double-checked estimate, two separate and independent estimates made by two estimators, and handed to the construction manager, who compares them and makes up his cost figures from his experience and the two independent estimates. Of course, the contractor should be able to use good judgment in the selection of architects, engineers and owners, with whom he figures, because it is very easy for unfairness on the part of those with whom he deals to cause him large losses, but the only real hazards, other than poor management, are the elements, unscrupulous or careless bidding of competitors and unfairness of architects, engineers or owners.

There is another hazard that can be reduced to a minimum by good judgment, and that is in the letting of sub-contracts, for it must be remembered that even though a sub-contractor has furnished a good and adequate bond, yet, if the sub-contractor fails, the owner is looking to the general contractor entirely, with probably a penalty for delay in completion. The general contractor cannot call on the bondsmen of the sub-contractor until he can show a loss and the amount of the loss, which can only be done at the completion of the job; when the time arrives to show the loss and collect from the bonding company, you very seldom collect any money on a bond of this character, for, in the desire to rush work to completion, more money will be paid to the sub-contractor than is due him, or the bond violated in some other way.

A serious objection from the contractor's point of view, to "lump sum" contracting is that no matter how much time and money he has spent on his organization, he is usually classed with any other contractor who can furnish satisfactory bonds. This is due to the lack of appreciation by the average layman of the fact that there can be a very material difference in the structure when completed, as between two different contractors, in spite of all reasonable inspection, although apparently the plans and specifications have been complied with in both cases. This lack of knowledge and experience on the part of the average layman makes it possible for bids to be received, at times, from those incompetent to do the work in hand. Naturally, it frequently happens that a good job is spoiled for a good contractor by unintelligent bidding of others, and is spoiled for the owner because he does not receive that for which he pays, and, in addition frequently has law-suits and other troubles in connection with his work. But this is not the most serious objection. There have been so many chances taken in the past, and so much "rule of thumb" method used in estimating, together with real and unavoidable losses, due to "acts of God" or other causes beyond the control of the contractor, that very few contracting concerns really have a good standing with the banks. Lack of sufficient funds, by reason of this poor standing, frequently causes a loss in what should be a profitable contract. It is impossible for banks to check an estimate and determine whether at the end of a job the

*Abstracted from paper read before a state meeting of the American Society of Civil Engineers.

contractor will show a gain or a loss in assets, and they are likely to withdraw credit at a critical time. In addition to this, if a contractor is bidding on all the work in his line which comes up in a certain territory, he is not likely to receive more than 1 out of 15 jobs bid upon, and the cost of estimating becomes a very large part of his overhead expense, as it is hardly possible to estimate, for example, a $300,000 job at a cost of less than $500. The only estimate by any bidder that does anyone any good is that of the successful bidder; the balance of the money spent by other contractors on estimating is an economic waste. You can be very sure that the "lump sum" contractor does not forget this when he estimates his cost of a job (or if he fails to include it, he does not know his own cost), and the owner pays in the end; for, like railroads, contractors are not Santa Clauses, and like other men, they have a feeling that no one is entitled to something for nothing.

From the viewpoint of the consulting engineer or architect, there are some real objections to "lump sum" contracting, for in the first place he increases his cost of supervision, which could be avoided by doing the work on a "cost plus" basis, and this is an economic waste. Furthermore, he is forced to look upon suggestions made by the contractor with a certain amount of suspicion, and the natural thought is, what advantage would the contractor making the suggestion obtain? In this way he loses a great deal of valuable assistance, because, even though he had confidence in the contractor, the owner, his client, might lose confidence in his expert advice if he were taking suggestions or receiving advice from one whose contractural relations were directly opposed to the interests of the owner. Again, contractors have been known to have some secret understanding among themselves, for this is sometimes done in spite of legislation against such practice. The modern first-class constructing and engineering organizations are the greatest enemies to "pooling," and the greatest friends to "cost plus" contracting.

Another natural objection of the architect or engineer is that he is not allowed to select an organization which to his mind, is the most efficient and can lend him most assistance, having some expert departments which he cannot afford to maintain. He must decide who the contractor shall be according to cold figures, knowing frequently in his own heart that it is not the best for the owner to accept the lowest bid, but fearing suspicion of the owner that he has ulterior motives if he recommends so highly some particular organization. In addition to this, in "lump sum" contracting there can be very little reciprocity as between engineer or architect and contractor. There is always a certain amount of give and take in any well-conducted contract, but there exists no opportunity for the contractor to bring to the engineer or architect, a commission for professional services by reason of his influence with some particular client, or for the reverse, the architect or engineer to turn over without competition a job for which a certain construction organization is particularly well equipped.

From the owner's viewpoint there are many objections to "lump sum" contracting, some of which have already been covered. In the first place, the contractor and the owner are not working along parallel lines. Their interests are not the same, and this cannot give the best results, though the contractor be ever so conscientious. Most all the objections already mentioned, of his engineer or his architect, would apply so far as the owner is concerned, because of conflicting interests, but if such a contract were entered into as to allow him to select a highly developed and flexible construction organization, and encourage the most effective use of such an organization, all parties would be working toward a common end. Other objections of the owner are that if the architect or engineer makes any mistakes, thereby causing extras or, for any other reason, changes should be made, it is not to the interests of the contractor to call attention to these in advance of signing the contract, but rather to await such a time as the owner would be obliged to pay him almost his own price. Of course, any small changes can be covered by a clause in the specifications, but it is impossible to cover any very large change in original plans. The owner dares not pay the contractor more than is due, according to his contract, even though he may know that he cannot get efficient service without the contractor having ample funds, for he might in this way vitiate the contractor's bond. In fact, the whole proceeding must be bound around with a large amount of red tape.

How much better, how much simpler, and how infinitely more to be desired, is a form of contract where the contractor, owner and expert are working in absolute harmony? Under such a contract, harmony exists because their interests are the same, and they practically form a partnership for a time. The "cost plus" contractor receives the wages of trust, and it goes without saying that there must be absolute integrity and efficiency in the organization before it is wise to deal with a contractor on any basis, but, being first satisfied with the contractor's organization and character, the advantages of the "cost plus" method are:

First, the rate of profit being fixed in advance the owner and contractor are in position to work together for the very best results for the money to be spent. Their interests do not conflict.

Second, desirable changes that arise during construction (and some always arise) can be made in exact equity to the owner.

Third, it should give an owner a better property—the best he and his engineer or architect and contractor can produce for the money spent, at a lower profit than he would usually pay on a flat sum basis—anyway not exceeding cost, plus a reasonable pre-agreed profit, which is as cheap as he is entitled to it; and,

Fourth, the work can be started immediately without waiting for completion of plans in all their details.

In a "cost plus" contract, the owner also receives the savings made in purchases, which are effected by studying conditions as requirements arise for materials, and here is opportunity for considerable saving, sometimes equalling in amount the entire fee of the contractor.

A reliable estimate of the eventual construction cost made by a well-organized and experienced contracting concern is a better guide for the owner as a rule than the bidder's figures on a "lump sum" contract letting. One of the most satisfactory methods of limiting the cost is to let all parties know in advance this limit and work in unison not to exceed it, but to get the most for the money spent, while to try to limit the cost by requiring a guaranteed maximum is only getting back to the red tape of the "lump sum" contract without gaining anything.

In conclusion, a "cost plus" contract is a bankable piece of paper.

A new method of clearing waterways of vegetable matter consists of a set of mowing machines attached to the stern of a launch. It is the invention of a Frenchman.

COST OF OILING HAMILTON'S STREETS

By E. R. Gray, B.A.Sc.
City Engineer, Hamilton, Ont.

THE accompanying expense sheet shows the suggested cost of the different operations in connection with the oiling of streets at Hamilton, Ont., during the past season.

The practice in Hamilton is to first carefully sweep all macadam roads with horse brooms, irregular portions being broomed out by hand. This operation, however, has not been charged against road oiling, as twice a year, in the spring and autumn, this work is done and quite properly charged to street cleaning account. Advantage is merely taken of this opportunity of putting the oil on a clean road.

After the street has been properly cleaned the oil is distributed by gravity from an ordinary water cart fitted with spray properly drilled for oil distribution. Following this operation, screenings and stone dust from the city quarry is spread over the oiled road by hand by two men working from a wagon.

In previous years the screenings and labor of distribution have been charged against roadway repairs. It is felt, however, that inasmuch as the screenings are made necessary by reason of the application of oil and since the oil rather than the screenings really forms the wearing surface, it is scarcely fair to charge it against roadway repairs any more than the cost of the whole operation of road oiling.

Funds to provide for the cost of road oiling, flushing and watering are raised by special assessment based on foot frontage. Properties on streets not so treated are not taxed.

Table "A" is based on the total area treated. This includes macadam and dirt roads. No screenings, however, are used on the dirt roads, the oil only being applied. The records were kept in this way in order to obtain a general statement.

Table "B" analyzes the screenings and oiling as applied only to macadam roads. The statement shows accurately the amount of screenings applied to the roads covered. Table "B 2" is a summary of this information.

In working up these data some speculation arose as to just what area should rightfully be considered as oiled.

It is understood, of course, that it is not practical (at least in Hamilton it was not so) to oil nearer than 18 or 20 inches of the curb in order to avoid the possibility of pouring oil on the sidewalk.

It was found, however, that the oil easily ran over this portion of the road to the curb, thus affectively oiling the road from curb to curb. It was therefore considered fair to measure that part of the street affectively treated as the portion oiled.

Cost Summary.

Oiling.

Direct labor cost	$ .00056
45 per cent. overhead	.00018
Material cost	.01394
Cost of oiling, per square yard	$ .01468

Screening.

Direct labor cost	$ .00125
45 per cent. overhead	.00039
Material cost	.00098
Cost of screening, per square yard	$ .00262
Total cost per square yard	$ .01730
Total cost per 100 square yards	$1.73

Recapitulation.

Non-productive repairs (estimated)	$152.51
Non-productive depreciation	182.42
Non-productive insurance	25.65
Engineer's expense (area of streets)	119.42
Total non-productive	$480.00

Per cent. non-productive of direct labor, $480 ÷ 1,510.37 = 31.

Total labor and material cost, as above	$13,960.58
Non-productive cost, as above	480.00
Total cost	$14,440.58

$14,440.58 ÷ 834,395 square yards = $.01730 as above summary.

Cost of teams per hour	$ .75
Cost of labor per hour	.35
Cost of oil per gallon	.096
Cost of screenings per ton	.85

Table A.—Statement of Cost of Street Oiling, 1917.

District No.	Area, sq. yd.	— Oiling — Labor cost. $	Material cost. $	Gallons oil.	Labor cost. $	— Placing Screenings — Material cost. $	Tons screenings.	Total labor cost. $	Total material cost. $	Total cost. $	Flat cost per sq. yd. $
1	38,672	36.21	591.61	6,098	83.98	48.15	58	120.19	639.96	760.15	.0197
2	153,659	77.50	1,923.01	19,537	167.00	104.06	145	244.50	2,027.07	2,271.57	.0148
3	163,995	95.21	1,907.40	19,392	195.69	155.77	185	290.90	2,063.17	2,354.07	.0144
4	150,838	76.25	1,849.78	18,895	169.36	133.07	166	245.61	1,982.85	2,228.46	.0148
5	186,574	81.75	2,949.48	30,116	205.08	173.07	212	286.83	3,122.55	3,409.38	.0183
6	81,382	51.75	1,294.56	13,140	114.50	91.68	112	166.25	1,386.24	1,552.49	.0191
7	35,502	21.55	574.57	5,836	60.11	53.06	62	81.66	627.63	709.29	.0200
8	23,773	23.65	545.49	5,561	50.78	55.25	65	74.43	600.74	675.17	.0284
Totals	834,395	463.87	11,636.10	118,575	1,046.50	814.11	1,005 Lbs.	1,510.37	12,450.21	13,960.58	
Averages per sq. yd.		.00056	.01394	.1421	.00125	.00098	2.4	.00181	.0.492	.01673	
Averages per 100 sq. yds.		.056	1.394	14.21	.12500	.09800	240	.18100	1.492	1.67300	

The overhead costs, amounting to 45 per cent. of the cost of oiling, seem rather high at first glance. This cost is detailed under the caption "Recapitulation."

The first item for repairs refers to labor of putting the carts into condition for the season's work, several of them being very old and practically unfit for service. Depreciation is figured on basis of 10 per cent. per annum.

Table B.—District Comparative Analysis of Oiling and Screening.

	Analysis of Oiling.			Analysis of Screening.		
District No.	Labor cost. $	Material cost. $	Oil per sq. yd.	Labor cost. $	Material cost. $	Screenings per sq. yd., lbs.
1	.00094	.0153	.1577	.00217	.00122	3
2	.00051	.0125	.1271	.00108	.00068	2
3	.00058	.0116	.1164	.00119	.00095	2¼
4	.00050	.0123	.1253	.00112	.00085	2
5	.00044	.0158	.1614	.00110	.00093	2⅓
6	.00063	.0159	.1614	.00141	.00112	2¾
7	.00060	.0160	.1644	.00170	.00150	3½
8	.00099	.0229	.2341	.00213	.00232	5½

Engineering expense refers to the work of making the necessary measurements upon which the statement is based. This item might rightfully be distributed over a term of years as the information will now be available for future use as long as the street is oiled. It was necessary to make the charge in this manner, however, as each year must bear the full cost of the season's work.

Table B2.

NOTE: Re cost of screening—

Total area oiled	834,395 sq. yds.
Area of streets oiled but not screened	30,999 sq. yds.
Area of streets screened	803,396 sq. yds.
Total cost of screening	$1,860.61

Actual flat cost of area screened...$ .00231 per sq. yd.
Actual flat cost of area screened...$ .231 per 100 sq. yds.

TORONTO-HAMILTON HIGHWAY MAINTENANCE

The maintenance gang on the Toronto and Hamilton cement concrete highway discontinued the use of a horse and wagon and a 3-bbl. tar kettle in filling the cracks and joints this season. A tar kettle having a capacity of only one barrel was substituted and was moved along the highway by the men. A ½-ton motor truck conveyed the men to and from work, transported the tar and blanketing material and hauled the tar kettle when long moves were made. During much of the time the truck and driver were employed by the construction department for a part of the day.

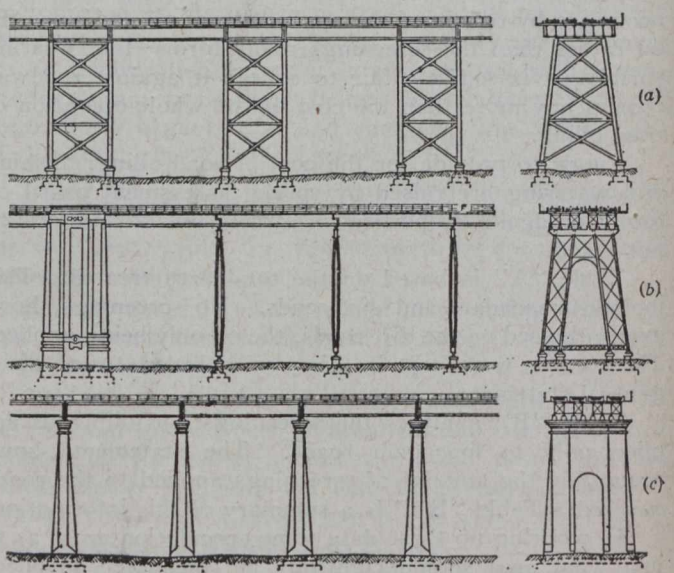
In some of the wider openings the objectionable settling away of the tar was avoided by caulking the bottom of the cracks with oakum. This treatment also effected a saving in the quantity of tar required, as none of it flowed away underneath the slab.

In an endeavor to clean out the openings quickly, a bellows was tried out, but the results were not satisfactory. All of the cracks were carefully cleaned and the narrow ones were chiseled down to a depth of about ½ in. An attempt was made to have the opening wider at the bottom than the top, so that the tar would tend to remain in place. Up to the present, substantially all of the tar poured this season is still adhering.—(By H. S. Van Scoyoc, chief engineer of the Toronto and Hamilton Highway Commission, writing in the November 29th, 1917, issue of Engineering News-Record of New York.)

COMPARATIVE DESIGNS OF PLATE GIRDER VIADUCTS*

By O. H. Ammann

TYPICAL portions of two preliminary designs for the plate girder viaducts and the design adopted are shown in Fig. 1. The top drawing (a) represents the typical American trestle viaduct with alternate tower spans, 40 ft. long and intermediate spans of 80 ft. This type, the advantages of which were cheapness and rapidity of erection, is now gradually being displaced by types of greater rigidity and durability, and better appearance. It would have been inappropriate and inadequate for the approaches to the Hell Gate Bridge. The drawing (b) (Fig. 1) represents the design made by Gustav Lindenthal in



Designs for Plate Girder Viaduct Approaches to Hell Gate Bridge

1906. It consists of plate girders, of nearly uniform span length of from 70 to 80 ft., resting on steel rocker bents. To resist the longitudinal forces from braking and traction solid masonry piers (stability piers) were to be provided about every tenth span. This design is superior in general appearance to the trestle design. The stability piers convey the impression of rigidity, and give opportunity for architectural treatment. The arch form selected for the steel rocker bents, although somewhat more expensive, is more pleasing than the ordinary two-column bent with single intersection diagonals. This type of viaduct is also stiffer, in the longitudinal direction at least, than the trestle type. The design (c) (Fig. 1) represents the type finally adopted, with concrete piers. It is superior to the other two types in appearance, rigidity, and durability, and is less costly to maintain.

(Concluded on page 498.)

*Abstracted from paper in Transactions of American Society of Civil Engineers.

ST. LAWRENCE RIVER POWER*

By Arthur V. White

THE Commission of Conservation of Canada has been endeavoring to have the natural resources of the country developed in a manner which will, so far as possible, pass them on to succeeding generations unabused by the uses to which they must now necessarily be applied.

In this connection, special attention was devoted to the beneficial use and conservation of Canada's water resources, and some of the earliest activities of this commission consist of investigations respecting the character and extent of the water-powers of Canada. In presenting the results of their research, the commission from time to time has advised respecting such subjects as water-powers development, the improvement of navigable rivers, the necessity for protecting against damage by flood, the preservation of soils against erosion, the conservation of underground waters, as well as upon other matters related to our water resources.

Some resources, such as minerals—perhaps more especially coal, oil and gas—if used, must, in time, necesarily become exhausted. On the other hand, such resources as the soil, plant growth, waterways and ground waters, may be conserved, and just as a good husbandman passes on his farm in an improved condition to that in which he received it, so the policies advocated by this commission have been directed to the passing on to succeeding generations in an improved condition, the heritage of the natural resources of this country.

St. Lawrence River Powers

We are now briefly to consider, chiefly in its economic aspects, one of Canada's great natural assets—the water-power possibilities of the St. Lawrence River.

The water-powers of this river, as yet, are largely within the control of the people. There is, however, a shortage of hydro-electric power which is being keenly felt both in Canada and the United States, and at present strong efforts are being made by private interests to obtain control of the enormously advantageous power in, or adjacent to, the international boundary.

Power Shortage in Eastern Ontario

There has been great shortage of power for supplying municipalities in Eastern Ontario. At the present time, the Hydro-Electric Power Commission of Ontario have urgent requests from such municipalities as Brockville, Prescott, Winchester, Chesterville, Cornwall, Mille Roche, Smith's Falls, Perth, Carleton Place, Kemptville and Almonte, for electric power to take care of connected loads aggregating from 15,000 to 20,000 h.p. with a present peak load of not less than 8,000 h.p.

The power shortage in Eastern Ontario, of late, has become acute. It had been hoped that power would have been available from the large development at the Cedars on the St. Lawrence River, but this power, although conveyed through the territory of the municipalities requiring power, was taken *en bloc* to the works of the Aluminum Company of America, situated at Messina, N.Y.

From time to time it has been suggested that some of this power might be brought back from Messina to Canada for supplying the needs of Canadian municipalities. This, however, has not been done, but instead, distributing systems have been established for supplying, from Messina, various municipalities in the northern part of the State of New York. Great industrial advantage has followed the utilization in the United States of the electrical power generated in Canada at "The Cedars" on the St. Lawrence River, and exported to Messina, N.Y.

There is very strong opposition, especially throughout Ontario, to any policy which permits the exportation of Canadian electrical energy required for use in Canada. The Federal government was memorialized upon this subject. It has been urged that no large power projects such, for example, as those on the international portion of the St. Lawrence River, should be developed without reserving, for use in Canada, her share of the power; and further, that such power as exists wholly in Canada should be reserved against the day of Canada's need.

If power is developed, as is proposed, for example, at Coteau Rapids, it is much more important that it be available for supplying the needs of such municipalities in Quebec and Ontario as would naturally be served from such power, than that the power be exploited by private interests, or exported and employed to build up industries in the United States.

The proposal to which I refer is that of the Power Development Company, Limited, who are applying for the rights of power development at the Coteau Rapids.* The Commission of Conservation and other organizations are opposing the project.

Coal Situation

As never before, the public interest has been aroused respecting both its fuel supply and its increasing dependence upon hydro-electric energy.

The central portion of Canada depends for its coal upon the United States. The present war conditions are going to drive home to Canadians as never before, the tremendous gravity of their position with respect to fuel.

If large quantities of electric energy be available at sufficiently cheap rates, it will doubtless be much more extensively employed for certain heating and other domestic uses, now served by coal. Precaution must be taken, however, to insure absolutely against wasteful uses.

Specific statements respecting the coal situation, especially in its broad national bearing, are published in my earlier reports. In 1910, referring to this subject, I used the following words, which are equally true to-day:

"Certainly the people of Canada are in better circumstances to maintain a supply of heat and power if their water-powers, including their full share of international water-powers, are reserved to themselves and not permitted to be exported except upon terms and conditions which will conserve absolutely the present and future interests of the citizens of Canada. Not only would the water-powers of Canada provide, to a certain extent, a substitute for the coal supply of the United States as a means of furnishing light and heat and power, but control of these water-powers would secure a basis upon which negotiations for coal could be conducted in a possible day of need. Canada would be in a position to exchange, if need be, part of her electric energy for part of the coal supply of the United States. It is obvious, however, that if the United States interests should control both the coal

*Abstracted from paper read before the annual meeting of the Commission of Conservation, Ottawa, November 27th, 28th, 1917.

*Re application to the Dominion Government made under the Navigable Waters Protection Act, R.S.C., Chapter 115. (See "Canada Gazette" for September 22, 1917, p. 969.)

and the water-powers, the situation of Canada would become exceedingly grave."*

I shall not here enlarge upon the coal situation, but shall deal more particularly with the power situation and the shortage of hydro-electric energy.

Inconveniences of Curtailed Output Reduced by Contract Stipulations

There has been a marked general tendency to exaggerate the quantities of water-power which may be developed. For tentative estimate of the power of the St. Lawrence we shall assume that practically the full low-water flow of the river would be available for power development.

If large power development should take place in the St. Lawrence River, considerable quantities of the electrical energy would, for a time at least, probably be utilized by electro-chemical industries. The tendency of vendors of electrical energy, in contracts with such large power users as the electro-chemical industries, is so stipulated that such customers must curtail consumption at times when there is depletion in the generated supply owing to unavoidable causes. By means of such contract arrangements the requirements of municipalities and of industries requiring smaller amounts of power continuously, may be safeguarded.

Possible Power Sites

On the St. Lawrence River below Lake Ontario, the first site where a power development could be made is in the vicinity of Morrisburg. With a dam near the foot of Ogden Island, a head could be obtained of about 11 feet, or, if a portion of the Galop Rapid were included, possibly an effective head of about 15 feet could be obtained. If utilization of the Galop Rapid be contemplated, then the question of regulating works to control the level of Lake Ontario becomes an important factor. In fact, for power developments on the St. Lawrence the regimen of flow from, and storage in, each and all of the Great Lakes must be taken into consideration.

The next possible development is that at the Long Sault Rapids, where a head of about 35 feet may be created. The head which may profitably be developed at this point has, by some engineers, been estimated at less than 35 feet; others estimate that it might be increased to about 40 feet.

Descending the river we have next, in a stretch of about 14 miles between Lake St. Francis and Lake St. Louis, three series of rapids—the Coteau, the Cedars and the Split Rock and Cascades. At the Cedars, the Cedars Rapids Manufacturing and Power Co. have constructed a large power plant to which additions are now being made and which, ultimately, will utilize by diversion 56,000 second-feet.

The Cedars Rapids Company utilize a head of about 32 feet, developed by means of a diversion canal some 2 miles long. The power house at the foot of the canal is designed for an ultimate development of 180,000 h.p. At present, units aggregating some 100,000 h.p. are installed. Extensions for two additional units are now being made. This company is exporting to the United States over 65,000 h.p., which is used in the plant of the Aluminum Co. of America at Messina, New York State.

Coming next to the Lachine Rapids, below Lake St. Louis, we have a head of about 30 feet in 4½ miles. Here about 17,000 h.p. has already been developed. The total undeveloped possibilities of the river at this point may be estimated at about 400,000 h.p.

What 65,000 h.p. Could Do

Few people have any conception of what the 65,000 h.p. now being exported to the United States by the Cedars Rapids Co. would mean if widely distributed to consumers of light and power, such as are found in our cities and towns. For instance, the Toronto Hydro-Electric Commission, supplying both light and power to over 40,000 customers up to 1916, met requirements with a little less than 50,000 h.p. The rates for light and power in Toronto are low—much lower, for example, than in Montreal. Including the requirements of the Toronto Street Railway, Toronto Electric Light Company, and the Toronto Hydro-Electric Commission, there is now required for light and power in the municipality of Toronto about 120,000 h.p.

It may be said, therefore, that the 65,000 h.p. exported to the State of New York from the Cedars could supply, at cheap rates, all the light and power required by a representative manufacturing city of 300,000 or more inhabitants, or would supply light and power to upwards of 35 average manufacturing cities of 10,000 inhabitants each; or it would take care of one-third of the present operations of the Ontario Hydro-Electric Commission in its Niagara system which supplies over 100 municipalities and over 100,000 customers.

When the benefits resulting from power thus widely distributed are contrasted with the localized benefits from the same power utilized in bulk, as in the electro-chemical industries, it will be perceived how much more the former, than the latter, contributes to the upbuilding of communities and the growth of the country at large.

Is it surprising that the former United States Secretary of War, Hon. Henry L. Stimson, stated, respecting Niagara power, that:

"The investigation (re power at Niagara Falls) which has been made by the engineers indicates that Canada, if we do not take it, will use the entire amount that the treaty permits in a very brief time, ... and it would result in giving to Canada very possibly, a large number of industries which otherwise would be established on this side of the Falls."

In a report to the chief of engineers, United States Army, Lieut.-Col. J. C. Sanford states:

"If advantage of power generated in Canada cannot be had on the American side, manufacturers will be attracted to Canada by this cheap power, and the industries of this country (the United States) will suffer accordingly. The effect of present restrictions on the importation of power is becoming noticeable. . . . Manufacturers at present contracting for additional Niagara power must locate, and are locating, in Canada."

The sub-committee on Niagara Falls power, appointed by the United States House of Representatives Committee on Foreign Affairs, states that it had been urged for its attention:

"That the Canadian companies were rapidly increasing their sales and would very soon take the full amount of

*Respecting various phases of this subject, consult an article by Arthur V. White on the "Exportation of Electricity," which appeared in the "University Magazine," October, 1916, pages 460 *et seq.* Consult also, "Toronto World," 18th March, 1912; also "Exportation of Electricity—An International Problem: Relation of a Possible Coal Embargo by United States to a Curtailment or Stoppage of Canada's Electric Power," in "The Monetary Times," of January 5th, 1917, pages 21 *et seq.* Consult also, "Annual Reports of Commission of Conservation," Ottawa.

water they were entitled to and the United States ought to get what power it was able to *now*."

And they add:

"If the advancement in the development of power on the Canadian side increases for another year or so—and it is not apparent to the committee that it will not—then the committee concluded that it was proper to take as large an amount as it could get for consumption in the villages, cities, factories and homes along *our* border."

Now, if, after giving full and just consideration, in its international aspect, to the vital subject of Canada's coal supply, it is found that the electrical energy generated in Canada can be retained for use in Canada, then highly beneficial results will be achieved which are unobtainable if the electricity is exported to the United States.

Summary of Power Sites

In summarizing the St. Lawrence water-powers, we may estimate the low-water power of the portion of the St. Lawrence River which is traversed by the International Boundary, at about 800,000 h.p., of which Canada is entitled to one-half, or 400,000 h.p.

The amount of power which lies wholly within Canada would be about 1,400,000 h.p. This, with its share of power along the international boundary, makes an estimated total for Canada of 1,800,000 low-water continuous horse-power.

It may representatively be detailed as follows:

Water Power on the St. Lawrence River*

(Tentative Schedule)

Site	Maximum Head Available	Maximum Estimated Low-water 24-hour Horse-power	Average estimated 24 hour low-water Horse-power (say
1. Morrisburg-Rapids Flat	15	230,000	200,000
2. Long Sault Rapid	40	650,000	575,000
3. Coteau Rapid	17	260,000	250,000
4. †Cedars Rapid	32	525,000	500,000
5. Split Rock & Cascades Rapid	18	280,000	250,000
6. Lachine Rapid	30 (?)	450,000	375,000
Total	—	2,395,000	2,150,000

*In this table some allowances have been made for efficiency and other factors in order to have the estimates fairly representative of the possible quantities which might be expected under representative low-water flow conditions.

†Under development for about one-third of the low-water flow of the river. Consideration would be given to the possibility of combining sites Nos. 3, 4 and 5, also of increasing No. 6.

Owing to the fact that vendors of power are able to adjust their deliveries, it is frequently possible to sell power which, during other hours, is used by another consumer. Thus, by way of example, the Hydro-Electric Power Commission of Ontario, by taking into consideration what is technically known as the "diversity load factor," can, I understand, supply contract requirements of 320,000 h.p. with a power capacity of 250,000 h.p.; therefore, assuming such a basis for the St. Lawrence River powers, Canada's 1,800,000 h.p. would take care of a power demand of some 2,400,000 horse-power.

The Ice Menace

In passing, permit me just to state that power development on the St. Lawrence River cannot properly be considered apart from the subject of the ice menace.

In the special report dealing with the Long Sault power project,* attention is drawn to the great menace which exists in the ice conditions manifested in the St. Lawrence River.

Too great caution cannot be exercised before attempting to harness natural forces of such magnitude as exist in the flow of the St. Lawrence River—a too radical disturbance of the balance which nature seeks to maintain may evoke disaster. These aspects of the problem of power development in the St. Lawrence are here emphasized, because they involve the weighing of basic physical factors of paramount importance.

Toronto Hydro-Electric Commission

In concluding, I shall briefly refer to one or two phases of the present power shortage, and the rapidly increasing demand for electric energy.

The Toronto Hydro-Electric Commission, which obtains power through the Hydro-Electric Power Commission of Ontario, and distributes light and power to Toronto, commenced operations on June 1st, 1911, with about 400 customers. At the present time—November, 1917—there are over 50,000 customers. To take care of this business has necessitated an outlay on the part of the municipality of Toronto of about $8,000,000. The operations of the commission, taking care of the 1917 December load, will, it is expected, require about 75,000 h.p. At the present time only about 50,000 h.p. is available. The Toronto commission is exerting every effort to compress its load, and to hold back even the natural increase in the requirements of its present customers. It can take on no new customers and of late has been issuing special appeals to present customers "to use as little current as possible until further notice, particularly from 4.30 to 6 in the afternoons on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays, and so help to avoid a possible power shortage for munition plants and other essential industries. The commission states that:

"Every economy, however small, will help to achieve the result aimed at. If each of the 50,000 Hydro customers in Toronto uses even one or two lights less during these hours it will mean a greater reduction than though the whole of the street lights in Toronto were turned off."

There is no doubt that a great deal of power and light is needlessly wasted. There was a time—and not very long ago—when the vendors of electrical energy were offering special inducements to encourage consumption, and customers were invited to use new electric devices as rapidly as such could be invented. The public has responded to these invitations and now—assuming that there is not a set-back to industrial activity—Ontario is faced with a power shortage which, until relieved, must constitute a serious check to her industrial growth.

Power for War Munitions

The Hydro-Electric Power Commission of Ontario at present requires for munitions an additional 140,000 h.p. This, however, they are not able to supply. Including the contract with the British Forgings, Limited, the commission at present is under contract to supply about 95,000 h.p.

The average individual has little idea of how diverse and extensive are the demands upon manufacturers for materials of war. A recent photograph shows a French

*See report, "Long Sault Rapids, St. Lawrence River—An Enquiry into the Constitutional and Other Aspects of the Project to Develop Power Therefrom," by Arthur V. White, Commission of Conservation, Ottawa, 1913.

soldier at his post with such individual equipment as: rifle, grenade-throwing gun, pistol, package of powder to be used against gas, a basket of hand grenades, bag of sand, pick-axe, gun-grenades, signal lantern, alarm bell for gas attacks, small reel of barbed wire, rocket scoop, corrugated iron hatch-grate, shovel, wire scissors, coarse broom, periscope, gun-carrier with periscope, and a gabion.

The Hydro-Electric Power Commission of Ontario at such centres as Niagara Falls, Welland, Toronto, Hamilton, Dundas, London, St. Catharines, Brantford, Kitchener, St. Thomas, Stratford, Guelph, Galt, Sarnia, Woodstock, Paris, Preston, Walkerville, Wallaceburg, Seaforth, etc., is supplying power for manufacturing munitions of war such as abrasives, aeroplanes, aluminum, beds, blankets, boots, brass sockets, brushes, camp ranges, carbide, castings, chemicals, clothing, cloth wire, cutlery, flour, fuses, harness, kit packs, primers, provisions, rifles, shells, shell parts, shell boxes, shell-making machinery, special lanterns, special steel plugs, special tools, wagons, etc., etc.

Munition Requirements

The munition plants being served with power by the municipalities and the commission from the Niagara system, in August, were taking a total of over 78,000 h.p. with firm contracts amounting to 94,600 h.p. Some of this power cannot be supplied without cutting off other customers. Additional present demands from the Union Carbide Company, the Electro Metals Company, and other munition manufacturers, total over 45,000 h.p. The Ontario Power Company, in August, for munitions and war materials, was supplying some 44,600 h.p. This makes a total demand upon the Hydro-Electric Power Commission and the Ontario Power Company for munitions, of over 186,000 h.p. Of this, however, 30,000 to 35,000 h.p. may be considered as off-peak power, thus leaving a net power capacity required of some 150,000 to 155,000 h.p. The shortage on the Niagara system for munitions for the commission and the municipalities considered by themselves may be placed at about 65,000 h.p.

Means of Relieving Shortage

What are some of the means by which this shortage may be supplied?

1. Increased utilization of steam power. This, at the present time, is out of the question as a means of dealing with the problems as a whole.

2. Supplying, temporarily, water from the unappropriated surplus, to permit the utilization of the excess capacity of the plants at Niagara. This, I understand, has been provided for.

3. Curtailment of the power now used for street and other lighting; also for certain power purposes, in order to liberate more power for manufacture of munitions.

4. Utilizing the water of existing plants under more efficient conditions, such as will exist in connection with the new Chippawa project, under a head of 300 to 305 feet. It will, however, be approximately three years before relief can be obtained by such means.

5. Limitation of the quantity of power at present being exported from Canada to the United States. Owing, however, to manufacturers of war munitions in the United States being, it is claimed, also short of power, the limitation of export will require very careful consideration in its international aspects.

As pointed out a year ago, no country need be expected to send out of its borders that which is essential to its own existence. Having in mind the present coal situation, it is unnecessary to emphasize the vital importance to Canada of this national and international fuel and power question. Canadians should appreciate the fact that the United States has been dealing with them generously in the present distressing coal situation. Portions of the United States are as badly off for coal as portions of Canada. Between the United States and Canada there is exchange of many natural and manufactured products, and the problems which are sure to arise, from time to time, in connection with such interchange can be satisfactorily solved, and the whole situation reduced to a good working basis. Canada, however, must by all means conserve against the day of her own need, such resources as are available for barter. These problems call for the best statesmanship which Canada can bring to bear upon them. Only by a knowledge of all facts relating to the subject can a wise administrative policy respecting our fuel and power problems be formulated and carried out.

COMPARATIVE DESIGNS OF VIADUCTS

(Continued from page 494.)

A comparison of estimated costs, with the prices prevailing at the time the design was made, showed that, for an average height of viaduct of 100 ft. on tangent, the steel trestle design would have been about 20 per cent. cheaper, and the design with steel rocker bents about 10 per cent. cheaper, than the adopted design. On a 3° curve the saving in first cost would have been only 15 per cent. and 5 per cent., respectively, as the centrifugal force of the trains requires additional material in the steel bents and towers, but not in the masonry piers. For heights of viaducts of less than 100 ft., the differences in cost are correspondingly less. With the high prices of steel prevailing at present, there would be little, if any, saving in favor of the steel trestle type.

The arched concrete piers mark a radical departure from the ordinary solid square concrete piers with plain surface and simple square coping. The rectangular body of the pier proper is only 6 ft. thick, from the coping down, but is reinforced by four buttresses which have a batter of 1:15. These piers convey the impression of elegance and yet of great rigidity. The appearance is enhanced by the massive and architecturally elaborate coping of cornices and mouldings.

The concrete is made of 1 part Portland cement, 2 parts sand and 4 parts gravel or broken stone, and is reinforced with steel rods, vertically and horizontally, against shrinkage and temperature cracks.

The present month is expected to witness the practical completion of the $3,500,000 bridge that is being built by the Paducah and Illinois Railroad over the Ohio River, about 12 miles west of Paducah, Ky. The bridge is 5,700 feet from end to end and 3,245 feet, exclusive of approaches. It has one of the longest single truss spans in the world, the main channel span being 720 feet.

The New York State barge canal, the successor of the old Erie Canal, is rapidly approaching completion. When finished it will be possible for 2,000,ton barges to pass all the way from Buffalo to New York by canal and Hudson River. The beginning of this waterway occurred in 1817. The work, as then contemplated, was finished five years later. The total cost of the new barge canal will be $150,000,000, equal to nearly half the amount spent on the Panama Canal.

ENGINEERING AND FINANCE OF PUBLIC SERVICE COMPANIES*

By Herbert A. Wagner

PUBLIC service corporations are companies organized to perform a necessary and specific service to the general public in a community, such as furnishing transportation, supplying light, heat, power, water or means of intercommunication.

Such companies are incorporated and organized in practically the same manner as other large corporations. They are usually promoted and financed by private capital. In addition to a State charter, however, they require a State, provincial or city franchise for the use of the public streets and roads for the transmission and distribution of their service. Through this franchise and by reason of the public character of their business they are subject to governmental regulation as to the manner in which they can use the public highways, issue their securities and charge for their service. To-day, in most states, the regulating power of the legislature, insofar as the control of the issue of securities and the fixing or limiting of service rates is concerned, is delegated to a public service commission. Before the advent of regulation by commission, in many of our cities two or more competing companies were permitted to organize and do business for such service as electric lighting and power, gas and telephone. Competition was depended upon to regulate prices for service. Now competition is the most wasteful of all means to regulate prices. It involves the duplication of capital, management, and sales organizations.

Concentration of capital, effort and production, and co-operation between concerns doing a like business produce the highest efficiency and the lowest costs. Competition is a means of regulation to be tolerated only when no other means are provided. So far, commission regulation has only been extended to the railroads and public service corporations, but in these lines the abandonment of competition has resulted in a growth of enterprise and in economies in development and operation never approached under the old regime of competition.

In every line of enterprise the cost of doing business, which must be more than covered by the earnings from sales, comprises the cost of material and labor, and what is known as "overhead expenses," which latter includes management, general expenses, rents, taxes, interest on capital invested, maintenance of plant and machinery, and depreciation.

In the public service business the "overhead expense" is far greater than the cost of material and labor, and in this and most lines of business this expense does not increase proportionately to the growth of business and output of product, while the cost of material and labor usually does. Consequently, the total cost of doing business always grows less per unit of output as the output increases. Thus, the greater the output the lower the cost, and the cheaper the product can be sold. Therefore, one large company can always sell its product or service far cheaper than two companies of half the size with the business divided between them.

The question as to whether the one company, without competition, will sell its product cheaper than the two in competition, or simply reap the larger profit, brings us back again to the question of regulation. In public service the answer is "Yes," for the public service commission limits the profits or return on investment which the public service company is permitted to earn. When capital is protected by regulated monopoly from the risks and uncertainties attending competitive enterprise, it is satisfied with a smaller return and a smaller "factor of safety." This again reduces the cost of doing business and assures lower rates for service.

As compared with the use of private capital for conducting public service enterprises you may hear, from time to time, from advocates of government or municipal ownership of such utilities.

In the face of government regulation through public service commissions there can be no sound argument in favor of government ownership, except it is based, as it frequently is, on the possibility of dishonesty, partiality, or incompetence on the part of the commissioners. As the commissioners are government appointees and public servants, it stands to reason that, insofar as they might be incompetent or unsuited for their positions, so, equally, might be those appointed to manage a government-owned utility. If partial government control should be a failure through the frailty of human nature in its employees, how much greater failure might be expected in complete governmental control with the same political appointees?

It is a deplorable fact that, as a rule, government and municipal departments are not efficiently conducted as compared with private enterprises. Political patronage and the desire to increase it cannot provide efficient working forces. Private capital demands ability and efficiency; politics demands numbers and favoritism, and the control of votes.

Now, we may consider matters more nearly concerned with engineering itself.

Let us suppose that the problem of constructing a great electric supply system, or of greatly adding to the capacity of an existing one, is put before the engineer. The first question which must be answered is, "considering the cost of construction and subsequent operation, can the enterprise be made to pay?" In this case, as in many other engineering problems, the engineer has precedent to assist him. Such enterprises have been made to pay in other localities, so why not in this one? If the local cost of fuel is not abnormally high, or if there is an available and adequate water power within reasonable distance, this question may be dismissed. Then comes the question of the source of power; shall it be steam or water power? Or, to make the problem simpler, we may assume that the question was put to the engineer, in the first place, through a promoter's desire to develop a water power for the supply of electric power to a nearby city.

The development of water power has been a very attractive and romantic enterprise. All you have to do is to build a dam, a power house, and a transmission line, and there you have it. Is the engineering difficult? Not extremely; it has all been done before. Well, then, why not go right ahead with it? But, first, the money to pay for it must be raised. What has the engineer to do with that? That is the promoter's or financier's part. Very true, but the promoter must be able to tell the people whom he seeks to persuade to invest their money in the stock or bonds of the proposed company, how much profit or return they may confidently expect to make on their investment. This information the engineer must supply.

The possible profit depends upon five principal things: The amount of power available; the first cost of develop-

*Abstracted from a lecture delivered in connection with the J. E. Aldred Course of Lectures, before the Department of Engineering, Johns Hopkins University.

ment; the cost of operating; the market for the power; and the possible average market price. From these elements can be pre-determined the gross income, the operating expenses, and the net earnings applicable to the payment of interest and dividends. The success of the enterprise will depend absolutely upon the accuracy with which these elements are forecasted. And it is the engineer who must do the forecasting. Many such enterprises have failed through the incompetence of the engineers employed. An engineer may be able to build what he is told to build, but if he cannot accurately estimate the cost of an installation and its operating results, he may bring ruin upon his employer and disgrace upon himself. He must have accurate knowledge of all costs of construction, of the cost of operation, and of market values for the service to be rendered or commodity to be supplied.

Water power propositions have often failed because the final first cost greatly exceeded the estimates of the engineers, or because the market proved to be far smaller than was estimated, and sometimes for both reasons. The development of many attractive water powers is commercially impossible owing to the great distance from a market for the power or to excessive cost of development. The electrical engineer must know how to determine, without mistake, whether the development of a proposed water power is commercially possible or not.

What I want to impress upon you is the fact that the engineer must not only be a designer and director of engineering projects, but, to be successful, he must be able to guarantee commercial results. A contractor would soon fail if his work cost him more than the amount of his bids. The contractor's bid is based upon his estimate of the cost of doing the job. The engineer must, in a sense, be a contractor, in that his estimate of the cost of work must never be less than the ultimate actual cost of the completed enterprise. Education along these lines has been given too little consideration and weight in the making of engineers. Then, too, the cost of construction and development may vary widely, according to the plans and designs adopted by the engineer.

That engineer is most successful who accomplishes the desired results in the cheapest possible way, and when I use the term "cheapest," it is qualified and limited by the word "results." The result must not be indifferently accomplished. It must be adequate; it must be fully, substantially, and permanently realized. Cheap work is rarely satisfactory, but work should be done cheaply in the sense that the design, methods and construction must be the most economical in the use of material and labor that engineering skill and experience can assure.

The Cost of Product or Service

It has not been my intention in this address to go into details of engineering construction, but rather to suggest to you the wide field of knowledge which must be covered by the engineer to make a success in his profession. The engineer's immediate work may be merely to provide a piece of mechanism, a power plant, or a distribution system, but whichever it may be it is usually in the nature of a tool to be used to accomplish a definite purpose, or an important link in a chain of structures or operations.

In order that his part of the work may fit properly into the whole, the engineer must know the purpose of the whole, how the various tools or parts must co-operate, and the final results to be achieved. The final results desired are usually commercial adaptability and profit.

In public service operations the cost of the product or service to be sold is the essential thing. A brief discussion of the elements of cost will be enlightening. In the first place, the supply of electricity is essentially a service rather than a product. The attitude of the electric service corporation is that of being ready to serve at all times.

The cost of standing ready to serve each customer connected to the supply lines is a large part of the total cost of service, and is independent of the actual amount of electricity consumed by the customer.

Valuation of Property

The engineer is frequently called upon to determine the value of existing property and equipment. Here, again, he must have a broad knowledge of the elements of cost, and the manner in which the normal growth of the business, the improvement and replacement of the various structures, and the condition in which they are maintained, affect the cost and value. If he attempts to base the value upon the estimated cost to reproduce the property in its present condition he must know how to make proper and full allowances for organization expense, interest on the money required during the period of construction, contractors' profits, the good-will in a going business acquired by years of successful trade, and franchise value, if it is public service property. Many of these items of value are known as "intangible" property, but they are, nevertheless, as properly to be considered in determining the total fair valuation as the visible physical elements of the property.

Analysis of Reports

It has been my particular purpose in this address to emphasize throughout the importance to the successful engineer of a broad knowledge of business methods. In this there must be a general understanding, at least, of accounting, as it is applied to properly record the history of the financing, construction and operation of the enterprises in which he is engaged. The financial reports and balance sheets of corporations are intended to show their financial condition, and the engineer should be able to intelligently interpret, analyze and verify them. He must be able to determine from them whether or not the business is really profitable, whether the distribution of earnings and profits is such as to assure the maintenance of the value of the assets, and whether or not the margin of profit is sufficient to make the securities of the company a good and attractive investment.

If, now, you have come to the conclusion that to have all the practical knowledge which has been outlined, the engineer must be a "business man," you have caught the keynote of my talk and belief.

The engineer should lose no opportunity in his career to acquire information and training which will enable him to qualify as a practical adviser to men of large business responsibilities.

In taking as the title of this address, "Engineering and Finance," the term "finance" was used in the sense of "pecuniary management in general." Finance has also been defined as "the science of monetary business or affairs."

Engineering, to-day, is applied science in business enterprise. Its greatest field at the present time is the promotion of efficiency in business. My endeavor has been to picture to you the engineer in business and to throw a little more light for you along the road to success.

LINES AND GRADES IN TUNNELS OF SMALL DIAMETER*

By Henry B. Pratt
Assistant Engineer, J. R. Worcester Company, Boston

IN the construction of two tunnels for the Edison Electric Illuminating Company of Boston, one under Fort Point Channel and the other under the Reserve Channel, it was found difficult to give lines and grades in the usual manner, with the transit set up on the tripod, owing to the fact that the diameter of the tunnels, which was only 7 ft. on the inside, did not permit of setting up the instrument without stopping the passage of cars on the construction track. The delay caused by stopping these cars was very serious, as it often meant that the whole gang on that end of the tunnel, not only in the heading but also in the shaft, lock and head house, was obliged to suspend operations until the cars were given free passage.

In order to avoid this delay a method was devised by which the instrument could be attached to the roof of the tunnel in an inverted position (see figure), allowing the passage of the cars beneath, the clearance between the top of the cars and the lowest part of the transit being about one foot. In order to use the instrument in this manner it was necessary to so arrange the level tube that the bubble could be seen when the instrument was upside down and the vertical arc in its normal position. The transit used was equipped with a 180-degree vertical arc, and after having the instrument put into good adjustment it was set up on the tripod, the telescope levelled, and a horizontal line marked about 50 ft. distant, coinciding with the horizontal cross-hair in the instrument, with the vertical arc reading zero. The level tube beneath the telescope was then removed and replaced in an inverted position, the telescope rotated vertically so as to bring the level tube over the telescope with the graduations uppermost, and the level tube so adjusted that when the cross-hair was on the mark the bubble was on centre. Now, by rotating the telescope back to its normal position and setting the vertical arc on zero, the telescope was brought perpendicular to the vertical axis of the instrument with the bubble on centre, although not in a readable position until the instrument was turned upside down. If the transit were equipped with a complete vertical circle, this same object could have been accomplished by rotating the telescope vertically 180 degrees from normal and clamping with the vertical arc, reading that figure which would bring the bubble into a readable position when the transit was turned upside down.

Wooden blocks about 8 ins. square were built into the roof of the tunnel as the work progressed, being placed at intervals of about 200 ft. To these blocks were attached metal sockets, such as the transit is screwed to when cased, care being taken to set them approximately on line. When giving line in the tunnel, the transit was screwed to one of these sockets, the vertical arc was set on zero and the instrument levelled by using levelling screws and observing the telescope bubble, which was now above the telescope with the graduations uppermost. It required some practice to level the instrument, as the screws had to be turned in the opposite direction from what they would be if the transit were in an upright position. The instrument was revolved horizontally in levelling, in the same manner in which a Wye level is revolved when being set up. In order to bring the transit on to the exact line, it was slipped laterally on the sliding head and brought on to line by observing two points which had previously been accurately established farther back in finished tunnel. The telescope could now be rotated vertically and line given ahead in the usual manner. After bringing the instrument on to line, a plug was set in the side of the tunnel at the level of the telescope and an offset read to the centre of the instrument in order that the transit could be set on line at any other time without making observations.

When giving grades the telescope was levelled, the height of instrument determined and rod readings taken in the usual manner. After once obtaining the height of the instrument on a "Set-up" on any particular socket it was found that the instrument would be near enough to the same height on successive set-ups on this socket to allow of giving grades without a further reading on the bench except in the case of establishing a bench ahead.

In order to prevent wear between plates of the transit due to the liability of particles of dirt working into the joint, the two plates were kept constantly clamped. As a further precaution, some heavy grease was run into the joint so that when the transit was screwed to the roof of the tunnel particles of mortar which would fall on the instrument would be prevented from working into this joint which was then exposed. As the tunnel in which this method was used was straight, there was no occasion to turn any angles or to set the instrument on a point, correct both for line and distance. If it were necessary to run out a curve using an instrument in this manner, it could be accomplished by giving tangent offsets, instead of reading angles, which would be somewhat difficult to do with the instrument upside down. It it were required to set the instrument correct both for line and distance, it could be done by setting two offset plugs, one on line with an offset for distance, the other at right angles to line with an offset to line.

In using a transit in this manner it is well to tighten the nut at bottom of spindle, so as to take up the play between the plates and also to make the instrument secure, as almost the whole weight of the transit is carried by this nut.

Transit in Inverted Position

*Journal of Boston Society of Civil Engineers.

This method of running lines and grades was found to be very satisfactory, as the engineers were enabled to do their work without feeling hurried, as they would have felt if they knew that they were causing the contractor a serious delay. The writer is indebted to C. W. Alexander for his able assistance in perfecting this method of tunnel survey.

COST OF GARBAGE REMOVAL AND STREET CLEANING AT SASKATOON

According to the annual report of C. J. Yorath, A.M.Can.Soc.C.E., city commissioner of Saskatoon, Sask., during the first ten months of this year the cleansing department removed 14,526 loads of refuse, garbage, ashes, etc., as compared with 15,679 loads for the corresponding period of last year.

The cost of removing this material, on account of the long haul to the nuisance ground, is excessive. The total cost for the ten months has amounted to $26,981 or at the rate of $1.79 per load. An up-to-date Packard refuse truck has been purchased to be used for the collection of house refuse, and which it is estimated will replace at least four teams.

The following is a comparative statement showing the estimated annual saving which will be effected by the use of two motor trucks for the collection of house refuse:—

	Operating per day.	Costs per year.
Cost of 2 trucks at $4,825 each, $9,650; sinking fund and interest based upon a lifetime of 5 years.	$ 7.48	$ 2,336.00
Two drivers at $3 per day	6.00	1,872.00
Insurance	.61	192.00
Insurance liability limit, $5,000 for one accident	.29	90.00
Tires	2.56	800.00
Gasoline, 14 gals. per day	5.00	1,560.00
Oil and grease, 69c. per day	.69	218.00
Helpers, 2 on each truck, 4 men 9 hours per day at 30c. per hour.	10.79	3,369.00
Total	$33.42	$10,437.00
Cost of operating eight teams at $5.50 per day	$44.00	$13,728.00
Net annual saving by operating motor trucks for garbage collection in lieu of horses		$ 3,291.00

A Welsh inventor has designed a combined piston and rotary pump, with no valves that can be easily clogged, for pumping heavy liquids.

Baron Megata, head of the special Japanese Finance Commission, declared in a recent address at a dinner given in his honor by Japanese bankers in New York that Japan could not continue much longer to aid the Entente Allies with shipping unless permitted to import steel plates from the United States. "Japan has increased the number and the size of her shipyards since the war began," he said, "and has sold and chartered to the Allies many ships, while others have been and are engaged in transporting munitions and supplies for them. The need for bottoms to-day is very great, and she is doing her utmost to fill it. She cannot continue her present help much longer, however, unless she is permitted to import steel plates from the United States. Her ability to contribute in this economic way toward the early and successful termination of the war should be taken advantage of. She has the yards, she has the skilled labor, she has the will to do. With America's aid and co-operation, she will have the essentials with which to do."

PRODUCTION OF IRON AND STEEL IN CANADA

The Mines Branch of the Department of Mines, Ottawa, has received from the producers complete returns of the production of pig iron in Canada and with the exception of two small plants, complete returns of the production of steel ingots and direct steel castings during the first nine months of 1917.

The total production of pig iron during the first nine months was 895,307 short tons, as against 844,717 tons during the first nine months of 1916. The average monthly production in 1917 was 99,478 tons, as against an average monthly production throughout 1916 of 97,438 tons.

Furnaces were in blast at Sydney and North Sydney, N.S., Hamilton, Port Colborne, Sault Ste. Marie, and Deseronto, Ont. Small quantities of pig iron were also produced in electric furnaces from scrap steel at Orillia, Collingwood, St. Catharines, Toronto, Ont., and at Montreal, Que. The total quantity of pig iron thus produced in electric furnaces during the nine months was 9,983 short tons.

The total production of steel ingots and direct castings during the first nine months was 1,265,183 short tons, as against 911,054 tons during the first nine months of 1916. The average monthly production during the first nine months of 1917 was 140,576 tons as against an average monthly production throughout 1916 of 106,268 tons.

The production of steel in electric furnaces included above was 30,960 tons during the first nine months of 1917 as against a total of 19,639 tons produced throughout 1916. The production of steel in electric furnaces in September was over 5,000 tons or at the rate of over 60,000 tons per annum.

UNITED STATES FEDERAL SHIPBUILDING YARDS

It is reported that the yards of the United States Federal Shipbuilding Corporation on the Hackensack Meadows will be the largest in the world. The company will start out with ten shipways of from 450 to 500 feet in length, but they will be extended later to permit the construction of giant ocean boats of 1,000 feet in length, which will compare favorably with the ocean-going palaces turned out in the famous ship-building yards of England and Scotland. The plant will cover nearly 100 acres of ground. Steel buildings will be erected to cover practically the entire acreage, including a plate mill of nearly 1,000 feet in length. Almost every essential in the manufacture of great ships will be turned out even to marine boilers and engines and electric fittings. Next to the machine, structural and fabricating plants will be located a large wood joining shop which will turn out wood fittings used in the ships. For the present the corporation will turn out standard size ships of 9,000 tons. The first two keels will be laid late in November, and the initial launchings will take place about April 1, 1918. The two completed boats will be ready for ocean service about June 1.

Remembering that 1879 was the first year of the incandescent electric lamp, references show that the number of establishments listed in 1914 was 1,030, employing 144,712 persons, a capital of $355,724,756, and with a value of product equal to a third of a billion dollars. The industry increased rapidly in that thirty-five years; and the reason was that the world was adopting electric light, owing to the successful pioneering of Thomas A. Edison with his incandescent bulb. For whatever has followed in the train of that first successful glowing filament is all directly due to Thomas A. Edison and his fight for what his genius knew to be possible in spite of the jeers of most of the practical and scientific men of the time. He followed his lamp with developments of the utmost importance in motor construction and the not less valuable device of the three-wire electric circuit, whereby very important economies of copper are secured.

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Principal Contents of this Issue

	PAGE
Hydro-Electric Power Development and Pulp Manufacturing Plant at Smooth Rock Falls, by James Dick..	485
"Lump Sum" vs. "Cost Plus" Contracts, by Fred. A. Jones	491
Cost of Oiling Hamilton's Streets, by E. R. Gray	493
Comparative Designs of Plate Girder Viaducts, by O. H. Ammann	494
St. Lawrence River Power, by Arthur V. White	495
Engineering and Finance of Public Service Companies, by Herbert A. Wagner	499
Lines and Grades in Tunnels of Small Diameter, by Henry B. Pratt	501
Cost of Garbage Removal and Street Cleaning at Saskatoon	502
Production of Iron and Steel in Canada	502
United States Federal Shipbuilding Yards	502
Editorial	503
Personals	504
Canadian Society of Civil Engineers	504
Canadian Society Civil Engineers Manitoba Branch	504
Coast to Coast	42
Construction News	44

PROVINCIAL CONSULTING ENGINEERING

The Commission of Conservation has just issued a report on "Rural Planning and Development," by Thomas Adams, town planning adviser to the commission. Much excellent information is to be found in the volume, and if most of Mr. Adams' recommendations are followed by the provincial and Dominion government authorities, it will be for the general good of Canada. Mr. Adams gives eight general recommendations for solving the five specific needs of the nation in regard to rural planning and development. With seven of these recommendations we are in hearty concurrence, but it is a question whether the eighth recommendation was entirely necessary. It reads as follows:—

"Provincial governments should reconsider their systems of administering colonization highways, municipal affairs and public health, with special regard to the need of securing more co-operation and efficiency in connection with land and municipal developments than is possible under present conditions and for increasing the responsibilities and powers of municipal authorities under the advice of a skilled department of local government in each province."

In explaining these recommendations more in detail, Mr. Adams further on in the report says in regard to the above recommendation that "until there is a skilled municipal department in each province to advise and help local authorities with engineering advice, we cannot expect satisfactory improvement in the status of the municipal and sanitary engineer nor effective local administration of public works and sanitation."

Mr. Adams may be right, but it seems to us that this recommendation, and particularly the more detailed explanation of it, is a caustic slight upon the present efficiency of the work of the municipal and sanitary engineers in Canada, and also upon the work of the consulting engineers who are employed in an advisory capacity. Compared with other countries, at least in North and South America, the local administration of public works in Canada is decidedly effective, and it is a matter of great doubt whether municipal and sanitary engineering anywhere else in America has been so efficient and free from politics as in Canada.

Most Canadian municipal engineers are trained technical men, appointed for their ability and in a more or less permanent capacity. They are studious and ready at all times to investigate and adopt improvements in sanitary practice, and it is a matter of doubt whether any provincially organized department is necessary to stir them to effective work.

The consulting engineers of Canada probably have had more experience along municipal and sanitary lines than in any other field, and have done very efficient work in this direction. We believe that any municipality in Canada will be as safely guided by the advice of almost any Canadian consulting engineer as by the advice of a provincial body.

Too frequently provincial bodies are even more affected by politics than are municipal bodies, and where politics does affect a provincial body, the results are far more sweeping and dangerous than in the case of the more restricted municipal affair. Great care should be exercised in the creation of provincial bodies having wide powers. One incapable or dishonest official, or one engineer with queer and impractical ideas, can do much harm if afforded the scope of provincial authority.

Is it not probable that engineers may be entrusted to surmount the obstacles of rural planning and development by individual and competitive effort, with greater satisfaction than would be obtained by the more machine-like, "steam roller" methods of an autocratic provincial body?

CONSERVATION OF RESOURCES

Much of the national organization of most countries is to-day engaged in systematic efforts to promote conservation of essential commodities. In Canada, however, we have not yet arrived at a proper conception of the economic utilization of our resources. In an unusually valuable address before the Commission of Conservation at its recent annual meeting, Sir Clifford Sifton, chairman of the Commission, reminded us of our persistence in the crude and wasteful methods naturally characteristic of a country where resources are abundant and where many of those who are engaged in their exploitation are totally lacking in the scientific education which is necessary in order to make the best use of that which is placed in their hands. "We are still largely dominated in Canada," said Sir Clifford, "by the idea that any ordinarily capable amateur can do the work which ought to be done by a trained scientific man, and until we eradicate this fallacy thoroughly, and in its place implant the view that men who are technically trained are the only men competent to deal with technical problems, we shall not begin to

attain to general success in making the best use of the materials which are at our disposal."

While it is true that we are still largely dominated by false ideas, it is also true that persistent work and agitation is bringing about substantially beneficial results. When the forestry branch of the department of the interior was established seventeen years ago, there was not at that time known to be a single trained forester in Canada. To-day there are 150 trained foresters in addition to 73 forestry students who have enlisted.

Sir Clifford Sifton stated that with regard to forestry, the various organizations at work have been successful in bringing about perhaps the greatest degree of improvement that is observable in connection with any department or branch of natural resources.

In the conservation of water powers, Sir Clifford said the different agencies at work have been, on the whole, fairly successful, although there is a continual struggle going on against the improvident alienation of power, and we are constantly required to be on our guard.

PERSONALS

Lieut. Ernest Irving Gill, B.A.Sc., of 1914, who went overseas with the R.C.H.A. and transferred to the C.F.A. when he reached France, is reported wounded.

Gunner E. B. Dunstan, who has been awarded the Military Medal, enlisted with the 25th Battalion, mostly composed of university men. He attended the School of Applied Science in Toronto, and went overseas in January, 1916.

H. H. Adams, a former division superintendent of the Michigan Central, and later the general manager of the T.H. & B. at Hamilton, Ont., is serving in France as commanding officer of a United States battalion of Engineers.

Stephen P. Brown, B.Sc., formerly chief engineer of the Mount Royal Tunnel and Terminal Co., Limited, has been appointed vice-president and general manager of the Ford, Bacon & Davis Corporation, general contractors, of New York City. Mr. Brown is a graduate of the Massachusetts Institute of Technology, and since 1915 has been a member of the Council of the Canadian Society of Civil Engineers.

Flight-Commander Harold Spencer Kirby, B.A.Sc., a graduate of the School of Applied Science in the University of Toronto, is now at his home in Calgary, Alta., on furlough. He was invalided from the Dardanelles in April, 1916, and returned to England in October of the same year. Since then he has been with the Royal Naval Air Service serving in France, where he won the rank of flight commander. Not long ago he was awarded the Distinguished Service Cross for great courage and initiative shown on many occasions.

Henry J. Fuller, president of the Canadian Fairbanks-Morse Co., Limited, and a former resident of Montreal, was elected president of the Vermont organization of E. & T. Fairbanks & Co., at a recent meeting of the board held at St. Johnsbury, Vt. The election of Mr. Fuller to this office is but another move which serves more closely to unite Canadian and American organizations, as Mr. Fuller is not only president of the Canadian Fairbanks-Morse Co., Limited, but is also a director of the Canadian Bank of Commerce, the National Trust Co. of Canada and other industrial concerns in the Dominion.

CANADIAN SOCIETY OF CIVIL ENGINEERS

The fourth meeting of the 1917-18 session was held Thursday, December 6th, at 8.15 p.m. Mr. Walter J. Francis, chairman of the Papers and Meetings Committee, occupied the chair. The speaker, Mr. George F. Porter, M.Can.Soc.C.E., engineer of construction, St. Lawrence Bridge Company, gave a description of the erection of the superstructure of the Quebec Bridge, illustrated by a splendid series of lantern slides.

Mr. Walter J. Francis, as chairman, expressed regret that Capt. Duchastel was unable to be present owing to an accident which confined him to a hospital.

In his opening remarks the speaker, Mr. Porter, said: "Gentlemen, I am very pleased that the chairman described this as an informal talk, as I have prepared no paper, but have selected slides from about eight hundred photographs which were taken during the progress of the work. The enormous size of the bridge and the greatness of the undertaking make it impossible to describe the work in detail. The slides which have been selected will show you in a more vivid manner than any verbal explanation I might give, how the work was undertaken and carried on."

In proposing a hearty vote of thanks to the speaker of the evening, Mr. R. A. Ross expressed the sentiments of the meeting in saying that those present were to be congratulated on having had the privilege of hearing the description of the work and seeing the splendid slides.

The third address of the series on the Quebec Bridge will be given by a past president, Mr. Phelps Johnson, who will lecture December 20th, giving more detailed views of the shop work necessary in the fabrication of the bridge.

CAN. SOC. C.E. MANITOBA BRANCH

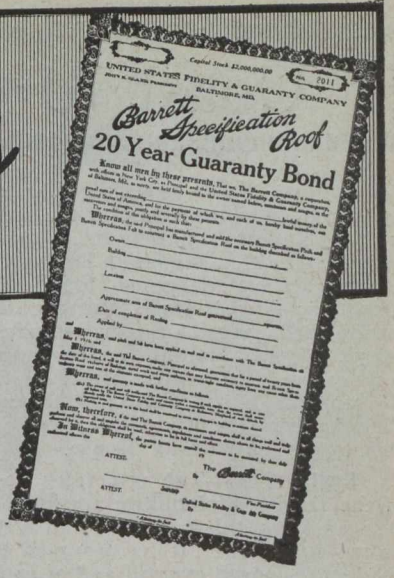
The following program has been arranged for the Manitoba branch of the Canadian Society of Civil Engineers:

December 18th, "Lignite Coal as Applied to Modern Steam Plants," T. L. Roberts; January 3rd, "Single Phase Power from Three Phase Systems," F. H. Farmer; January 21st, "Durability of Concrete in Western Canada," F. J. Greene; February 7th, "Electrical Systems for Automobiles," J. F. M. Wilson; February 18th, "Foundations for High Buildings," B. S. McKenzie; March 7th, "Operation of the Winnipeg Electrical Railway," R. H. Long; March 18th, "Modern Steam Practice," Theodore Kipp; April 4th, "The City Light and Power Department," E. V. Caton and J. G. Glassco; April 15th, "Operations of Hydrographic Department," M. C. Hendry; May 2nd, "Powdered Fuels," George Pratt; May 20th, "Rates for Electric Service," R. A. Sara.

The following is a list of patents recently issued through the agency of Messrs. Ridout and Maybee, 59 Yonge St., Toronto: John R. Blakeslee, processes of making bolts, spikes and the like; Percy E. Correll, the construction of headlamps; Arthur Bequelin, time switch; Alfred G. Fox, means for feeding fuel to furnaces; George W. Berry, apparatus for forming hinge members on the lids and bodies of sheet metal receptacles; John Flint, compounds for use in lieu of rubber; John G. Robinson, steam superheaters; Victor A. G. Cecil, water heaters.

Barrett Specification Roofs

Made in Canada



For All First-Class Buildings—

Here is a random selection of some structures from different parts of the Dominion.

Every one of these buildings is covered with a Barrett Specification Roof.

We did not have to hunt around very much to get these photographs because most large modern structures, such as factories, railroad terminals, hotels, warehouses, etc., carry Barrett Specification Roofs.

The reason is that for permanent buildings, large and small, Barrett Specification Roofs are by far the most economical and satisfactory; in fact, they are in a class by themselves.

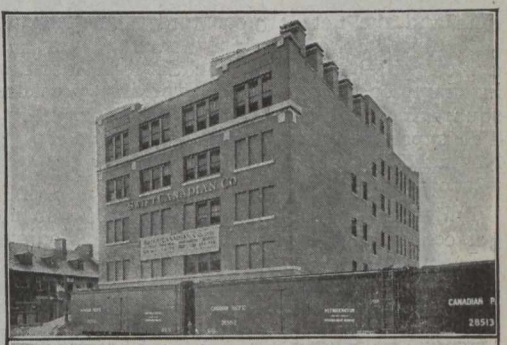
This is best evidenced by the fact that no other roof-covering carries more than a *ten-year* guarantee, while Barrett Specification Roofs now carry a Surety Bond Guaranty for *twenty years*, and, further, these roofs take the base rate of fire insurance.

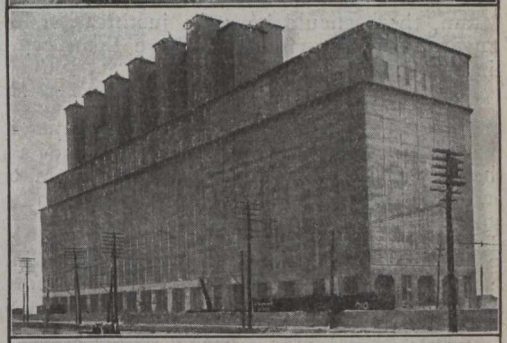
20-YEAR GUARANTY BOND

We are now prepared to give a 20-Year Surety Bond Guaranty on every Barrett Specification Roof of fifty squares and over in all towns of 25,000 population and more, *and in smaller places where our Inspection Service is available.*

This Surety Bond will be furnished by us *without charge.* Our only requirements are that the roofing contractor shall be approved by us and that The Barrett Specification dated May 1, 1916, shall be strictly followed.

Further information and copies of The Barrett 20-Year Specification free on request.





The Barrett Company
LIMITED

MONTREAL TORONTO WINNIPEG VANCOUVER
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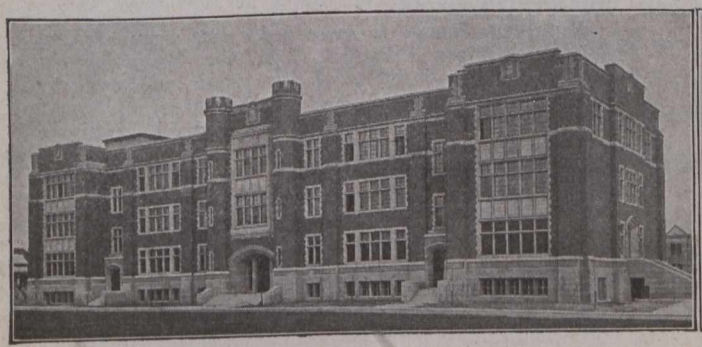

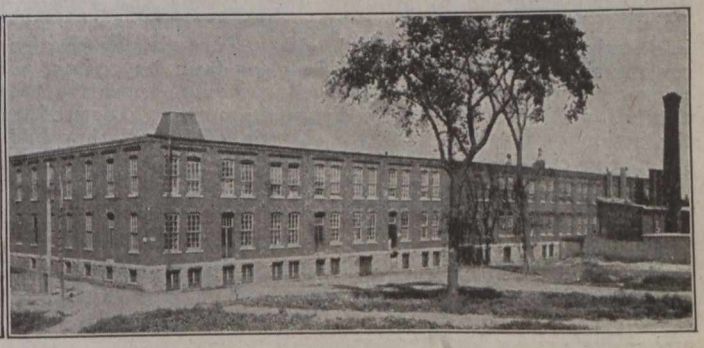

Coast to Coast

Halifax, N.S.—The following list of buildings costing $50,000 or more were lost in the recent fire:—Canadian Government Railway round house; Canadian Government Railway Station; Halifax Brewery; Drydock and Government Warehouses; Hollis & Sons' foundry; King Edward Hotel; Armories; Market Hall; Military Hospital on pier; Wellington Barracks; Acadia Sugar Refinery; Dominion Textile Company's factory; Halifax Exhibition Buildings; Alexander McKay school; Brunswick Street Methodist school; Canadian Government repair shops; Richmond, St. Mark's Anglican Church; St. Joseph's school; Home of the Deaf; Protestant Orphanage; Admiralty House.

Levis, Que.—The new ferry now building at the yards of the Davie Shipbuilding and Repairing Company will have a speed of 14 miles an hour and will have a hold capacity of 70,000 cubic feet. It is designed to carry 20 cars, will be 308 feet in length over all and of 52 feet breadth, with a depth of 20 feet 6 inches. The gross tonnage is estimated at 5,000 tons and the net at 3,000 tons. The engines installed will be one four-cylinder triple, 2,200 L.H.P., and the boilers installed will be four of the Scottish marine type, 11½ feet in diameter, 175 pounds working pressure, having 5,500 square feet of heating surface and 143 feet of grate area. The capacity of No. 1 hold will be 40,000 cubic feet, and of No. 2 hold 30,000 feet. The area of the main deck will be 13,000 square feet.

Medicine Hat, Alta.—No attempt was made this year to get construction work started on the Medicine Hat to Hanna branch of the Canadian Northern Railway, as the attempt made last year was more or less of a failure. But now that the Dominion Government has taken over this road and purchased it from the original owners, Messrs. Mackenzie & Mann, there should be some justification in approaching the government in an effort to have them complete this branch line as soon as possible.

Montreal, Que.—Controller Cote referring to the new proposal to build foundations of a power station, said that the matter did not concern the building of a power house, but the foundations of a pumping station in order to secure a sufficient supply of water for Montreal in 1919. The lateral conduit had a capacity of 66,000,000 gallons, but this year that much had been pumped daily by the city, and statistics showed that 40,000 people had been added to the city's population during the last year, and that in a year and a half at the most the city would be obliged to pump more than that quantity. Therefore, if means were not taken to put water in the canal for the commencement of the summer of 1919, the city would not be able to give its citizens all the water they needed. That situation should be faced immediately. Some months would be needed to prepare plans for the pumping station, and it would not be right to risk waiting for six months until after the new administration comes in. Only $20,000 or $25,000 was needed at present for the plans, and $400,000 for the foundations afterwards. That was much easier than to spend $2,000,000 for the finishing of the Cook contract.

Montreal, Que.—The contract awarded to the Cook Construction Co. in July, 1913, for the enlargement of the city aqueduct at a cost of $2,232,000, has been cancelled by the Board of Control. The work is less than one-half completed. Both parties agreed to arbitrate their claims and counterclaims, which, as originally submitted, amounted to one million and three-quarters on each side. The city authorities consented to omit one item of $900,000 from its claims, as otherwise the company announced it would appeal to the courts for a settlement of the disputed amounts. Discussing the action of the board, Mayor Martin said that they had saved the city $3,000,000 by cancelling the contract, and, owing to the high cost of material and labor, that additional amount would be required to complete the works.

Ottawa, Ont.—At the annual meeting in Ottawa on November 28th. of the Dominion Conservation Commission, A. V. White, C.E., read a paper urging that nothing be done to alienate power rights on the St. Lawrence River until a comprehensive survey had been made. Sir John Kennedy, consulting engineer of the Montreal Harbor Commission, believed that a scheme of development should be agreed upon by an engineering commission and then handed over to a joint commission such as the International Waterways Commission. R. A. Ross, a Hydro-electric engineer, from Montreal, agreed, and also advocated a scientific survey of the whole of Canada's power and undeveloped energy.

Ottawa, Ont.—"No serious attempt has been made to grapple with the problem of preventing the serious and irreparable waste which is constantly going on in the mining of our coal areas." This was the statement made by Sir Clifford Sifton at the annual meeting of the Dominion Commission of Conservation. He said that the permanent waste of very large quantities of valuable coal still goes on. The war has stimulated mineral production in many lines, including copper, nickel, asbestos, zinc, silver, lead, chromite, cobalt, pig iron and graphite. The establishment at Shawinigan Falls of an electrolytic process for recovering metallic magnesium from magnesite has greatly stimulated the production of this mineral. Magnesium is used in connection with the war for the manufacture of star shells and flares, and as an alloy with aluminum in the manufacture of aeroplane parts.

Province of Ontario.—There will be extraordinary progress in York county and throughout Ontario in highways improvement after the war, declared Mr. George S. Henry, M.P.P., secretary of the Ontario Good Roads Association, before the York Pioneer and Historical Society recently in an address on "Good Roads in York County." Mr. Henry's address covered road construction in York county from the days of the old French regime, through the time of the old toll roads down to the present commission control system. Yonge Street was opened up by settlers, who, in return for the land along the trail given them by the Government, agreed to stump and level Yonge Street to make a passable roadway. Settlers somehow or other evaded their duty in that respect and finally soldiers had to do the work. Under the toll system, Mr. Henry said, the old councils evidently starved road maintenance to keep down the tax rate, for the records show a year in York county where the tolls amount to $30,000 and the expenditures $13,000.

Quebec, Que.—Composed of sixteen freight cars, one van and one private car, weighing 1,245 tons, the first freight train crossed the Quebec bridge last week. It was the exact length of the central span, and when the full weight of the train rested on it, the expansion of the structure was merely five-sixteenths of an inch.

Victoria, B.C.—The land settlement board is making preparatory investigation of the Sumas dyking scheme, which, if carried into effect, will mean the bringing into a position for agricultural development of an area approximating 50,000 acres. Within a short time announcement will be made that the board has taken over the area. Hon. John Oliver and Maxwell Smith, chairman of the board, left for the mainland on business connected with the reclamation scheme. It is estimated it will cost $1,500,000 for the project and occupy some years to complete.

Windsor, Ont.—A resolution was passed by the City Council to give the use of water at the foot of Brock St. to a syndicate of Toronto men, headed by Chas. Miller, for the purpose of operating an international ferry line between Windsor and Detroit. The matter was left in such shape that the new company must organize within two years, and, failing to do so, the water rights will revert to the corporation again. The company intends to expend from one-half to a million dollars in the purchase of new modern material, and boats will be able to take care of the traffic, as well as the automobiles. The boats are to be "double-ended," similar to those used in the Hudson River at New York.

Winnipeg, Man.—A large order has been secured by the Manitoba Rolling Mills Co. from the Orient for iron and steel bars. This is required for repair and upkeep of railway equipment, as well as in shipyards and engineering trades of China and Japan. This is the beginning of what will probably develop into a large export business between Western Canada and the Orient. The Manitoba Rolling Mill Co. have only been operating for the last eighteen months and during that time their output has increased until to-day it approximates 2,000 tons per month of finished product. They are also supplying considerable tonnage to be used in connection with wooden shipbuilding in Canada, for the upkeep of railway rolling equipment and engineering trades, as well as for use in the manufacture of agricultural implements.

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 projected, contracts awarded, changes in staffs, etc.

▲—Denotes an item regarding work advertised in *The Canadian Engineer.*
+—Denotes contract awarded. **The names of successful contractors are printed in CAPITALS.**

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

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
Donalda, Alta., erection of school building	Dec. 15.	Nov. 22.	46
London, Ont., supply of asphalt cement, road filler and broken stone	Dec. 14.	Nov. 29.	50
Ottawa, Ont., supply of electric conduits, outlets and fittings	Dec. 17.	Dec. 6.	48
Toronto, Ont., construction of drainage system (wrought iron pipe)	Jan. 15.	Nov. 29.	52
Winnipeg, Man., construction of pressure pipe line, manufacture and supply of 48-inch pre-moulded reinforced concrete pressure pipe, and supply of cast-iron pipe and specials	Dec. 14.	Dec. 6.	46

FACTORIES AND LARGE BUILDINGS

Anyox, B.C.—The Granby Consolidated Mining, Smelting and Power Co. will shortly erect a coke plant to cost $1,500,000.

Brantford, Ont.—Charles Lake's brass foundry destroyed, November 30th. The foundry was a frame and brick building.

Brantford, Ont.—The City Council have granted a fixed assessment of $34,000 to the Steel Company of Canada on condition that they erect a $100,000 addition to their local plant there, to employ fifty additional hands.

Fort Steele, B.C.—A large compressor plant is in process of installation.

Fort William, Ont.—The property of the Conley Frog and Switch Works, situated in Port Arthur, adjoining the northern boundary of Fort William, has been purchased by the Terminal Land Co. A factory was under construction on the property by the Conley Co. before the war, but was never brought to completion. It is stated that the plant will be equipped and operated.

Lethbridge, Alta.—Installation of power plant equipment at a cost of $63,000 is being contemplated by the City Council. City Commissioner, A. M. Grace.

Maisonneuve, Que.—Mr. Beique, representing the Canadian Machine Company, has requested the city council for a guarantee of $250,000 of debentures for the erection of a big factory. The council stated that no action could be taken on this matter until it was known how much the company would invest, and that they would have to conform to the city by-law in the matter of securing aid.

Montreal, Que.—Extension to the A. R. Whittall's Canning Co. will be made at a cost of $25,000.

Moose Jaw, Sask.—The total of the building permits for November was $34,000, $30,000 of which is covered by the Ross Hospital addition. All told, there were five permits granted during the month.

Nelson, B.C.—Three additional pavilions for the Balfour Military Sanitarium costing approximately $24,000 was advised by Capt. Symons, advisory architect for the Military Hospitals Commission.

Nobleford, Alta.—Tenders of the new Knights of Pythias hall have now been opened, and that of Mr. Anderson has been accepted. The price of the contract is a good one, and the work has to be completed early in January.

Port Arthur, Ont.—The construction of a potash plant is being contemplated by the board of trade.

Quebec, Que.—A factory to cost $20,000 will be erected by the J. B. Drolet Co.

Regina, Sask.—Plans for the erection of a hotel at Qu'Appelle, with the addition of accommodation in the basement for a passenger station, will be carried out by the Grand Trunk Pacific, provided that the consent of the Local Government Board is obtained to transfer the guarantee on terminal bonds. The building will be ten stories.

Sidney, B.C.—Erection of bunkhouses to accommodate the workmen of the Granby Consolidated Mining, Smelting and Power Co. will shortly take place.

Three Rivers, Que.—The Canada Steamship Company are considering the erection of 800 concrete bungalows to accommodate the laborers who will work at the Cape de la Madeleine shipyard of their subsidiary concern, the Tidewater Shipbuilding Company. Jules Balcer, proprietor of Houliston Park, near the Wabassa Cotton Mills, has been approached with an offer for his property as a site for the huts.

Toronto, Ont.—A local plant, employing 500 people, will be operated by the International Business Machines Co., Limited.

Toronto, Ont.—Building permit has been granted to the Canada Metal Co., for a $2,000 addition to their factory on 27 Fraser Ave. City engineer, G. G. Powell.

Toronto, Ont.—Permit has been granted by the city architect to the T. Eaton Co., for the erection of a one-story delivery building at the corner of Coxwell Avenue in the G.T.R. right-of-way. It will cost $45,000.

Toronto, Ont.—Permit has been granted to the Liquid Air Society to erect a one-story tile and steel addition to their factory, 18 Boler Ave. Cost will be $2,600. City engineer, G. G. Powell.

Van Anda, B.C.—Extensive enlargements to the plant of the Pacific Mining Co. are being made, especially in the limestone department.

Vancouver, B.C.—Permit has been granted to the Schaake Engineering Co. by City Building Inspector R. A. McKenzie for the first unit of an extensive machine shop and engineering works to be erected on that site. This first unit will comprise a machine shop that will cost $46,750 for the building alone, and will house machinery and equipment that will be able to handle almost any class of repair work, as well as construct machinery.

Winnipeg, Man.—Building permits for the eleven months of this year number 1,216, the buildings concerned being of the value of $2,194,550. For the same period of 1916 permits numbered 1,078, and of the value of $2,478,400. The largest permit taken out this month was for a drying plant for the Anchor Elevator Co. This will cost $20,000, and be erected on Logan Ave., near McPhillips St.