PAGES

MISSING

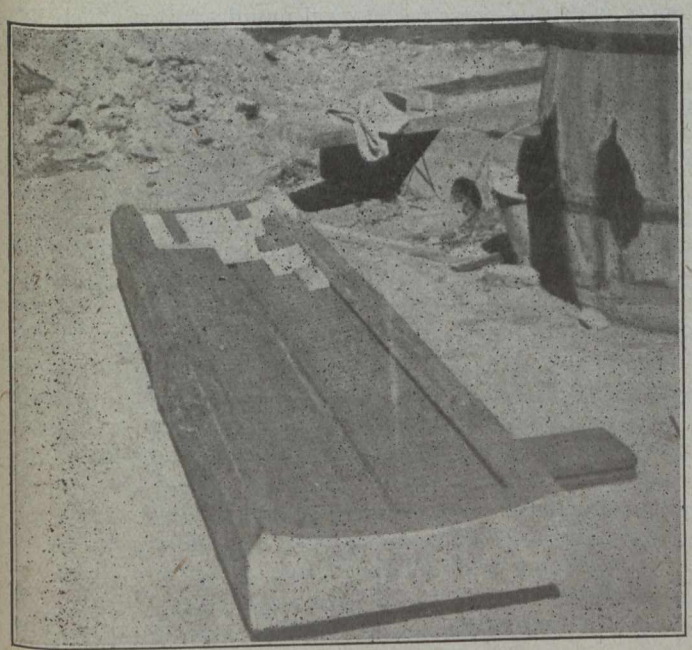
The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Activated Sludge Experimental Work at Milwaukee

Influence of Low Temperatures Not Detrimental—Sludge Can be Converted into a Profitable Marketable Fertilizer—Determination of Best Methods of Diffusing Air Throughout the Sewage—Third Annual Report of Milwaukee Sewage Commission.

THE following extracts, taken from the third annual report of the Milwaukee (Wis.) Sewage Commission, which commission has made an unusually valuable contribution to the commercializing of the activated sludge process of sewage disposal, are of timely interest. The report describes the changes which have been found necessary, refers to the erroneous assumptions made in



Showing concrete retainer for wood block diffusers. A few wood blocks shown in place. Blocks ½" thick and from 2½" to 4" square.

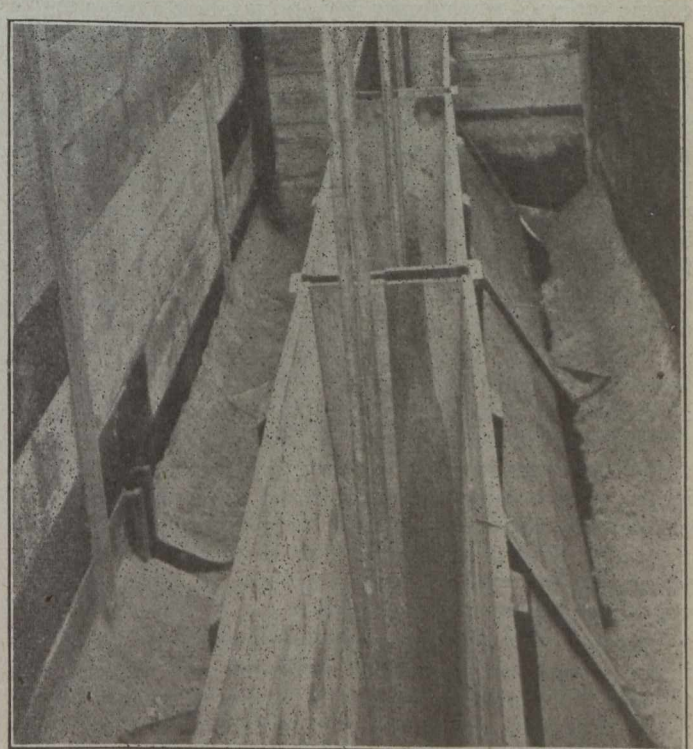
the original design of the plant and what was done to overcome the difficulties that confronted those in charge of the experiments. The report continues as follows:—

The permanent plant was designed, from the information then available, to treat 1,600,000 gallons per 24 hours with a four-hour period of detention and about 2,000,000 gallons with a three-hour period. The sedimentation tank was designed to provide for the maximum quantity treated on the basis of 22 minutes sedimentation period.

It was soon discovered that several serious errors had been made in our assumptions which prevented the plant from satisfactorily treating the volume of sewage for which it had been designed. The most prominent of these were that the conduits which carried the mixed liquor and activated sludge from one set of tanks to another became partially stopped up with the sludge which settled to the bottom almost as soon as the mixture entered the conduit. This sludge became septic and the dissolved oxygen in the liquor in tank No. 3, for instance, was less than that in No. 2, it having been taken up by the septic sludge contained in the conduit connecting the two tanks.

This, of course, pointed to the necessity of eliminating in our final plant all connecting conduits designed to carry the mixture of sludge and sewage.

The building-up of the air pressure in the tanks from 5½ pounds to nearly 8 pounds, with a consequent loss of air necessary for oxidation led us to examine the filtros plates in the bottom of the tanks. We found these largely stopped up with a mixture of oil and fine particles of dust. This determined the absolute necessity of providing an air blower of a type which would certainly exclude all oil from the air discharge pipe, and the thorough washing of all air passing to the filtros plates. The excelsior filter which we had provided for this service having proven inefficient, other methods had to be devised.



Showing baffles in Nordell Aerating Tank. Baffles in form of chimneys with flared sides and curved bottom, standing about 3" above wood block diffusers. Liquid contents of tank forced upward through chimneys by air pressure and passes back to diffusers on the outside of chimneys, making complete circulation and high velocity when passing over surface of diffusers.

We also determined from a careful testing of the porosity of the plates before, after and during service that a plate of fine porosity was less efficient than a coarser one. That is, instead of a plate which would pass from 2 to 4 cubic feet of air per minute per square

foot under a 2-inch water pressure, one which would pass from 10 to 12 cubic feet of air per minute created less friction, maintained more uniform diffusion, and was less liable to stoppage.

The sedimentation tank was built 28 ft. 4 ins. in diameter to a depth of 3 feet below water level, and 4 feet in diameter at a depth of 11 ft. 6 ins. below water level. The bottom being built of a slope about 1 to 1. The 4-foot diameter section extended to 34 feet below water level. A 12-inch diameter pipe extended from a few feet above the surface of the water to 9 inches above the bottom of the tank. An air pipe was built inside this 12-inch pipe through which the air is delivered to raise the sludge, accumulating in the bottom of the tank, through the 12-inch pipe to the top and deliver it either to the raw sewage or to the aerating sludge tanks.

The operation of this tank soon proved several facts: That a slope of 1 to 1 was not sufficient to keep the sludge moving towards the central chamber; that it would remain on this slope and become septic reducing the dissolved oxygen in the effluent; that the velocity through the tank was too great and double the detention period was necessary; that there was a distinct relation between the density of the sludge raised from the bottom of the tank and the velocity by which it flowed. That is, a high velocity would raise a wetter sludge than a low velocity of flow. Thus the 12-inch sludge riser pipe should be reduced to 6 inches; and moreover, the sludge should be taken downward, rather than upward, from the apex of the sludge chamber.

The best we could do with the plant as originally designed, was to put through about 750,000 gallons of coarse screened sewage per day and produce a clear stable effluent, reducing the bacteria about 95%, suspended matter 97%, and oxygen consumed about 80%.

Recognizing that the greatest defect was in the sedimentation tank, we improvised No. 11 tank, which had been designed as a sludge aerating and storage tank, into a sedimentation tank. This tank was 30 feet in diameter with an effective depth of about 9 feet. It was divided by a spiral wall into a continuous compartment about 6 feet wide and about 90 feet long.

Reference to Mr. Copeland's report will explain in detail the changes made in turning this tank into a sedimentation tank and need not be repeated here, but the facts observed during the period this tank was operated as a sedimentation tank were, that we obtained a satisfactory effluent at the rate of 750,000 gallons per day with an effective head equal to nearly one-fourth of the head in the main sedimentation tank and with about one-half of the cubical contents; that we satisfactorily treated 1,500,000 gallons of raw sewage through the aerating tanks and were in a fair way to increase this rate when our big pump went out of service.

In other words, the greatest defect of the plant was in the sedimentation end and not in the aerating end, and that the main problem which now confronts us is to design a sedimentation tank which will produce an uniform horizontal velocity of 3 feet per minute or a vertical velocity of 8 inches per minute and insure the complete removal continuously of precipitated sludge as rapidly as formed.

During the shutdown of the plant we decided, after thoroughly examining the condition of the filtros plates, to remove them, substitute new ones over the entire plant and start anew. The General Filtration Company magnanimously consented to co-operate with us and furnish us without cost all the plates we needed and to furnish the best it could produce.

The Connersville Blower Company revised the bearings of the two blowers it had furnished so that all oil would be eliminated from the inside of the blower casing, and we set up an air washer furnished by the Spray Engineering Company to wash and dry the air before it reached the blower. This new installation has just been completed and we hope within the next few months to obtain much more satisfactory results from our plant than heretofore.

Sludge Disposal.—To record all the details of the experiments we have made during the year in investigating the sludge disposal problem, would fill many pages. Everything which held any promise of success has been tried so far as time and labor have been available, to the end that we have determined primarily that activated sludge can be successfully dewatered and reduced to a fertilizer base at an expense less than its value, and that there is ample available market for all we can produce.

Early in the year H. R. Worthington furnished, at its own expense, a Berrigan Press, 6 ft. x 9 ft. in size. Mr. Berrigan, the designer, and Mr. Towle, the engineer for Worthington, carried on a continuous line of experiments with this press for several months, after which we operated it ourselves until the plant shut down.

Starting with the production of less than 100 pounds of pressed cake per pressing, the press was developed to a point where it produced about 1,800 pounds per pressing, containing 75% moisture.

The operation of the press was reversed so that the filter bags could be filled and emptied much more rapidly, and various types of bags were tried out. Investigations were made of the porosity of the bags under the existing conditions, their tendency to shrink, and the necessity for cleaning and repair. Careful estimates were made, so far as information was available, of the cost of pressing, including the cost and upkeep of the filter bags.

The approximate cost, based upon treating 100 million gallons per day, excluding overhead charges on building, is as follows:—

Overhead charges—10% of cost	$1.21
Labor—8 hours—3 shifts	1.36
Cleaning and upkeep of bags	.64
Power	.09
Contingencies	.16
Total cost, per dry ton	$3.46

From our investigations one-half a ton of dry sludge is produced from one million gallons of sewage treated, the approximate cost of pressing sludge would be $1.73 per million gallons of sewage.

From the information available at the present time, the approximate cost of drying and grinding the sludge, exclusive of overhead charges for building, are as follows:—

Overhead charges—15% of cost	$0.39
Labor—8 hours—3 shifts	.73
Fuel—one cent per 82,000 B.t.u.	1.10
Power—one cent per kw. hr.	.52
Grinding	.25
Contingencies	.18
Total cost of drying, per dry ton.	$3.17

On the basis of one million gallons producing one-half ton of dry sludge, the approximate cost of drying will be $1.59 per million gallons of sewage treated, or $3.32 per million gallons of sewage treated for reducing the sludge produced to a fertilizer basis.

The value of this sludge as a fertilizer is based upon the quick availability of its contained nitrogen as NH_3. From growing experiments being carried out at the University of Illinois during the last 18 months, the availability of this nitrogen has been proven beyond any doubt and its value is equal to the same quantity of NH_3 contained in any of the high-grade fertilizers.

It would appear appropriate, after over two years of continuous experimental work upon sewage disposal, to present at this time a brief résumé of the conclusions reached. In forming these conclusions there are certain determining conditions connected with the Milwaukee situation, which are not common to all large municipalities, to-wit:—

The natural drainage of the present city and the area embraced within the anticipated limits of 1950 converge into one outlet, the harbor entrance.

The public water supply is secured from Lake Michigan in 50 feet depth of water at a point located about 3½ miles from the harbor entrance. This condition requires a high standard effluent of uniform quality to be produced from a sewage treatment plant.

There is no constant current in any one direction in the lake. The velocity and direction are largely due to meteorological conditions.

The only logical site for a sewage disposal plant is on or near the lake shore and the only available ground is Jones Island.

The natural island has far too small an area to locate a sewage disposal plant thereupon, and such plant must be built upon ground made out into the lake.

There is no low ground either in the city or its proximity suitable to the disposition of sludge; in fact, low ground is so scarce that those who are required to dispose of waste materials pay for the privilege of filling in the low ground. Sludge could not be used to make up land into the lake, as it would cause a nuisance which would not be tolerated by the owners of the lake front and might pollute the bathing beaches. It is considered inimical to public policy and to the future of our harbor to deposit sewage sludge in the lake. It therefore appears mandatory to either incinerate the sludge or reduce it to and dispose of it as a fertilizer.

Locating the disposal plant within the city limits, as appears necessary, prohibits a sewage treatment process which produces objectionable odors or flies.

Chemical precipitation removed the solids in suspension to a satisfactory degree, but the effluent produced did not reach the stability requirements. The sludge produced was enormous and its value was not sufficient to warrant the cost necessary to reduce it to a fertilizer. Its incineration would cost between $12 and $14 per million gallons of sewage treated.

Treatment by colloidar slate tanks gave a satisfactory effluent most of the time, but produced enormous quantities of sludge with low value as a fertilizer. The first cost of such a plant would be prohibitory.

Fine screening, considered as a single process, would neither remove sufficient suspended matter to meet the requirements nor improve the stability of the sewage.

Electrolysis was both offensive and uncertain. It had to be augmented with lime treatment and produced large quantities of sludge which was unprofitable to reduce to a fertilizer. From our experiments carried out with this process, the operating charges would be prohibitory.

Sedimentation by Imhoff tanks reduced the suspended matters about 50%, but produced a highly putrescible effluent. To satisfactorily sterilize this effluent required approximately 9 parts of chlorine, costing about $5.30 per million gallons. The sludge produced was not of sufficient value to warrant its reduction to a fertilizer, and to incinerate it would cost approximately $5 per million gallons of sewage treated.

Imhoff tank and sprinkling filters followed by final sedimentation produced a satisfactory effluent capable of being discharged into the lake without endangering the water supply. This treatment left us with the sludge to dispose of by incineration, cut out the sterilization, produced objectionable odors and flies, and required a prohibitory area of ground (nearly 100 acres) to be made up in the lake. The overhead charges for first cost of plant, under the existing conditions, add nearly $9 per million gallons to the cost of treatment by this process.

Activated sludge, if properly designed, built and operated, produces a clear, non-putrescible effluent, with a reduction of at least 95% bacteria and 98% suspended matters, and a sludge of sufficient value to warrant its reduction to a fertilizer. Its operation is odorless and free from flies and it occupies a minimum area of ground.

On the other hand, it requires constant and expert supervision for its successful operation and large operating cost for air and sludge disposal. Its cost, including all overhead, operating and sludge disposal, is estimated to be from $12 to $15 per million gallons, from which must be deducted such returns as may be obtained from the sale of the sludge, which has been estimated in preceding pages to be from $5 to $6 per million gallons, or a net cost of from $7 to $10 per million gallons of sewage treated.

Of all the processes experimented with the activated sludge appears to be the only one which fits the existing conditions in Milwaukee.

The maximum volume of air required to produce a stable effluent from the Menomonee Valley sewage, from which 95% of bacteria and 98% of suspended solids have been removed, is 2 cubic feet per gallon of sewage, based on 10 feet effective head of sewage in the aerating tanks.

The maximum aerating period for both sewage and activated sludge is 4 hours.

The percentage of activated sludge in contact with the sewage may range from 15 to 25, without materially affecting results.

The sedimentation period required is from 40 to 50 minutes. The maximum horizontal velocity is 3 feet per minute and the vertical velocity about 8 inches per minute. Uniform velocities must be maintained as far as possible.

The slopes for successfully removing sludge from the sedimentation tanks should be from 1 to 2, to 1 to 3, and it is preferable to remove the sludge through a down pipe built in the bottom of the sedimentation tank.

Breaking up the air in small bubbles increases the oxygen absorbed by the sewage in the aerating tanks, but sufficient air must be diffused through the sewage to rapidly disturb its entire volume and to maintain the solids in suspension. Baffles properly placed undoubtedly increase the efficiency of the tank.

Filtros plates are a satisfactory media for air diffusion. To maintain their efficiency they should be carefully made and placed, fairly uniform in porosity and all oil and dust should be excluded from the air passing to and through the plates.

Wood plates give smaller bubbles than filtros plates at less loss in pressure, but insufficient experiments have been carried out to warrant their adoption.

The sewage can be clarified in from one to one and one-half hours' aeration in the presence of well activated

sludge, by using from ½ to 1 cubic foot of air per gallon in a 10-foot depth of tank, but the activity of the sludge cannot be maintained without additional aeration.

If clarification alone was required, aerating the sludge three hours and the sewage one hour would produce the desired results.

Maintaining a sludge blanket near the surface of the sedimentation tank filters the floating matters from the liquor and produces a sparkling, clear effluent, but this blanket is difficult to maintain, as it is quickly affected by temperature changes, variations of flow through and sludge from tank.

The aerating tanks can take care of storm water flow when designed to provide for average dry-weather flow by increasing the volume of air and the activated sludge, but extra sedimentation area must be provided for storm flow if standard effluent is to be maintained.

Conduits cannot be used to carry a mixture of sewage and activated sludge, because the sludge settles too quickly, even though velocities of 2 feet per second are maintained.

The activated sludge precipitated in the sedimentation tanks contains about 99% water. This may be reduced by subsequent settlement for from 1 to 3 hours to 96%.

Overaeration of sludge reduces its volume and its tendency to flock, and decreases its specific gravity.

Sludge can be dewatered satisfactorily from 96% to 75% moisture by either a plate press or pressure press without the addition of lime or other base. The minimum cost for this process is still undetermined.

The filter bags used in the presses must be cleaned frequently to maintain efficiency. This can be done by soaking in a bath of dilute caustic soda and hot water.

Sludge, after pressing, can be stored in a building without creating offensive odors more than 50 feet away, and can be easily handled.

The dewatering of sludge from 75% to 10% moisture can be satisfactorily accomplished by either the indirect steam or direct heat dryers, without appreciable loss of ammonia. The minimum cost for this operation is still undetermined.

Milwaukee sludge, after drying, contains from 4.5 to 5% of ammonia as a fertilizer. There is ample market for such a production when reduced to the proper form.

Estimating four hours' aeration of sewage and two hours subsequent settlement of sludge, eight million gallons of sewage can be treated upon one acre of ground.

Although there are many other conclusions of minor importance which have been reached from the experiments made, those enumerated above are of the most importance in determining the design of the large plant.

A $2,500,000 coal pier that can load 7,000 tons of coal an hour has been opened by the Baltimore & Ohio Railroad at Curtis Bay, near Baltimore. The structure is of unusual interest because of its capacity, which is claimed to be the largest of any coal pier yet constructed, and because it handles coal by belt conveyors instead of by gravity. This arrangement greatly reduces the breakage by making three feet the maximum fall for coal from the time it leaves the car until it reaches the ship. At the land end of the pier, which is of concrete and steel, are two car dumpers and next to them are balancing bins, into which certain of the belt conveyors empty. On the pier are four travelling loading towers that can serve as many ships, all at one time. They are supplied with coal by sixty-inch belts, having a maximum speed of five hundred feet per minute. Supplementing these are two towers that trim the ships' loads. The functions of the entire plant are interlocked and controlled electrically by push buttons.

Letter to the Editor

MR. TYE'S RAILWAY PAPER.

Sir,—In three or four issues of your paper you have published "resumees" of the majority and minority reports of the Commission to Enquire into Railways and Transportation in Canada, as also Mr. Tye's paper in full, in addition to some editorials on the subject. It is somewhat significant, perhaps, that while Mr. Tye's paper was read before the Canadian Society of Civil Engineers in public, and the widest publicity was given to it throughout the country, no advance notice of such a paper was sent out and consequently there was no chance for discussion or criticism at the time it was read.

After the reading comments were invited, but these will be presumably bound up with the proceedings of the society, and will be seen by no one but the members. In view of these facts I would ask you to publish my reply to Mr. Tye as given to the Canadian Society. There are two sides to every question and it is only fair that the railways criticized should have a chance to present their side and to point out the errors and inaccuracies in the originals.

HENRY K. WICKSTEED, B.A.Sc.,
Chief Engineer Location, C.N.R.

Toronto, Ont., June 8th, 1917.

[NOTE.—*The Canadian Engineer* did not know that Mr. Wicksteed had written a letter to the Canadian Society until his letter of June 8th was received. We have pleasure in reprinting herewith the copy of the letter to the society which was enclosed in Mr. Wicksteed's letter of June 8th. The letter to the society was dated April 16th, 1917, and was addressed to the secretary at Montreal. Following is its complete text.—EDITOR.]

The writer has read with much interest Mr. Tye's paper on "Canada's Railway Problem and Its Solution," and must compliment that gentleman on its preparation. At the same time, there appear to be some points in it to which exception may be taken and others which will bear amplification.

Taking Mr. Tye's conclusions in order:—

1. The National Transcontinental, the Grand Trunk Pacific and the Canadian Northern railways are unable to earn their operating expenses and their fixed charges. Canada has built, and is operating, the first of these roads, and Canada and the various provinces have guaranteed the principal and interest of most of the bonds of the other two. As the roads are unable to earn their fixed charges, they must, of necessity, be paid by the country.

Regarding conclusion No. 1.—This gives the impression that the Canadian Northern has not at any time paid, nor has any definite prospect of paying, its fixed charges. Mr. Tye shows further on that so long as the Canadian Northern remained west of Port Arthur it was wonderfully successful, and if his paper had been written after instead of before the publication of the last annual report, he would probably have modified his conclusion as to its prospects in the future. If in the first year of operation of the full system a deficit of only $258,000 is shown, the prospects for the future must be admitted to be very good indeed.

2. The failure of these roads is due to the duplication of lines by all the railways, encouraged and bonused by the government; to the excessive cost of the Grand Trunk Pacific and National Transcontinental railways; to the failure of the Grand Trunk Pacific to provide itself with an adequate

system of feeders in the west, and to the construction, by the Canadian Northern, of the long and unproductive stretches of road across British Columbia and Northern Ontario, without feeders, terminals, etc.

Conclusion No. 2.—The writer deplores with Mr. Tye the duplication of lines by the different Trunk Systems, but would point out that as far as the Canadian Northern is concerned, the "long stretches" of unproductive line were forced on it by the construction of the Grand Trunk Pacific and Transcontinental Railways as a measure of self-preservation. It had lines both east and west, the latter earning handsome returns and the former "doing well" (they have since become self-supporting). It was obvious that when connected up they could be reasonably expected to do much better, and this has, the writer submits, been definitely proved by the results. The parallellism came from the Transcontinental and Grand Trunk Pacific.

The "stretches" are long, assuredly, but the unproductiveness is hardly proven. There is very good reason indeed for believing that both of these stretches will in a comparatively short time yield very good returns indeed for local traffic alone. The unproductiveness is on account of their newness. The policy of the Canadian Northern, the policy of the state, has been to construct in advance of development rather than to await it, and the progress of Canada's commerce scarcely seems to bear out the proposition that the policy has been in error.

3. If the Canadian Northern, the Grand Trunk Pacific and National Transcontinental be maintained in two separate systems, it will cost at least $400,000,000 to build the necessary branch line feeders and terminals, to provide them with adequate rolling stock, and put them in proper physical condition to compete with the Canadian Pacific.

No. 3.—As far as the Canadian Northern is concerned, only a small fraction of the sum Mr. Tye mentions is necessary to put it upon a self-supporting basis, which is all we are at present concerned with. Except in the metropolitan cities, the territories served by the Canadian Northern and Canadian Pacific are fairly well defined and separate.

4. It will be necessary that the Grand Trunk Pacific build five to six thousand miles of feeders in the west.

5. It will be necessary that the Canadian Northern build two to three thousand miles of feeders in the east, and terminals costing many millions in Montreal, Toronto, Ottawa, Quebec and Vancouver.

No. 5.—The Canadian Northern has in contemplation in the east a very limited number of miles which it considers essential,—scarcely over one hundred. As to terminals, those in Montreal are well advanced towards completion. In Toronto and Ottawa the same may be said. In Quebec the Canadian Northern is probably better situated than any other road and only in the matter of a passenger station is it behind the C.P.R. In Vancouver its terminals are also in progress.

6. Canada has already sufficient railway mileage for years to come. The additional mileage necessary for these roads could only be had by duplicating existing lines. Such duplication of lines would only add to the burden to be borne by Canada in the way of subsidies, guarantees, etc., without doing the country any good.

No. 6.—This must be admitted as nearly true if Mr. Tye refers merely to mileage in itself and not to the position of such mileage, but if he means that no more mileage should be constructed anywhere for many years to come, the writer cannot by any means agree with him. This would be tantamount to saying that Central Canada is fully developed and settled and has no resources outside of the territory now occupied, and that further expansion should not be encouraged. To such a proposition the writer cannot subscribe. He believes that there is very much more to be done in the way of expansion and that any unnecessary mileage constructed is that due to one road's invading the territory already served and developed by another; in short, to duplication; but it does not follow that the same amount of mileage judiciously placed will not be a necessity in a short time if development is to continue.

7. Canada has sufficient railway mileage and traffic for two good transcontinental systems—the Canadian Pacific and another—but not enough for three.

No. 7.—The writer would repeat that the policy of Canada has been to build in advance of settlement and it seems to have been a successful policy. What the future may show we cannot tell. The invasion of the northern part of the prairie provinces by the Grand Trunk Pacific is unfortunate and would seem to be unwise. In the east there is little interference by the Canadian Northern with any existing system.

8. A consolidation of the Grand Trunk, the Grand Trunk Pacific, Transcontinental and Canadian Northern railways would give a well-balanced system. The Grand Trunk has an excellent system in the east, with terminals in all large and important centres; the Canadian Northern has not. The Canadian Northern has a good system of feeders in the west; the Grand Trunk has not. Each is strong where the other is weak. Combining them must, of necessity, be the most economical and efficient way of handling the situation.

No. 8.—The writer agrees with this principle in part but objects to some of the statements made in support of it. The Grand Trunk has nothing in the northern part of the provinces of Quebec and does not enter Quebec city at all. Surely Quebec, Three Rivers, Joliette, Grand Mere, Shawinigan Falls and Chicoutimi are important centres, as well as Hull, St. Jerome, La Tuque and Lachute.

9. Such a combination would not require more than $100,000,000 to provide it with sufficient rolling stock and to put it in proper physical condition to compete with the Canadian Pacific.

10. The saving in capital cost would be at least $300,000,000 and, at present rates of interest, the saving in fixed charges, at least $15,000,000 per annum.

Nos. 9 and 10.—Granted. But the Canadian Northern does not need this expenditure to make it self-supporting.

11. The Transcontinental cost $100,000 per mile to build The parallel Canadian Northern cost less than $50,000 per mile, and is, in every way, as efficient an instrument of transportation. The Quebec bridge, with approaches, will cost $40,000,000, and will not be necessary for many long years to come.

12. The Transcontinental, including the Quebec bridge, has cost Canada at least $100,000,000 more to build than it would have cost the Canadian Pacific to build as efficient a road.

Nos. 11 and 12.—Quite true, but it is not quite obvious why Mr. Tye has picked out the Canadian Pacific as the only efficient railway builder.

13. Including operating expenses and fixed charges, it costs the Canadian Pacific about $70 to do $100 worth of business. Including operating expenses and interest on cost, it costs the Intercolonial and the other Canadian government roads from $200 to $220 to do $100 worth of business.

14. Canada should follow the wise example set by Sir John Macdonald when dealing with the Canadian Pacific in 1879-80, and form a new private corporation, with sufficient power and the necessary safeguards, to take over and consolidate the Grand Trunk, Grand Trunk Pacific, Transcontinental and Canadian Northern railways, and develop another Canadian Pacific, rather than to have the government take them over and develop another and a vaster and more expensive Intercolonial.

15. Conditions for the formation of such a company are much more favorable than they were in 1880, as western Canada had not then been proven, as it since has been, to be capable of supporting a large and prosperous population.

16. Such a combination would start with gross earnings of at least $100,000,000 per annum, with a probable average

increase of 8 per cent. per annum, and probable net earnings of from $25,000,000 to $30,000,000 per annum, and a net revenue from other sources of about $2,800,000.

17. Its fixed charges at consolidation would be about $35,000,000, and it would be under the necessity of spending, in the first five to seven years, at least $100,000,000 to provide rolling stock and to put its properties in good physical condition.

18. Deficits for some time to come would be inevitable, owing to the heavy fixed charges amounting to about $35,000,000, as compared with $10,300,000 per annum for the Canadian Pacific.

19. As these high fixed charges are caused by the excessive cost of government construction and by duplication of lines, bonused and guaranteed by the government, Canada must pay them.

20. The fixed charges would be at least $15,000,000 less with one private system than with two, and very much less with private than with government management.

21. With such a combination as has been outlined, the series of deficits should not last more than five to ten years, after which the road should be very successful.

22. In order to control its policy, and to share in its certain prosperity, Canada should have an interest in the new company. The Dominion government should furnish 40 per cent. of the money required, own 40 per cent. of the stock, and appoint 40 per cent. of the directorate, but take no part in the actual management. This would give all the advantage of government control without any of the manifest disadvantages of government management.

23. Once this combination was successful, Canada should once and for all abandon the vicious policy of bonusing railway construction, either by gifts of money or land, or by the still more vicious policy of guaranteeing the bonds of railway companies of which it has no direct control.

Nos. 13 to 23.—Mr. Tye's object seems to be to show that the government can get out of a bad bargain by consolidating these roads and putting up $100,000,000, better than in any other way. Is this the whole duty of a government? The Canadian Pacific and the Canadian Northern have both been built under this so-called "vicious" system of bonusing and guaranteeing, and both have done wonders in opening up the country. Could they have been built otherwise? The experiment was tried in the case of the C.P.R. and abandoned. It was tried again in the case of the Transcontinental and Mr. Tye condemns the experiment as an absolute failure, which it is.

The C.P.R., in spite of the enormous subsidies granted it, came very close to failure at least once in its early career, and the government came to its assistance. It had no opposition. The Canadian Northern, with less assistance, has fought its way for a perfectly logical development at almost every step. Its financial success may be said to be certain, but a perfectly unforeseen series of contingencies have deferred such success. It has admittedly rendered an enormous service in the development of the country. Under these circumstances is there a moral right to deprive its owners of their property and the fruits of their labors? Such work as these men have done is impossible for a government such as ours to do. Mr. Tye clearly shows this. Without the stimulus of profit, without exemption from interference, private individuals will not undertake it, and in spite of the implied negative contained in consideration 22, there is much development work still to be done in Canada, and the writer is very doubtful whether there is any better way of securing it than by grants of land worthless without such development.

Probably Mr. Tye will contend that it is not confiscation but consolidation which he proposes, but if the Canadian Northern is to be loaded down with the enormous debt of the lines which it did not create; with the creation of which it had nothing to do except by its initial success to point the way; the result is surely much the same, and the discouragement to private enterprise, to thrift, intelligence, courage and perseverence will probably have a worse effect on the moral and material progress of the country than can be offset by any financial gain or saving.

The government now owns 40 per cent. of the stock of the Canadian Northern and will participate in any value which this will have in the future and in any dividends which may accrue. Would it not be better that the lines which the government has built, and the Grand Trunk Pacific have built with liberal government aid, and which are continuous with one another across the continent, should be allowed to work out their own salvation? The writer heartily agrees with Mr. Tye that their building was a mistake. Should not the mistake be paid for by those who are responsible for it? And should a perfectly legitimate and logical enterprise which but for this mistake would already be a financial success, be burdened with it?

To accuse Mr. Tye of unfairness is the last thing in the writer's mind, but there are several points on which he is evidently misinformed. Some of these have been pointed out. Quebec terminals, for instance, and the financial status of Quebec lines generally. In the case of the Montreal terminals he submits a map which is somewhat misleading. The city extends nearly to the Back River, the map not nearly so far. Hence the Canadian Northern yards at Cartierville do not appear in the picture at all, nor does the extension of the line to the Lachine Canal, nor anything but the fag end of the eastern line through Maisonneuve, along which such a phenomenal development has taken place.

The policy of the Canadian Northern has been in Montreal and elsewhere to create development, not to follow it. A passenger terminal in the city proper, and a freight yard for receipt and delivery, were considered necessities; a sorting and classification yard in a central locality was not so considered. The line through Maisonneuve was built 15 years ago through farm property. To-day it has tributary to it some of the greatest industries in the city or the country, and a population of 40,000 people along its tracks. This seems to the writer to be a line of development which deserves a good deal of credit.

The unfortunate delay in the completion of the Mount Royal Tunnel, owing to the unprecedented financial situation, has undoubtedly contributed more than any other element to prevent the Canadian Northern from making an even better financial showing than it has. Not only has the large expenditure on the tunnel itself and on the terminal property been earning no interest, but the whole line west to Port Arthur, 1,000 miles, has suffered and been comparatively unproductive through the delay in the completion of this terminal.

Imagine the Grand Trunk or the C.P.R. with its Montreal terminals wiped out for three years! The one road would be ruined and the other very seriously embarrassed.

The writer would repeat that the C.N.R. asks for nothing in the west or centre but a little patience and forbearance on the part of the public while it works out its own problems. Mr. Tye gracefully endorses the high standard of location and construction of its new lines. Another high authority pronounces them the "best in existence." If the older portion of the system in the prairie provinces is not quite up to the standard of the balance of the main line on either end, the reason is obvious. This is the colonization or development portion and there is no greater evidence to the writer's mind of

the business acumen of the builders of both the Canadian Pacific and Canadian Northern than this: that they kept their capital charges low in the early day of development.

Mr. Tye himself shows that there is no more severe condemnation which can be urged against the National Transcontinental and the Grand Trunk Pacific than their enormous cost through undeveloped territory. Development roads are needed in Canada, many miles of them, but development roads have no right to cost $100,000 per mile, and there can be little excuse for the construction of the National Transcontinental except development.

The Canadian Northern to-day between Winnipeg and Edmonton is an infinitely better line than the Canadian Pacific of 25 years ago between the same meridians, and the money required for betterments comparatively trifling. The main line will then be, as it now is, for three-fourths of its length (to quote the same high authority again), "the best long-distance line in existence." This applies not only to its standards of grades and curvature, but to the selection of its general route and the territory which it serves. This is no reflection on the work of the C.P.R. men in earlier days. There were reasons for its more southerly location across the prairies and around Lake Superior other than the attainment of the best physical standards.

The C.N.R. started where the C.P.R. left off, and with the benefit of its experience as well as that of the American lines. If it had not profited by the lesson the reflection would have been on the executive of the newer road.

[NOTE.—The following paragraphs were not included in the manuscript sent to the Canadian Society, but are included in the manuscript sent to *The Canadian Engineer* with a note from Mr. Wicksteed to the effect that they are additional paragraphs.—EDITOR.]

Mr. Tye shows that the cost of the Transcontinental and G.T.P. is excessive. The writer heartily agrees, but granting the extravagance, are they altogether useless? and being built, is it quite unreasonable that a government should keep them in repair? One of the functions conceded to a government is regulation of rates and tariffs. What better check on unfair tariffs could there be than a first-class road connecting the main centres? The plea for the Trent Valley Canal was that it would put a check on freight rates.

The Intercolonial and the C.P.R. were first projected as "political" necessities, as a continuous binder between the provinces. The I.C.R. remained in the hands of the government, the C.P.R. passed into private hands and became a commercial power. The I.C.R. became a burden to the country, but not an insuperable one, and during the last months of military operations has been an essential factor.

May not the N.T.R. and the western section of the G.T.R. make the same plea for existence, that they may some day be a military necessity? The C.N.R. and C.P.R. are both vulnerable on Lake Superior and along the Fraser River, so are the St. Lawrence and the Welland canals. The N.T.R. and Intercolonial are safe, and while a possible difference with our southern neighbors seems a more remote possibility than ever before, quarrels do occur in almost unexpected ways, and "preparedness" is the best antidote and the modern by-word. Germany's experience seems to be that military railways are the best form of "preparedness."

A function which has never as yet been ascribed to any government is that of active competition with private mercantile ventures. Aside from the impossibility of economical management which has been often pointed out, the ethical principles involved in a government's using its unlimited credit and power to destroy the business of a privately owned competitor seems altogether indefensible. Whatever may be urged for nationalization of all railways (and it seems to be very hard to make out a case), competition is unpermissible because of the inequality of the competitors.

HOW KITCHENER FIRED ITS CITY ENGINEER.

Under the above heading, The Toronto Star last Saturday published the following special dispatch from Kitchener, Ont.:—

A case of considerable interest was heard before Magistrate Weir yesterday when Alderman P. M. Bowman appeared to answer to the charge of offering material consideration to Alderman Jack Reid, contrary to the Municipal Act, if he would come back from Owen Sound and vote for the dismissal of Engineer Johnston.

There was also a second charge, that of offering Alderman Brubacher certain things in reference to his assessment if he would vote all right. From the evidence adduced the dismissal of City Engineer Johnston was a part of the propaganda of the Citizens' League, as Bowman told Reid that the Citizens' League would pay his expenses and railway fare if he would come back from Owen Sound and vote for the dismissal of Johnston at the April council meeting.

Alderman Brubacher in his evidence stated that he had been visited by Alderman Bowman, who told him that certain members of the city council couldn't understand why Brubacher was taking the position in favor of Johnston, and he (Brubacher) told them that he had always found him all right, and would support him. The witness was told that some of the aldermen were in favor of putting in the east end storm drain which affected his property. Bowman then told him that there was a meeting that night and "if you cannot vote in favor of Michel, you had better stay away from the meeting."

In the matter of Alderman Reid, he told of having been called upon twice at his home by Bowman to try and arrange for Reid to come back from Owen Sound to vote on the engineering question, and after he had gone to Owen Sound, of receiving a telephone communication asking him to come back. In the matter of who was to pay expenses, Bowman had said: "I believe the Citizens' League will pay them."

After hearing the evidence for the prosecution, Magistrate Weir adjourned the case until June 26th.

FUEL COMMISSIONER FOR CANADA.

Charles A. Magrath, C.E., D.T.S., chairman of the Canadian section of the International Joint Commission, has been appointed special commissioner to deal with the fuel situation in Canada. Wide powers are conferred upon him, including the fixing, if necessary, of prices. Authority will also be given to take over and operate as a war measure the mines in the Crow's Nest country, where operations are tied up by a strike. The coal situation and the outlook for next winter are considered so critical that the government decided that there must be a central authority having drastic powers of regulation of supply and demand. The action was taken under the War Measures Act. Mr. Magrath will enter upon his duties immediately and will work in conjunction with the Railway Commission in equalizing distribution.

THE DESIGN OF A TOWER FOR A 50,000-GALLON HEMISPHERICAL BOTTOM TANK.*

PERHAPS the most common size and type of elevated steel water tank in use to-day is the 50,000-gallon tank with hemispherical bottom. Its average height is about 75 feet and it is usually supported on a four-post tower. We will attempt to go through the various steps in the design of the tower in the shortest and simplest way.

The structure must be strong enough to withstand the following loads: (1) The water in the tank; (2) the weight of the tank and tower itself; (3) the wind load.

Other loads sometimes considered are snow on the roof, and the weight of people on the balcony, but it is evident that snow would not stay on a roof while the maximum wind load was acting, and it is not customary for any one to take a pleasure trip up to the balcony of an exposed water tower when a hurricane is blowing at the rate of 100 miles per hour.

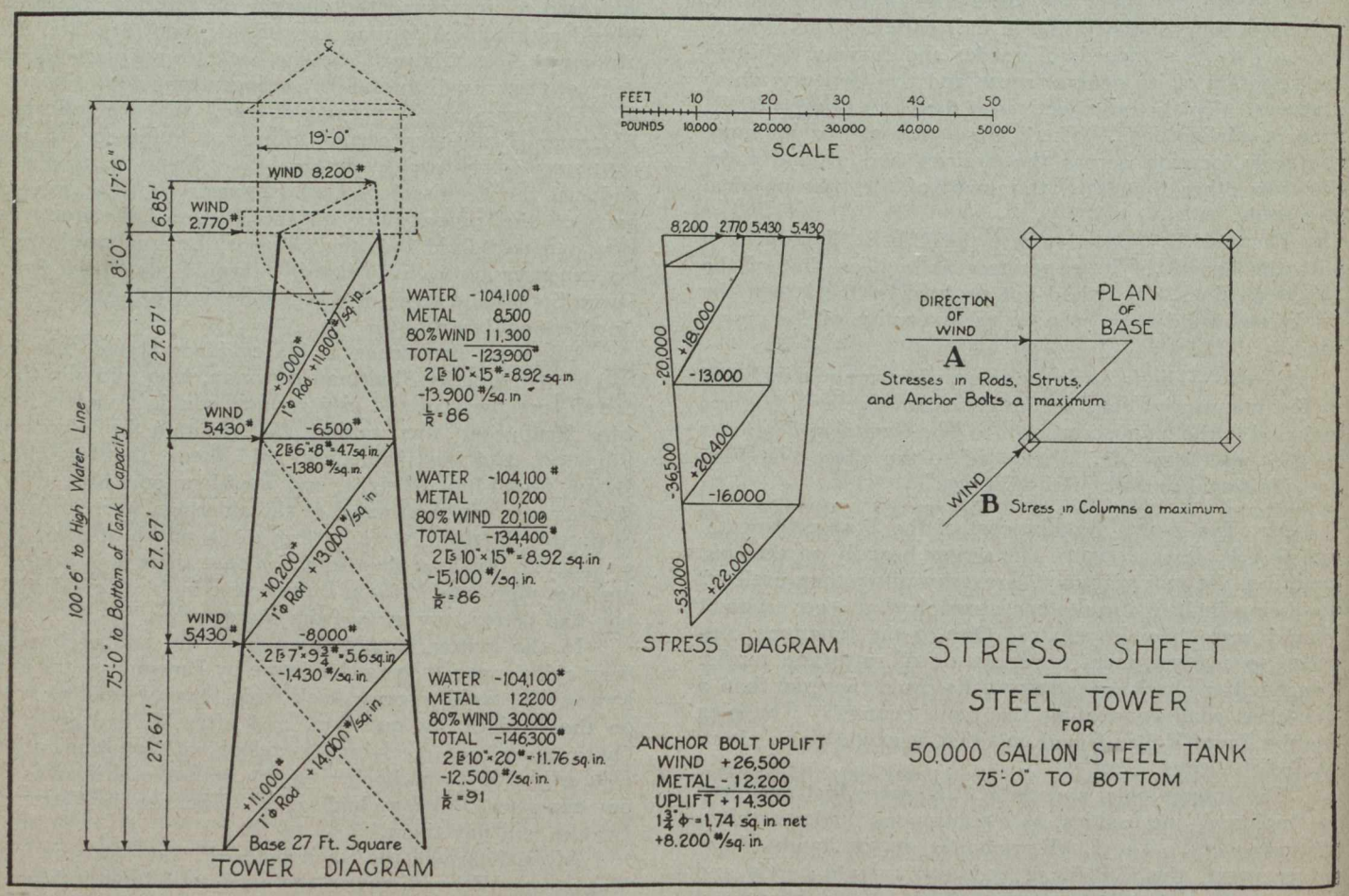
The stresses caused by the above loads will be considered in the order given.

(1) Water Load.—The weight of the water is transmitted directly to the foundations through the columns. The struts and rods receive no part of this load. Each column takes one-quarter of the total water load, or 104,100 pounds. Opposite each panel on the diagram is given the loading on the columns. The water load is given first and it remains the same in each panel.

(2) Metal Load.—The weight of the tank and tower itself, or metal load, can be only approximated at first. After the design is finished and the total weight of the structure is calculated, the correct metal loads can be substituted, and the stresses recalculated.

(3) Wind Load.—The maximum wind velocity in any part of this country will produce a pressure of about 15 pounds per square foot of projected area on a surface such as that of a hemispherical bottom tank. For the particular tank given this load is 8,200 pounds, and it is considered acting at the centre of gravity of the projected area, which is 6.85 feet above the balcony line.

It is common practice to assume the wind load on a four-post tower to be 200 pounds per vertical foot and to assume that it acts at the panel point, or strut line. The tower is 83 feet to balcony and has three panels of 27⅔ feet each. The tower wind load is then 2,770 pounds at the balcony and 5,430 pounds at each panel point. These loads are shown on the tower diagram with arrows indicating their direction and point of application.



The wind stresses are usually determined by the graphical method, as this is perhaps the easiest and quickest way. It is not material just how the stress diagram is drawn; although the result should be the same as that shown, another system may give a diagram in the reverse order. In the case given, the loads were laid off at the top and the forces were taken counter-clockwise around each point.

The maximum stresses in the rods and struts occur when the wind is blowing from direction A. These stresses are one-half of those obtained from the stress diagram, as the wind loads used in drawing the diagram were the loads for both sides of the tower.

The maximum column stresses occur when the wind is blowing from direction B and they are equal to .707

(Continued on page 505.)

*From "The Water Tower," published by the Chicago Bridge & Iron Co.

PUMPING IN THE METROPOLITAN WATER DISTRICT OF MASSACHUSETTS.*

By A. O. Doane,
Division Engineer, Metropolitan Water Board, Boston.

THE Metropolitan Water District of Massachusetts was established by an act of legislature in 1895. It includes the city of Boston and seventeen other neighboring cities and towns, and had an estimated population in 1916 of 1,190,220. The average daily consumption of water in the district for 1916, of which half was supplied by gravity, was 103,876,000 gallons or 87.3 per capita.

The water supply is obtained from the old Boston reservoir No. 3 on the Sudbury River, the Sudbury reservoir (commenced by the city of Boston and completed by the Metropolitan Water Board), and from the Wachusett reservoir, constructed by the board on the south branch of the Nashua River at Clinton. Lake Cochituate, from which the first large supply for Boston was obtained, and the old Boston reservoirs on the Sudbury River, except reservoir No. 3, are now held in reserve.

Half of the water drawn from the Wachusett and Sudbury reservoirs is brought to a point in Weston, through the Weston aqueduct. It then flows through 60-inch and 48-inch cast-iron pipes and furnishes the gravity supply to the lower parts of the district. Spot Pond, in the extreme northerly part of the district, is connected with this pipe system and acts as a storage and compensating reservoir. The remainder of the water drawn from these reservoirs, together with the water from the old Boston reservoir No. 3, is conveyed by the Sudbury aqueduct to Chestnut Hill reservoir. All this water is pumped at the Chestnut Hill pumping stations. When water from Lake Cochituate is used, it comes to Chestnut Hill Reservoir through the Cochituate aqueduct.

On January 1, 1898, the city of Boston pumping stations came under the control of the Metropolitan Water Board, and the Mystic pumping station and several of the smaller stations in the district were shut down. When the new Metropolitan pumping stations were completed, all of the small pumping plants were abandoned, and all the pumping for the district is now done at five stations by high duty pumping engines instead of at seventeen widely separated stations by low duty pumping machines of a type now obsolete.

All the water delivered to the Chestnut Hill reservoir is pumped at two pumping stations located on the southeasterly side of the reservoir. The older building, known as Chestnut Hill pumping station No. 1, was built by the city of Boston in 1887.

The pumping plant consists of two 8,000,000-gallon Gaskill horizontal fly-wheel engines, built by the Holly Manufacturing Co. in 1887; one 20,000,000-gallon vertical triple expansion crank and fly-wheel engine, designed by the late E. D. Leavitt and built by the Quintard Iron Works in 1895 (this engine has Riedler mechanically operated valves in water end); and one 30,000,000-gallon vertical triple expansion crank and fly-wheel engine, built by the E. P. Allis Company in 1898.

The boiler plant consists of one Belpaire boiler, 90 inches in diameter and 34 feet long; two vertical Dean boilers, 98 inches in diameter and 24 feet long; and three horizontal tubular boilers 64 inches in diameter and 18½ feet long. There is also a 168-tube Sturtevant economizer.

*Paper read before the American Water Works Association, May 8th, 1917.

Only a comparatively small quantity of water is now pumped at this station, as most of the water for the supply of the higher portion of the southerly part of the district is pumped at pumping station No. 2 by the 40,000,000-gallon Holly pumping engine.

Chestnut Hill Pumping Station No. 2.—This station was built by the Metropolitan Water Board in 1900. The pumping plant consists of four vertical triple expansion crank and fly-wheel engines, all built by the Holly Manufacturing Co.; three of these engines are of 35,000,000-gallon capacity each and were installed in 1900, and the fourth is of 40,000,000-gallon capacity and was erected in 1911.

The boiler room contains five boilers, all of the vertical fire tube type, designed by F. W. Dean. The three older boilers are 98 inches in diameter, 29½ feet high over all, and each contains 384 2-inch tubes 15 feet long. The other two boilers are 109 inches in diameter and 29½ feet high over all, and each contains 484 2-inch tubes 15 feet long.

There are two 144-tube economizers, one a Sturtevant and the other a Green.

The coal house has a capacity of 1,000 tons, and the loaded cars come into it on a trestle about 15 feet high. An ash tunnel extends under the boilers, and the ashes are dumped through an opening in the floor into a car in the tunnel. The loaded ash cars are raised to tracks outside the building leading to a dump, by means of a hydraulic elevator.

The 40,000,000-gallon engine is used for supplying the southern high-service district and operates against an average head of 124.54 feet. The three older engines pump water for the lower parts of the district, including the low-lying portion of the city of Boston.

Owing to a large increase in the amount of water supplied by gravity, the pumping to this service has been much reduced and the pumps are now largely used to regulate the pressure in the mains by supplying water during periods of maximum draft and to raise the pressure during large fires.

The combined daily average high service pumping at both of the Chestnut Hill pumping stations was 34,371,300 gallons in 1916; the average lift was 124.13 feet; the cost per million gallons pumped, based on pumping station expenses, was $3.0682.

The low-service pumping was done at station No. 2, and amounted to a daily average of 33,875,000 gallons from January 1 to February 7, 1916. On February 8 a large main supplying water by gravity from the Weston aqueduct was put in service, and the daily average pumping for the remainder of the year was 15,365,000 gallons. The average lift was also reduced from 41.51 feet to 33.70 feet. The change, while reducing the total cost of water pumped about $4,000, raised the cost of pumping per million gallons to $4.14, of $1.80 more than in 1915.

The Spot Pond pumping station is situated on the shore of Spot Pond. The engine room contains a Holly 20,000,000-gallon vertical triple expansion crank and fly-wheel engine and a 10,000,000-gallon vertical compound crank and fly-wheel engine designed by the late E. D. Leavitt and built by the Blake Manufacturing Co. This engine was erected at the Mystic Pumping Station of the city of Boston and was transferred to Spot Pond in 1899, after the Mystic station was abandoned.

The boiler room contains three Dean vertical internally fired fire tube boilers 92 inches in diameter, 29 feet 4 inches long over all, each containing 256 2¼-inch tubes 15 feet long.

A Green 144-tube economizer is used to heat the boiler feed water.

The water is pumped from Spot Bond to the Fells and Bear Hill reservoirs. From these reservoirs it is distributed to the higher portions of the northerly part of the district. The daily average quantity pumped in 1916 was 7,106,000 gallons, against an average lift of 129.06 feet. The cost of pumping was $5.8289 per million gallons.

The northern extra high service pumping station is located in Arlington and pumps water from the low service system for the supply of the higher parts of the town of Arlington and for the entire supply of the town of Lexington. The pumping plant consists of one Allis-Chalmers cross-compound crank and fly-wheel engine and one Blake compound duplex engine used as a reserve pump. Both have a daily capacity of 1,500,000 gallons.

There are two 54-inch horizontal tubular boilers in brick settings.

The daily average pumping in 1916 was 797,000 gallons; the average lift was 281.7 feet; and the cost per million gallons pumped was $36.42. This was partly due to expensive repairs to the Allis-Chalmers engine and more extended use of the low duty Blake pump.

The southern extra high service pumping station is located in the Hyde Park district of Boston, and pumps water from the southern high service mains for the supply of elevated territory in the southern part of the district.

The station contains two 3,000,000-gallon cross-compound crank and fly-wheel engines built by the Laidlaw-Dunn-Gordon Co., and two 54-inch horizontal tubular boilers in brick settings. The daily average pumping in 1916 was 655,000 gallons; and the cost per million gallons pumped was $30.31.

The five pumping stations are operated under the direction of the superintendent of pumping stations, Arthur E. O'Neil, who reports to Mr. William E. Foss, chief engineer of waterworks. The men work in eight-hour shifts, and are allowed one day off in seven and a vacation with pay.

Coal and lubricating oil are purchased under specification and are regularly tested at a laboratory at the main office of the board in Boston. In addition to the laboratory tests of fuel, special boiler tests are made from time to time, especially when changes in the brand of coal used are contemplated. In this way much information regarding the actual working of the coal is obtained, which is not shown by the calorimeter or other laboratory tests.

Synopsis of Coal Specifications.—The coal shall be of good quality, free from dirt and excessive dust, a sample of which when dried at 221° F., hereinafter called dry coal, will approximate the following standard of heat value and analysis:—

British thermal units	14,800 per pound.
Volatile matter	18 to 20 per cent.
Ash	7 per cent.
Sulphur	1 per cent.

Coal which when dry contains less than 14,300 British thermal units per pound, more than 23 per cent. of volatile matter, more than 9 per cent. of ash, or 1.50 per cent. of sulphur may, at the option of the chief engineer, be rejected, and if rejected shall be removed by and at the expense of the contractor.

Payments.—For each 50 British thermal units or fraction thereof in the dry coal in excess of 14,800 the price per ton shall be increased one cent, and for each 50 British thermal units or fraction thereof less than 14,700 the price per ton shall be decreased two cents.

For each ½ of 1 per cent. or fraction thereof of ash in the dry coal in excess of 8 per cent. the price per ton shall be decreased one cent.

When the analysis of the coal shows moisture in the coal as received in excess of 3 per cent., the amount of weight due to moisture in excess of 3 per cent. shall be deducted from the total weight of the coal, and the net weight so determined shall be taken as the amount of coal to be paid for.

Coal for the pumping stations has been purchased on the heat unit basis since 1908, the board having been one of the pioneers in adopting this method of buying coal.

The specifications as outlined above have given general satisfaction and are fair to both dealer and consumer, which is an important point.

Fuel suited to the type of boiler, as well as draft and load conditions, is obtained and any loss of efficiency due to a poor lot of coal is compensated by the reduction in price.

Limiting the volatile matter is of considerable importance where vertical internally fired fire tube boilers are in use, as it is difficult to obtain complete combustion of a high volatile coal before the gases strike the heating surfaces of the boiler.

The limitation of sulphur is desirable, as the element in combination with iron and other constituents of the ash is apt to form bad clinkers, and also from the fact that the presence of 2 per cent. or more of sulphur is in most cases a very good indication that the coal is liable to spontaneous combustion. While it is well known that this action is due to absorption of oxygen by the coal, both sulphur and moisture seem to play an important part in starting the trouble, although some coals low in sulphur heat badly while others high in sulphur do not.

As the greatest opportunity for economy is commonly found in the boiler room, particular attention is paid to this part of the plant. Care is taken to see that the method of firing and depth of coal on the grates is suited to the fuel and load, that the tubes and heating surfaces and other parts of the boiler are kept clean, and the boilers are washed out at regular intervals. Particular care is taken to keep the lower tube sheets of the vertical boilers free from scale to avoid overheating the tube ends. The brick settings of horizontal boilers require careful watching to avoid infiltration of air through cracks or porous masonry.

Recording steam gauges have a considerable moral effect on the firemen, and in connection with log charts giving the hourly readings of instruments in the engine and fire rooms keep the superintendent informed of what goes on in the plant during the entire 24 hours.

An apparatus for the continuous determination of CO_2 is installed at pumping station No. 2, but has not proved very satisfactory in operation as, owing to its delicate and complicated construction, it is liable to get out of order and requires more expert attention than it is practical to give.

Leaks in steam pipe lines are promptly repaired, as it is astonishing how much loss may be caused by an apparently insignificant leak.

There are four fuel economizers in service, but the conditions are not favorable for large savings owing to the steady load and large proportion of heat absorbed by the boiler heating surface, with consequent low flue temperature. The economizers do, however, act as settling reservoirs and to a limited extent as feed water purifiers, and as steam-driven auxiliaries are scarce in the Metro-

politan stations they add some heat to the feed water, which would otherwise have to be obtained from live steam in order to comply with the state law, which requires boiler feed water to have a temperature of at least 120° F.

Careful attention to methods of firing, such as depth of fire, regulation of draft, working of fire, charging and spreading of coal, makes for economy. As a general rule, charging small amounts of coal frequently and maintaining as thin a fire bed as practicable give the best results. Hand firing is the method employed, although stokers have been used and also forced draft with hand firing. There is considerable danger in using forced draft in internally fired fire tube boilers of getting a blow pipe or Bunsen burner effect, causing intense local heating which results in burning the furnace sheets or crown sheets and tube ends.

It has been found economical to burn a certain proportion of small anthracite coal, known as Birdseye, mixed with bituminous coal. From 25 to 50 per cent. of Birdseye can be burned with advantage with natural draft, depending on the draft available, load conditions and depth of fuel bed and characteristics of the coal used in regard to coking and clinkering. A larger proportion of Birdseye can be used economically by carrying a thin fire bed, taking care to avoid the formation of holes and working the fires as little as possible. If the air supply is obstructed by a thick fuel bed or formation of clinkers, imperfect combustion ensues. If the fire is sliced or shaken too much, a large proportion of the fine coal falls into the ash pit unburned.

One advantage of using a considerable proportion of anthracite is that it greatly reduces the formation of smoke; another is that mixing it with a bituminous coal having an ash of low fusibility tends to prevent the formation of a layer of melted ash, which would cut off the air supply to the fuel bed.

The boiler feed water is metered and in most cases it is necessary to use a hot water meter. Various makes of these instruments of the disc, piston or rotary type have been tried, but all are unsatisfactory as they rapidly lose accuracy and require constant repairs. A Venturi meter gives the best results, as there are no moving parts in the hot water, but the great cost of the registers makes them out of the question for most small plants.

It has been found advantageous to use as small steam pipes as will allow of the proper admission of steam to the engine, and by the use of a large separator on the engine the size may be still further reduced.

The advantages of a small pipe are low first cost of pipe, fittings and coverings, less radiating surface and consequent condensation, quicker passage of steam from boiler to engine, and greater flexibility of bends which reduces the strains due to expansion and contraction. The small size pipe is particularly advantageous when the steam is superheated.

While no large economics are possible in the engine room, care is taken to see that the valves of the engines are properly set, that cylinders and bearings are properly lubricated, that both steam and water packings are in good shape, and that the rubber pump valves are kept in good condition, otherwise there would be an excessive amount of slip. It is found that with outside packed water plungers the slip should not exceed 1½ per cent.

For packing single-acting water plungers, a packing made up in the form of a double wedge has been found satisfactory, as on the discharge stroke the water pressure forces the wedges together and prevents leakage, while on the suction stroke the packing is comparatively loose and causes but little friction.

For packing steam piston rods, metallic packing is used and it wears for years without attention.

Most of the air pumps and feed water pumps are direct connected to reciprocating parts of the main engines, and have the same length of stroke as the main plungers. This arrangement requires but little attention and has the same economy of operation as the main engine, but is not as flexible in operation as the independent steam-driven pumps. The exhaust steam from the latter can be used to heat the feed water, giving a good over-all economy and saving the boilers from strains due to cold feed water.

The action of the long-stroke pumps sets up violent strains in the piping unless it is well protected by air chambers kept filled with air.

Surface condensers are used exclusively. Some are of the so-called waterworks type, where the exhaust steam passes through the tubes and all the water pumped passes through the shell, flowing over the outside of the tubes; while in others a portion of the water pumped is by-passed through the tubes and the steam is condensed on the outside of the tubes. As a rule, the waterworks type gives better satisfaction, as the circulating water is cooler owing to the larger volume, there is no trouble with by-pass devices, and the interior of the tubes is not clogged by any material carried by the water.

The table at the bottom of the page gives the results of duty trials of some of the pumping engines.

The Arlington and Hyde Park engines are of the horizontal cross-compound crank and fly-wheel type; all others are vertical triple expansion crank and fly-wheel engines. The duties are based on plunger displacement, and where not otherwise noted on dry steam and coal.

Results of Duty Trials of Pumping Engines

Location of Engine.	Capacity. Mil. U.S. Gals. in 24 Hours.	Average Lift. Feet.	Duty. Million Foot Pounds per 1,000 Lbs. Steam.	Million B. T. U.	100 Lbs. Coal.	Efficiency Mechanical.	Thermal.
Chestnut Hill Pumping Station No. 1	20	137.48	.....	145.470	150.045	.....	.....
	30	140.35	178.497	157.002	173.869	93.29	21.63
Chestnut Hill Pumping Station No. 2	35*	44.68	157.349	140.533	156.322	88.23	20.50
	40	132.09	175.066	155.547	149.135	90.10	20.01
Spot Pond Pumping Station	20	125.27	173.620	156.592	177.961	96.53	20.85
Arlington Pumping Station	1.5	290.3	115.959†	.....	90.025‡	.....	.....
Hyde Park Pumping Station, Engine No. 14	3	.....	121.022†	111.880	113.488‡	93.2	.....

*Average of three 35-million-gallon engines tested together. †Moist steam. ‡Moist coal.

In regular service the duties are computed weekly on the coal basis, and are therefore records of plant efficiency. It is found that where the conditions are such that the engines can run at rated capacity on 24-hour service, the results compare favorably with those obtained at duty trials, but where the engines are not run continuously or operate below the rated capacity, or as frequently happens are subjected to both these handicaps, the duty is seriously affected and may be only from 50 to 75 per cent. of the trial duty, depending on conditions. The engines at the small pumping stations and the low-service pumping engines are particularly subject to these unfavorable conditions.

The efficiency of the boiler plant is satisfactory. All the larger boilers are of the internally fired fire tube type, and as the load is steady while the engines are running and the boilers have ample heating surface for the work, very little heat goes to waste.

Carefully conducted boiler tests have shown that the Belpaire boiler has a combined efficiency of boiler, furnace and grate of 80.3 per cent., and the Dean vertical boilers of 80.4 per cent. The horizontal tubular type boilers have shown efficiency of 74 per cent. under not particularly favorable circumstances.

In regular service the 109-inch Dean boilers gave for the year 1916 an average evaporation from and at 212° F. of 12.3 pounds of water per pound of coal. The horizontal tubular boilers show from 9.5 to 10 pounds evaporation.

These figures have proved stumbling blocks to certain worthy gentlemen who have proposed to install their fuel-saving devices and have guaranteed a 25 per cent. saving of coal.

The human element as represented by the pumping station force, particularly of the fire-room division, is of the greatest importance. Unceasing vigilance on the part of the supervising authority, careful selection of the help and firm but considerate treatment of the men is necessary to get the best results.

Many large corporations have adopted the policy of paying a bonus to the firemen, based on actual savings effected. This has in many cases effected a notable reduction in the fuel bill. This method, however, seems to be impracticable in state or municipal work.

In conclusion, a word of caution may not be out of place. While economy is desirable, it is well to remember that in the pumping service reliability is of paramount importance, and it does not seem good policy to endanger it by attempting to make small savings in machinery, supplies or labor.

CANADIAN ELECTRIC RAILWAY ASSOCIATION.

At the recent annual meeting of the Association held in the Windsor Hotel, Montreal, the following officers were elected for the ensuing year:—President, C. L. Wilson, assistant general manager, Toronto and York Radial Railway, Toronto; hon. secretary-treasurer, Acton Burrows, Toronto.

The Executive Committee is as follows:—J. D. Fraser, director and secretary-treasurer of the Ottawa Electric Railway, Ottawa; A. Gaboury, superintendent Montreal Tramways, Montreal; E. P. Coleman, Hamilton; G. Gordon Gale, vice-president and manager, Hull Electric Railway, Hull; J. S. Mackenzie, purchasing agent, Winnipeg Electric Railway, Winnipeg; H. G. Matthews, general manager, Quebec Rail-Way, Light, Heat & Power Co., Quebec; E. L. Milliken, manager Cape Breton Electric Railway, Sydney, C.B., and Aubrey A. Burrows, Toronto.

CANADIAN ENGINEERS AT THE FRONT.

"Extraordinarily difficult conditions of transportation of men, munitions and supplies have been overcome under the direction of Canadian engineers," says Stewart Lyon, official correspondent for the Canadian Press, in a recent article written for Canadian daily newspapers.

"Engineers from allied countries who have visited Vimy Ridge and the region behind," says Mr. Lyon, "express profound admiration and amazement at the magnitude of the work done in a few months. Thousands of men built the waterworks plants, roads, etc., without which the conquest of the Ridge and the holding of it after its capture would have been impossible.

"The railway system begun by the French during the campaign of 1915, was reconstructed and brought into general use. Under the direction of Canadian engineers, galleries were constructed as quarters for the troops and dressing stations for the wounded. There were water pipes, and a supply for hundreds of thousands of men. There were also storage places for food and ammunition.

"Streams miles back, an abandoned coal shaft and a spring at Vimy Ridge, almost under the Boche lines, were the chief sources of supply. Forty-five miles of 4-inch pipe were laid sufficiently deep to protect them against shell fire.

"It has already been told in despatches of the tremendous labor involved in the construction and maintenance of roads and light railways. Some of the troubles were unique. Trees near the Front were cut down to provide material for plank roads but were found to be full of splinters of shells. Shrapnel and bullets played havoc with the teeth of the saws in the portable sawmills, and as no saws with individual teeth could be obtained, the teeth had to be filed by hand after every break.

"The plank roads and light railways were the only possible means of getting supplies up to Vimy Ridge after our artillery had destroyed the German road system.

"Many breaks occurred in the railway in a single night, but section hands were ready in an instant to repair them. The result was an accumulation of thousands of pounds of projectiles ready for the day of the attack. During a single 24-hour period, 457 tons of explosives were carried on one light railway, which is believed to be a record on the battlefield for a position where the enemy could see every movement for miles behind the front. The result of these engineering devices was a decisive victory which forced Von Hindenburg to throw in reserves which he had hoped to use elsewhere in an offensive. The work of the Canadian engineers helped materially to bring about this result."

The following is a list of Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, 59 Yonge St., Toronto, from whom further particulars may be obtained: William G. Stephenson, coupling devices or apparatus for the vestibules or gangways of corridor rolling stock for railways; Dean S. Harley, portable fire escape; Chapman Double Ball Bearing Co. of Canada, Limited, elevating trucks; Sebastjon Z. de Ferranti, electrical transformers; Francis E. Matthews and Edward H. Strange, process for the purification of unsaturated hydro-carbons containing the conjugated double bond; Thomas K. Irwin, treatment of sewage and other waste liquids; Elwood Grissinger, telephone systems; Toronto Type Foundry Co., Limited, thread milling and chamfering attachment for lathes.

STREET RAILWAY NEGATIVE RETURN SYSTEM FOR THE MITIGATION OF ELECTROLYSIS.*

By L. A. Herdt, M.Can.Soc.C.E., and E. G. Burr, A.M.Can.Soc.C.E.

WITH the rapid growth in the extent of electric railway lines and the traffic carried by them, the importance of providing a proper return of the current from the cars to the power houses and sub-stations and thus protecting piping systems, cables and other underground structures, against electrolysis, should be recognized by electrical railway engineers.

Serious corrosion of pipes, with attending damages, has occurred in various cities, as is well known, and efforts in certain instances have been made to eliminate the danger. However, it is a fact that as engineers are only human and liable to the error of advocacy, namely, seeing only one side of the question, the engineers of both interests, that is, the engineer of the company owning and operating the electric railway, and those of the company owning the underground structures, are still earnestly debating where to place the responsibility for damage done by stray currents. The often recurring result is that lawyers are brought into the debate and the courts become the stage of action. Judgment obtained after long delay is usually a legal compromise with orders for certain measures for the alleviation of the nuisance.

Such measures are rarely far-reaching or fundamental enough to do more than remove the particular cause of complaint for a time. The merry-go-round of suit, judgments, expenditure on measures of alleviation and legal costs, and then recurrence of the trouble continues ad infinitum.

But as times change the street railway systems serving growing urban districts themselves include underground structures consisting of lead-sheathed cables liable to destruction by currents straying from returns.

Thus a community of interest in the proper methods to avoid damage occurs, and the interest of all parties becomes the same. Engineers alive to the necessity of avoiding damage at the minimum cost may then be asked to apply the solution of the problem that will remove the trouble.

Various Methods of Electrolysis Mitigation.—The various methods of electrolysis mitigation which have been for years the subject of discussion can be divided into two groups:—

(1) Those methods applicable to underground pipes and cable systems.

(2) Those applicable to the railway negative returns.

Of the various methods under the first heading, namely, chemical protection of pipes, cement coatings of pipes, insulating joints in piping systems, pipe drainage and cable drainage, none are entirely suitable for general use and cannot be considered as primary means of preventing electrolysis damage. These methods have their usefulness, but they are suitable only to special conditions and cannot be considered as important factors in any general plan for electrolysis mitigation.

Of the various methods covered under the second heading, that is, those applicable to the railway negative returns, such methods are suitable as will keep the track voltage gradient, that is, the voltage drop per 1,000 feet of track within certain limits, and will reduce the overall maximum difference of potential between any two points of the return system, also within limits, as well as those which will increase the resistance from tracks to earth. These methods are fundamental, as they control the causes of the straying of current from the tracks. Experience has shown what limits of track voltage gradient and overall potential differences can be allowed. Some ordinances grade the allowable limits to the density of the traffic, allowing greater latitude in the suburban districts than in the urban ones; for in fixing voltage limitations, the voltage limit prescribed should evidently be largely determined by the degree of development of the underground utilities in that district.

A track construction which results in a relatively high resistance of leakage path from rail to earth is eminently desirable but difficult to provide in city streets with flush rails and paved streets.

In Great Britain, where the operation of electric railways is governed by regulations of the Board of Trade, regulation No. 3 requires that the maximum difference of potential between any two points on the track return shall not be more than 7 volts, and also prescribes current densities in rails equivalent to a voltage gradient limit in the tracks to about one volt per 1,000 ft. at peak load.

That is, it is sufficient to say, that if the voltage gradient nowhere exceeds one volt per 1,000 ft. and the maximum difference of potential between any two points (reasonably remote from one another) on the returns, is not more than 7 volts—these readings taken at peak load—almost complete immunity from electrolysis damage will result. (The peak load is here considered to be the average of the readings for twenty minutes at peak load.)

Under the conditions cited above, any residual current leakage, or electrolysis effect that may occur, can conveniently, properly and equitably be taken care of by the party owning the structures affected, by methods cited above under Class (1).

To reduce the track voltage drop in an electric railway system various methods are in use:—

(*a*) Improvement of condition of bonding of rail joints.

(*b*) Subdivision of load amongst substations properly located.

(*c*) Installation of negative return feeders with the negative bus grounded at the station.

(*d*) Installation of negative return feeders insulated throughout their length and connected to the negative bus which is not grounded but is maintained at a potential lower than ground.

These methods have been applied in various ways.

In general, methods (*a*) should be applied in all cases to the maximum practical degree of perfection.

Methods (*b*), (*c*) and (*d*) all aim at the same result—namely, the taking of current from the tracks at an increased number of points.

Methods (*c*) and (*d*), however, are radically different from one another inasmuch as method (*d*) divides the system into a network of mains with separate feeders, whilst method (*c*) shuts the mains by so-called feeders.

It will be found in general that method (*c*) will require a prohibitive amount of copper to reduce the track voltage gradient and overall difference of potential within the limits stated previously. A glance at appendix A will show that the current density in the return path through the track is so low, when calculated for the equivalent copper section of the rails, that any attempt to shunt the current will require excessively large copper conductors. For example, the conductance of a single track 100-lb.

*Abstract of paper read before the Canadian Society of Civil Engineers, April 19, 1917.

rails is equivalent to about two million circular mills of copper and would require this amount added to shunt one-half of the current. If greater current densities are allowed the current will follow a shunt path through the earth and other underground structures. It may be here stated that the limits of 1 volt per 1,000 ft. is by no means too low, and in congested districts where extensive underground structures are in existence this value may with great advantage be lowered.

In method (*d*), however, since the feeders are only connected to the tracks at its outer end and the negative bar is not connected to the tracks except through the insulated feeders, the voltage drop in them may be any value desirable, without reference to the above-mentioned track voltage gradient or overall difference of potential; and for this reason, the conductor section of the negative feeders can be decided by conditions of economy only. The potential gradients in the tracks depends entirely on the amount of current carried and where this becomes excessive the current is diverted through the feeder.

In a large electric railway system, if this is desirable, the potential gradient need not be entirely in the direction of the station but may be reversed so that the integral of the gradients will give a low value of overall potential differences.

Many railway engineers have claimed that the maintenance of such low voltage gradients as have been specified would require prohibitive expense in copper conductors for heavily loaded street railway systems such as are general on this continent. This is not the case, however. Such claims may be true when method (*c*) is employed; that is, when rails are shunted by the return feeder and the bus connected to ground; but the authors desire to point out that with the insulated return feeder system as outlined above and further described below, such regulation can be easily adhered to at reasonable cost.

The authors thought it would be interesting to the Society to discuss briefly the means by which the modification of the track returns of a street railway system in Canada from method (*c*) to method (*d*) has resulted in a decided reduction of track gradients and overall potential difference, with a consequent disappearance of electrolysis trouble.

Design of the Return System.—The return system of a street railway will be in the form of a network of conductors (the bonded rails) with loads at various points (the cars).

It is only required to consider the negative side of the system since the positive network of trolley wires, mains and feeders has no bearing on the problem with which this paper is concerned. The first step is, therefore, to prepare a plan of the system showing the car position at time of peak load, this data being obtained from the car operating schedules. Average values of current can be apportioned to each car, having due regard to the size of the car equipment and allowance being made for grades and curves, if considered advisable, the whole plan to form a representation of the way the load is distributed over the system.

From data such as that given in appendix A, the resistance of the several parts of the returns can be obtained and the problem becomes a simple power engineering problem of the design of the network to carry the load within the stated limits of potential difference and voltage drop per thousand feet.

The rails form the network of mains and the current from the cars is collected on the network and returned through feeders connected to the station or stations.

It is advantageous at this point to consider the general line of development of a continuous current distributing system for light and power.

A direct current distribution system of small size will naturally take the form of a radial system with feeders run out to the nearest load and continuing therefrom as a main with the loads connected thereto.

The next development will take the form of cross-tie mains connected to the ends of more than one feeder, then further cross mains are installed connecting the outer end of radial mains so that a network is constructed with the radial mains near the station, acting also as feeders to the outer cross-tie main.

In larger systems radial mains cannot feed the outer districts within the desirable voltage regulation limits, and it is necessary either to install additional stations to feed the outer districts or special extra feeders to the outer districts with a means of providing for the extra voltage drop; or, again, the extension of the radial feeders to tap the mains or network at points farther from the station, so that the current from the outer districts is taken from the radial mains at some intermediate point, and the current flows in the main from the nearest loads in a reversed direction.

The choice of method will resolve itself into a question of economics.

It is of special interest to note that in nowise would the alternative expedient of increasing the section of the radial mains be resorted to; as they are normally of large size, a large amount of copper would be required to moderately decrease their resistance, whereas in a feeder having only one point of connection to the load; that is, at the junction to the main, the voltage drop in it can be made any value desirable from consideration of power loss and current-carrying capacity.

All the feeders can be designed with the same voltage drop, or if this requires excessive copper in the longer

Appendix A.—Resistance of Street Railway Track with Electrically Brazed Bonds

	1,000 Feet Single Track, 2 Rails Bonded						
Rail size, lbs. per yd.	Rail resistance ohms per ft. without bonds.	Res. in ohms with 00 B & S bonds.	Cir. mills equiv. copper section at 25° C.	Amps. for 1 volt per 1,000 ft. gradient.	Res. in ohms. with 0000 B & S bonds.	Cir. mills equiv. copper section at 25° C.	Amps. for 1 volt per 1,000 ft. gradient.
50	20.10×10^{-6}	.01027	1.05×10^{6}	97.5	.01016	1.065×10^{6}	98.5
60	16.65×10^{-6}	.00854	1.265×10^{6}	117.0	.00844	1.28×10^{6}	118.5
70	14.39×10^{-6}	.00741	1.46×10^{6}	135.0	.00731	1.48×10^{6}	137.0
80	12.5×10^{-6}	.00647	1.67×10^{6}	155.0	.00637	1.70×10^{6}	157.0
90	11.36×10^{-6}	.00590	1.83×10^{6}	170.0	.00579	1.87×10^{6}	173.0
100	10.21×10^{-6}	.00532	2.03×10^{6}	188.0	.00522	2.07×10^{6}	192.0

feeders, several bus voltages may be maintained at the station.

The return system of a street railway is strictly analogous to any other D.C. network system of distribution and is subject to the same economical limitations controlling the design.

It may be said, therefore, that such a system should consist of a network of mains formed by the tracks with feeders connected thereto in sufficient numbers and properly located to keep the maximum voltage difference between any two points on the track system and the voltage gradient in the track within prescribed limits, while allowing such voltage drops in the feeders as consideration of power loss and cost of copper may dictate.

The above line of development will, however, be open to the consideration of using an increased number of substations instead of excessively long feeders, and the question itself becomes a further consideration of economic analysis with, however, the complicating condition of the advantages and disadvantages from an operating standpoint of an increased number of substations.

A number of electric railway systems, the growth of which resulted in the occurrence of electrolysis with the original layout, were able to return to satisfactory conditions for a period of several years by increasing the number of substations, but conditions have become again unsatisfactory, to the author's knowledge, due to further growth.

It is surely extraordinary that street railways, of all companies operating D.C. distributing network, should attempt to obtain close voltage regulation of their negative network by combining the function of main and feeder in one conductor, while experience in all other D.C. networks has shown the separate feeder and main system to be the only method capable of giving close regulation at anything but prohibitive cost.

THE MONTREAL AQUEDUCT PROJECT.

After a conference last week with the consulting engineers, Messrs. Vautelet, McRae, and St. Laurent, the Montreal Board of Control resolved to instruct Chief Engineer Mercier to prepare plans showing the modifications in the aqueduct scheme required according to the engineers' projects Nos. 2, 4 and 5. Controller Cote said, after the meeting, that when this information was available the board would be in a position to decide what project should be finally selected.

It was further resolved by the board to instruct the chief engineer to prepare specifications for the supply of electricity for pumping purposes. This is in accordance with project No. 5 of the report of the consulting engineers.

Controller Cote said that the quotations on electric power would be asked for periods of 10, 20 and 40 years. Personally he was in favor of adopting project No. 2, which is the present plan, with modifications.

Controller Cote further stated that during the discussion Mr. Vautelet declared that as regards the manufacture of artificial ice, as outlined in the report, with the surplus power of the city's plant in summer time, ice could be provided for a population of 1,500,000 persons if desired.

The United States supplied $536,354 worth or 80 per cent. of the total railway imports of Peru in 1915. The total value of the supplies imported was $664,103, the largest item of which was rails and accessories, $445,420.

THE DESIGN OF A TOWER FOR A 50,000-GALLON HEMISPHERICAL BOTTOM TANK.

(Continued from page 498.)

times the column stresses obtained from the diagram. This may be easily proved by taking moments about a line perpendicular to the direction of the wind. The maximum column wind stress is not the result of a constant load and occurs but rarely, so only 80 per cent. of it has been used in designing the columns.

With the total stresses in the tower determined we may now select the sections to be used for the various tower members.

Columns.—As the loads on the columns can be accurately determined and are only subject to gradual changes, it is permissible to use higher unit stresses than is customary in structures such as railroad bridges. For 10-inch channels, laced, give a maximum $\frac{L}{R}$, or slenderness ratio of 91, and unit stresses well within the allowable.

Rods.—One-inch diameter rods in each panel give unit stresses varying from 9,000 to 11,000 pounds per square inch.

Struts.—Struts are usually made heavy enough to carry erection equipment, and are much larger than is needed to provide for the wind stresses alone. The struts selected in the accompanying design will carry a load of 2,000 pounds at the centre in addition to the wind. The unit stresses due to wind are quite small.

Anchor Bolts.—When the tank is empty, the maximum wind load is sufficient to tip the structure over on two of its column bases. Anchor bolts are provided to prevent this. The net uplift is 14,300 pounds and it is taken care of by one 1¾-inch anchor bolt. Provision for rusting is made by selecting a large bolt with consequent low unit stress.

Foundations.—The maximum load under each foundation is equal to the sum of the maximum lower panel column loads plus the weight of the foundation. The foundation base should be large enough to distribute this load over the soil with a safe unit bearing pressure. Three thousand six hundred pounds per square foot is a conservative unit pressure to use with average soil conditions. The foundation should also be heavy enough to resist the maximum uplift, but except for small tanks on high towers, the uplift is usually not as great as the weight of the foundation.

When the members have been selected the weight of the structure can be calculated and the metal loads adjusted. This will probably not affect the design if the original metal loads were well chosen. We now have a design in which the stresses are fully known—one that we are sure will do the work for which it was intended.

We should not be too strongly influenced by designs of older structures. Because a tower has stood up in the past is no reason for believing that its design is faultless. Perhaps it is on the verge of failure, or, on the other hand, is far too heavy, and consequently uneconomical. With a good design the most is procured for the money expended.

In England and Wales there are 3,639 miles of canals; in Scotland, 183 miles, and in Ireland, 848 miles—a total for the United Kingdom of 4,670 miles, or 3,822 miles for Great Britain. Of the total mileage, 1,363 miles are owned by various railway companies.

RAILROAD DEVELOPMENT, COST AND WAGES

Government Railroads Compare Unfavorably with Private Enterprises in These Features.

The following memorandum has been issued by the Canadian Northern Railway:—

In the three cardinal features—development of country traversed, cost of service to the public and wages paid to employees—the state-owned railway systems, even those of Australasia, compare unfavorably with the privately owned railways of Canada and the United States.

The railways of North America give the cheapest railway service in the world and the wages of North American trainmen are the highest of which there is any record.

The only country with state-owned and operated railways to which economists point with any degree of assurance is Germany. The reasons for success there and the reasons presaging a lack of success in democracies, are given by Mr. W. M. Acworth, the British representative on the international board of inquiry into the Canadian railway situation, who, in speaking of the English railways, said recently:—

"Now, I am no foe of government railways. On the contrary, I believe that in countries with a population less self-reliant than our own, such a policy is necessary. In a country with a bureaucracy as well-trained and as well-organized as that of Prussia, it may even be desirable. Nay, more I am not concerned to deny that even here state purchase might do something to bring up the worst railway services more nearly to the level of the best. But a careful study of the evidence has convinced me that in the long run state control ends in keeping down the best to the level of the worst, and that, taking them all for all, the private railway companies of England and the United States have served the public better than the government railways of the continent, or of our Australian colonies, and which is still more to the point, are likely to serve it better in the future."

Germany and Canada.

The employees in 1913 on the railways of Germany numbered 786,466 and were paid, on the average $408.97 per year, 38 per cent. of the gross earnings. In Germany, all classes of freight considered, one and a third cents or 13 mills were collected for each ton of goods moved one mile.

In Canada during the fiscal year ended June 30, 1915,—the figures are used because they were those compiled from official records by the Bureau of Railway News and Statistics, Chicago—the employees numbered 124,142, who received on the average $727 per year, more than 45 per cent. of the gross earnings. Yet in Canada the railways collected only 7.51 mills, or about three-quarters of a cent for each ton of freight moved one mile. The rate charged in the United States for similar service in 1915 was 7.380 mills, or about ⅛ of a mill less per ton than in Canada.

In Australasia, where are established the only democracies constitutionally comparable with Canada, the railway situation is exceedingly complicated and the conditions—revenues collected and wages paid—vary in each division of the island continent.

Results in Australia.

New South Wales in 1914-15 had 4,057 miles of railway, and 24,515 employees exclusive of some 1,500 reported with the expeditionary forces. The state received 1.90 cents or nearly 20 mills for each ton of freight moved one mile (and in addition there are terminal receipts per ton of 23⅓ cents) and paid each employee on the average $741. Without counting in the terminal charges at all this 1.90 cents per ton per mile constitutes an increase of ⅛ of a cent upon the figures for 1914. The railways of New South Wales comprise the only standard gauge system in Australia.

Queensland in 1914-15 had 4,730 miles of railway of 3½-foot gauge. In addition there were some 400 miles of line in private hands and operated by local authorities and companies. The statistics do not say how much Queensland collects for each ton of freight, but this state pays to its 11,267 railway employees a little less than $650 per year.

South Australia in 1914-15 had 2,026 miles of railway, of which more than 1,100 were 3½-foot gauge and the remainder 5 feet 3 inches, in 1915. The employees numbered 10,182 and the average wages paid were $412.95 per year. The railways of South Australia charge 2.12 cents, or more than 20 mills for moving each ton of freight a mile, an increase of more than ¼ of a cent per ton upon the figures of 1914.

Western Australia in 1914-15 had 3,096 miles of railway entirely 3½-foot gauge. There were employed 8,148 persons and the average wages paid were $790.30 per year. In this system, also, it is not shown how much the railway collects for each ton of freight carried one mile.

Victoria in 1914-15 had 3,848 miles of railway, 122 miles of which is 2½-foot gauge and 3,726 miles 5 feet 3 in. The statistics do not show how much this state charges for moving freight, but point out that it pays its employees on the average $660.73 per year.

New Zealand in 1913-14 had 2,861 miles of railway entirely 3½-foot gauge. Employees numbered 14,176 and the average wage paid was $674.28. The statistics do not show the details of the revenues obtained for moving freight.

The wages paid on the Australasian systems vary, and the average for the six divisions is $654.76 compared with $727, the average paid in wages in Canada in 1915.

In Canada the enterprise of the railways has broken up the country into farms. In Australia there are ranches many thousands of square miles in extent, and the exports of wheat tell the story of the failure of the Australian railways to stimulate general farming activities.

TO BUILD STEEL SHIPS.

Mr. R. P. Butchart and Captain J. W. Troup, director and assistant director, respectively, for the Imperial Munitions Board for British Columbia, on their return to the Pacific coast from Ottawa, where they were in consultation with the Imperial Munitions Board in regard to the construction of wooden steamships, made the following statement:—

"The Imperial Munitions Board has decided upon the building in Canada of a standard type of vessel, 250 feet long, 43 feet 6 inches beam and 25 feet deep, with a deadweight capacity of about 2,800 tons on a draft of 21 feet. The vessels are to be built very strongly, with box girder stelsons. They have a deep tank forward for water ballast. They are to be propelled by steam, with triple expansion engines of about 950 indicated horse-power. The matter of geared turbines from England is being considered for some of the ships. The vessels are to be built of Douglas fir to Lloyd's requirements for A1 classification.

"The authorities are in favor of concentrating on steel shipbuilding in Canada rather than on wooden ships, it being considered preferable to build boats of steel construction."

Mr. Butchart and Captain Troup have placed the facilities of British Columbia before the board, and as soon as they have an opportunity of lining up the situation in British Columbia they will report to the board as to the building that could be undertaken there. The programme that has so far been outlined is not extensive. It remains to be seen what facilities and what inducements British Columbia can offer to the authorities.

C.N.R. EMPLOYEES SIGN PETITION.

Employees of the Canadian Northern Railway presented a memorial to the Prime Minister last week, protesting "in the strongest terms possible against putting into effect of the majority report of the Royal Commission," which investigated the Canadian railway situation. The memorial was from conductors, engineers, trainmen and firemen. It opposes the nationalization of the Canadian Northern and Grand Trunk systems, and urges that Government operation of a railroad by commission or otherwise free from political influences is practically impossible. It quotes with approval the conclusions of the minority report, made by A. H. Smith, "the only practical American railway man on the Royal Commission." In conclusion it contends that if the Canadian Northern is given some further assistance, especially to secure equipment, the company will be able to work out its own salvation.

LESS THAN ONE-THIRD STATE-OWNED

That is Record of World's 700,000 Miles of Railways—Evidence of W. M. Acworth

While it was true that "most countries own their own railways," the statement is misleading, said Mr. W. M. Acworth, the English railroad authority, in giving evidence before a special meeting of the Joint Committee of Congress on Inter-State Commerce. Mr. Acworth, with Sir Henry Drayton, signed the majority report of the Royal Commission, which investigated the Canadian railway situation. Bulgaria, for illustration, owns its railways, which comprise only 1,204 miles. Bulgaria counts as one country, and so does the United States. But the United States has more than 200 times the Bulgarian mileage, all owned privately. Accordingly, on a mileage basis, the witness pointed out, less than one-third of the world's 700,000 miles of railways is owned by states. Mr. Acworth dealt first with Prussia, which he regarded as the best example of an efficient nationalized railway system. Following the war of 1870, which unified Germany under the leadership of Prussia, Bismarck attempted to acquire all the railways of Germany in order to weld the newly formed empire into one unit. In 1879, the ministry submitted to the Prussian parliament an elaborate memorandum in support of the policy of nationalizing the railroads then in private hands. The significant feature of this memorandum, said Mr. Acworth, was the emphasis placed upon the importance of railways for military purposes. "On the whole," said he, "it is abundantly clear that the main reason for Bismarck's action was of a political nature. It is in harmony with all Prussian history that the importance of military considerations and the necessity of making public control paramount in the life of the country should weigh above all other considerations with a Prussian statesman; and after the war with France and the creation of the German empire, these considerations might be expected to have even greater weight than at any other time."

Old Equipment and Methods.

Citing Professor Schumacher, of Bonn, Mr. Acworth said that the freight receipts per ton mile in 1880 and 1909 in Germany were respectively 1.65 and 1.41 cents. The corresponding receipts per ton-mile for American railways were, in 1882, 1.23 cents, and in 1909, 0.763 cents. In other words, the American ton-mile rate started at the beginning of the period 25 per cent. below the Prussian rate, and it fell in the course of the 29 years, not 15 per cent., but nearly 40 per cent. At the end of the period, the American rate was not much more than one-half the Prussian rate—0.763 cents compared with 1.41 cents. The witness added that progressive rate reductions in Germany had ceased long before 1909. Proceeding he said:—

"While American companies have revolutionized their equipment and methods of operation, Prussia has clung to old equipment and old methods. This is typical. In all the history of railway development it has been the private companies that have led the way, the state systems that have brought up the rear. Railroading is a progressive science. New ideas lead to new inventions, to new plant and methods. This means the spending of much new capital. The state official mistrusts ideas, pours cold water on new inventions and grudges new expenditure. In practical operation, German railway officials have taught the railway world nothing. It would be difficult to point to a single important invention or improvement the introduction of which the world owes to a state railway. That Prussia is the only country where the state system shows a profit after payment of operating expenses and interest on capital follows because Prussia bought the railroads at a most opportune moment, and has been powerful enough to maintain a scale of rates unaltered over a long period of years. When it comes to railroad tariffs, no country has gone as far as Prussia in giving advantage to the big shipper over the small man."

State Ownership in Italy.

Referring to Italy, Mr. Acworth said: "It has tried state ownership and operation, private ownership and operation, state ownership with private operation, and now, for the last ten years, it has reverted to both ownership and operation by the state." The Italian parliament on April 22, 1905, determined to take over the railways of Italy. In the first year of nationalization the operating ratio was 73.4; in no subsequent year has it fallen below 79.5, and for the three years, 1911-1913, it averaged 84.4 Each year shows a substantial advance in operating costs over the year preceding it. The figure in the first year of the period was $57,885,600; in the last it is $102,264,560, an increase of over 78 per cent. He continued:—

"The final result is that whereas in the financial year 1906-07 the railways paid over to the treasury $9,796,366 as a return on a capital of $1,091,404,045, which is roughly, 1 per cent., in the last year they only returned $5,402,656 on a capital that meanwhile had risen to $1,374,975,952, which is, roughly, two-fifths of 1 per cent. In at least two cases just before the war, concessions had been granted to a private enterprise which was to take over a portion of the existing state railway, to build an extension with the help of a substantial state subsidies, and then work on its own account both sections as one undertaking.

"Australia furnishes the most conspicuous instance of railway construction by the state, because private enterprise refused to undertake the task. Speaking broadly, the seven separate states which make up Australia have 20,000 miles of railway owned and worked by the respective governments. And it must be frankly said that public opinion is entirely in favor of the system. Having regard to the well-known fact that state socialism has been carried further in Australia than in any other part of the world, this is not surprising."

Australian Rates Excessive.

Ton-mile rates on the state railroads in Australia are excessive compared with other countries, said the witness. In two states they average 2.20 and 2.12 per ton-mile. The corresponding private railroad rate in Canada is only 0.75 cent and in the United States 0.73 cent. A mixed system of state and private ownership prevails in Russia, Austria and India, owing mainly to political and military reasons. Referring specifically to one company, which had paid an average dividend of 12 per cent. for five years previous to its acquisition by the Austrian government, Mr. Acworth quoted the president of the Austrian chamber of deputies in describing the result of the state's administration up to 1910. Said that official:—

"We have always been in favor of the state taking over the railways, but if we had been able to foresee the results of the management, I assure you we would have hesitated a little longer. We are still in favor of the principle, but it does seem to us that our government has performed a remarkable feat when it has succeeded in creating a deficit on the Northern Railway. The government have enlisted an army of new employees; they have gone much too far in the reduction of hours of labor; instead of commercial management, they have appointed lawyers to posts that require business men or experts; they have established an entirely unpractical bureaucracy. At the present moment we are face to face with a deficit of $25,000,000. There would be no deficit at all if the return from our railways were that which it ought to be. I repeat that absolute imbecility has characterized the taking over of our railways. We must introduce business ideas into the government service."

Private Railways in Russia.

Of late years in Russia the tendency seems to be in the direction of private railroad enterprise, subsidized and closely controlled by the government. Continuing, Mr. Acworth said:—

"While in Holland some of the most important lines were built by the state, the operation has always been wholly in private hands. In 1908 a motion in parliament in favor of nationalization was brought forward and defeated. A parliamentary commission to investigate the question was subsequently appointed and reported unfavorably. The financial result to the state is not over satisfactory, but is due largely to the competition of the rivers and canals, which intersect the country. The railways have to depend mainly on passengers and high-class freight for their income.

"For more than 30 years the French government have owned and worked a system of lines in the central west of France. The financial results were very unsatisfactory—the operating ratio over a series of years ranged between 72 and 83 per cent. Among the great companies much the weakest financially is the Western. Year after year the French government had to find a considerable portion of the dividend for this road. During the last ten years of company manage-

ment the state had to pay an average of $2,894,280 a year to meet its liability under the dividend guarantee. During the first three years after the transfer of this road to the government, the latter had to pay $6,753,320, $8,875,792 and $14,934,484, respectively. For the year 1913 the figure was $14,752,237."

Moreover, the service to the public was absolutely demoralized, and compensation for accidents, loss and damage rose from an average of $400,000 under company rule to $2,045,291 in 1911. The minister of public works criticized the state administration as a "frightful fraud," said Mr. Acworth, and the senate passed a resolution referring to "the deplorable situation of the state system, the insecurity and irregularity of its workings."

In 1897 Switzerland took over all the railways of the country. Immediately an increase in expenses was noted, due to higher wages and reduced working hours. In three years, after meeting operating expenses and the charges of the debt, there was an accumulated deficit of over $2,500,000. In 1900 the ton-mile rate was slightly under 3 cents a mile; in 1911 it was slightly over. At the date of the last account, so far from being reduced, the sum paid for the acquisition of the railways had risen $270,000.

CANADIAN DES MOINES STEEL CO., LIMITED.

The Pittsburgh-Des Moines Steel Co., of Pittsburgh, Pa., and Des Moines, Iowa, has purchased the property of the Chatham Bridge Co., 298 Inches Ave., Chatham, Ont., and has incorporated the Canadian-Des Moines Steel Co., Ltd.

The Chatham plant has been enlarged and completely equipped to handle all standard types of steel structures, including mill buildings, office buildings, fire escapes and bridges. The company will make a specialty here, as in the United States, of the manufacture and erection of elevated steel tanks for municipal, industrial and railway service, and other special structures such as standpipes, storage tanks, smoke stacks, barges and coaling stations.

The risers of the elevated tanks are enclosed in wooden frost cases and the water is prevented from freezing by a steam coil in the tank or by a special heater which takes water from the base of the riser and heats it and delivers it through a separate pipe into the tank. This method of heating may utilize exhaust steam from a power plant.

Another specialty of the company in the United States has been the manufacture of wireless telegraph towers. Towers from 100 ft. to 600 ft. high have been built for the United States Government at various stations.

All steel for delivery in Canada will be fabricated at the Chatham plant, and all sales will also be handled from Chatham.

NIAGARA FALLS POWER COMPANY.

The annual report of the Niagara Falls Power Company states that all permitted means have been taken to meet the rapidly increasing demand for power. Two additional generating units in the Canadian plant have been completed and placed in service. A third unit is now in process of being added. The management points out that the rapid increase in power use in Canada has led the government considerably to reduce its permits for the exportation of Niagara power, and adds: "The export license of our Canadian company has been reduced from 75,000 horse-power to 30,000 horse-power. We have, therefore, been obliged to withdraw 45,000 horse-power from United States industries, despite insistent demands."

In Alpena, Mich., the death rate from typhoid fever ranged from 30 to 95 per hundred thousand population, each year from 1900 to November, 1915, when a liquid chlorine plant was installed. In the first twelve months of operation of the chlorinator there were only 11 cases of typhoid fever and only one death, and of these cases it was known that at least five were contracted outside of the city. Instructions to the people to boil the water had not been regarded sufficiently by all the people, and sterilization of the whole supply was found to be the only positive safeguard.

HERRON BROS. vs. CANADIAN STEWART CO.

In *The Canadian Engineer* of May 24, 1917, it was stated that Justice Masten had given judgment in favor of the plaintiffs in the suit of Herron Bros. vs. Canadian Stewart Co. to recover 90 per cent. of the price of piles said to be delivered to the defendant. That item was copied from Toronto daily newspapers, there being no reason to doubt its accuracy. The Canadian Stewart Co. have subsequently afforded *The Canadian Engineer* an opportunity to read the full judgment, however, and it is desired to correct the previous item, as from the judgment it appears that no amount was awarded to Herron Bros., but that a declaration was made that the plaintiffs might make reference to a master regarding the accounts between themselves and the defendants generally and on the questions raised by the defendants' counterclaim; the master to report specially as to whether the piles or any of them which were rejected in August, September and October, 1915, by the Department of Public Works, were so rejected in consequence of defects existing at the date of delivery to the defendants or whether they were rejected in consequence of deterioration which arose after delivery.

Justice Masten's judgment concludes as follows: "The defendants (the Canadian Stewart Co.) succeed on the main issue now before me and are entitled to costs down to and including the trial, but excluding any cost of the issue relative to the agreement of March 31st, 1916. If a reference is taken, further directions and costs subsequent to the trial are reserved."

Herron Bros. wrote to the Canadian Stewart Co. on November 14th, 1914, saying: "We quite realize under the conditions of our contract that we have to replace any piles that have been culled or may be culled by the government engineer or his inspectors, and we have not the slightest inclination to avoid any responsibility in the matter—all we ask is fair treatment."

In his summing up, Justice Masten says: "We have no written repudiation or limitation by the plaintiffs of the letter of November 14th, 1914, until after the catastrophe in July, 1915. But I am of the opinion that upon receipt by the defendants of the piles when unloaded at the cars, the property in the piles passed to the defendants, and the piles were then in their custody and at their risk so that they are chargeable with any subsequent deterioration, but subject always to defendants' right to return any pile and require it replaced if subsequently rejected by the government engineer in consequence of defects existing at the time of its delivery by the plaintiffs to defendants."

CANADIAN CAR AND FOUNDRY COMPANY.

The statement of the Canadian Car & Foundry Co., covering the year ending Sept. 30th, 1916, it is understood in Montreal circles, will not show any results from the Russian contracts, as at that date the business was not completed, but at the annual meeting, in July, the management will be in a position to give the shareholders full particulars as to the profits made on the Russian business. The statement to be issued covers the Canadian business and it is intimated that profits, after bond interest and depreciation, will be around $375,000.

PROTECTING THE WATER SUPPLY.

The beneficial effect of proper supervision, and particularly of maintaining forest growth, in waterworks catchment areas, is being more fully recognized. A recent example is in the state of Pennsylvania, where the Commissioner of Forestry urged the planting of trees on those portions of their waterworks catchment areas not useful for agriculture. Favorable replies were received from one-half and, of the remainder, over 100 had no land requiring planting. To those who replied favorably, all planting facilities were afforded, including the services of a forester, and seedlings were offered at bare cost of packing and shipping, about 50 cents per 1,000 seedlings delivered. Applications were made for a total of 446,100 young trees for use on about 230 acres.—(By Leo G. Denis, in "Conservation.")

Editorials

CANADIAN SOCIETY OF CIVIL ENGINEERS IN THE MARITIME PROVINCES.

In 1887 the Canadian Society of Civil Engineers was established in Montreal, but no branches of the society were organized for eighteen years, or until 1905, when the first branch was founded in Sydney, N.S., with fourteen members.

Geo. H. Duggan, general manager of the Dominion Bridge Co., and immediate past president of the society, was one of the active organizers of the branch at that time. Those were booming times in the Nova Scotia steel and mining industries, however, and the branch survived only one year, business apparently having too great a demand upon the members' time for them to be able to devote any attention to the society meetings.

In 1906 the Toronto Branch was organized, and this was rapidly followed by others from Quebec to Victoria, so that there are now ten branches of the society, with a total branch membership of approximately one thousand. However, the Maritime Provinces, where the branch idea started, remains without a branch, as there is no such organization east of Quebec.

Mr. Duggan's presidential address, read before the society last January, showed that there were 252 corporate members (members or associate members) in the district east of Montreal, or 11.9 per cent. of the total corporate membership of the society. An analysis of the 1916 list of members shows that there are 138 corporate members, or approximately 6.6 per cent. of the corporate membership of the society, resident in the Maritime Provinces or Newfoundland.

It is obvious that there should be a branch of the Canadian Society of Civil Engineers in the Maritime Provinces, not only on account of the number of members living there, but more especially on account of the very great importance of the big engineering industries in those provinces. A live branch would no doubt attract some of the many engineers working in the Maritime Provinces who are not as yet affiliated with the society. *The Canadian Engineer* understands that E. G. Horne, A.M.Can.Soc.C.E., of St. John, N.B., is endeavoring to establish a branch at either St. John or Halifax, or possibly a joint St. John-Halifax branch, and it is to be hoped that all members of the society will give their earnest support to Mr. Horne and those associated with him in the effort.

POLITICS UBER ALLES!

Politics appears to have the upper hand of patriotism at Ottawa. Despite the railway situation and the many other problems which require urgent attention, it seems that parliament is about to dissolve and to plunge the country into the throes of an election.

Sir Wilfrid Laurier blames Sir Robert Borden for the failure of attempts at coalition, and Sir Robert places the blame upon Sir Wilfrid's shoulders. The average engineer, contractor or business man in general will be inclined to blame both of them for not sacrificing their own and party interests to a sufficient extent that all outstanding differences be settled by some means.

England early found the necessity of a national government in time of war, but Canada, after nearly three years of war, has yet to learn how to forget party politics and fight shoulder to shoulder.

Next to the war, the most important matter before parliament is the railway problem. The delay which must necessarily ensue in the settlement of this problem will not be to the benefit of the shippers of Canada or of the people generally. Apparently there will be no parliamentary relief during the coming winter for the freight congestion troubles.

The system upon which our government is founded does not very well admit of a third party. The whole working of the government is based upon the assumption of a two-party House of Commons. Were it not for this, the business men of the country no doubt would be strongly tempted to organize a third party to take part in the coming election—a National Party which would appoint lawyers to legal positions, business men for business executive jobs, and engineers where engineering executive work is required.

BUSINESS IN QUEBEC

A number of Canadian firms seem to recognize the value of the French language as an aid to developing trade with Quebec province. Aside from racial and political considerations, many firms in Ontario and elsewhere tell *The Canadian Engineer* that their business has greatly increased as a result of printing their catalogues and circulars in the French language for circulation in that section of the country. Instances are known where letters in English have been thrown away by the recipients without any effort to ascertain their contents; the same applies to catalogues and other advertising matter printed in English. An inquiry recently made by *The Canadian Engineer* yields the general opinion that as there are many country districts in the province where French is practically the only language spoken, it is obvious that the use of the French language should be a factor in increasing sales there.

An Ontario correspondent relates his business experiences in Quebec and points out that to get the best results in doing business anywhere, one must speak the language that is best understood. For that reason, it is well that the language of the country into which a person goes to do business should be known by him. Besides a knowledge of the language, it is well to have some knowledge of the habits, customs and characteristics of the people. Personality also has a strong influence in doing business. Some interesting opinions on this subject were received.

It is often said that French-Canadians do not speak the "genuine Parisian French." According to Mr. Leon Lorrain, secretary of the Montreal Chamber of Commerce, there is not such a thing as Parisian French. "In Paris, Montreal, Quebec or any other French-speaking centre," he says, "people speak more or less correctly according to the education they have received; but they speak French. In a parallel case, the English language, though spoken with a different accent in each country, is still the English language, understood by all."

PERSONALS.

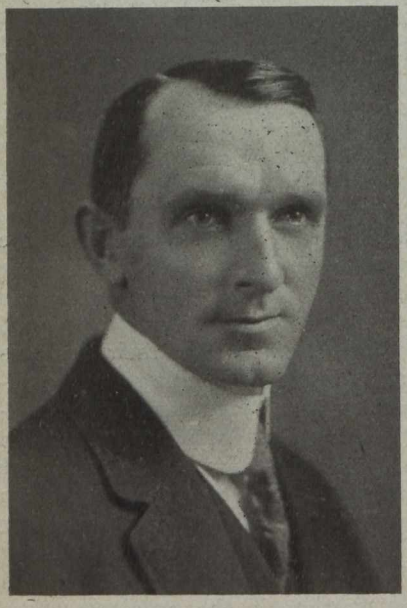
REGINALD H. BALFOUR, B.A.Sc., has been appointed sales manager of the Eugene F. Phillips Electrical Works, Ltd., Montreal. Mr. Balfour is a graduate of McGill University and an associate member of the Canadian Society of Civil Engineers. He was formerly engineer for the Montreal Electrical Commission.

JAMES B. BEGG, road superintendent of Victoria County, Ont., has resigned.

MARCEL C. J. BEULLAC, B.Sc., M.Can.Soc.C.E., who has been an officer in the French army for the past two and a half years, has been invalided home and has rejoined the city contracting office of the Dominion Bridge Co. at Montreal.

W. M. BREWER was elected chairman of the Western Branch of the Canadian Mining Institute at its recent meeting held in Victoria, B.C.

LAWFORD GRANT has been appointed managing-director and treasurer of the Eugene F. Phillips Electrical Works, Ltd., Montreal. Mr. Grant came to Canada in 1907 as president and managing-director of the Canadian British Insulated Co., Ltd. In 1913 he accepted a position as assistant manager of the Phillips Company, and now succeeds Geo. H. Olney, who was the head of that firm for eighteen years, Mr. Olney having recently retired owing to ill health. Mr. Grant is a civil and electrical engineer, and was formerly engineer for the British Insulated & Helsby Cables, Ltd., of England. Among the many large undertakings which he carried out for the latter company was the electrification of the government dock yard and naval base at Malta. The Phillips plant is in size among the first half-dozen of the insulated wire and cable works on this continent.



M. DONALDSON, M.Can.Soc.C.E., vice-president and general manager of the Grand Trunk Pacific Railway Company, is reported to be seriously ill in a Montreal hospital.

Capt. A. DOUGLAS FISKEN, reported wounded and gassed, was educated at Trinity College School at Port Hope and at the Military College, Kingston. After graduating in 1910, he was employed as an engineer in New York City until war broke out, when he returned to join the Canadian forces.

Flight-Lieut. O. J. GAGNIER, reported wounded, graduated with the 1917 class in applied science in civil engineering at McGill University. He took his preliminary course at Long Branch, Ont., last year, then went overseas to join the Royal Naval Air Service.

W. H. BREITHAUPT, M.Can.Soc.C.E., has been elected chairman of the new town-planning commission at Kitchener, Ont. NORMAN C. HELMUTH was appointed as secretary.

JOHN D. GALLOWAY, assistant mineralogist, Department of Mines, Victoria, B.C., has been appointed engineer for the Northeastern Mineral Survey district with headquarters at Hazelton. Mr. Galloway is a graduate of McGill University.

WM. WREN HAY, Jr. Can. Soc. C.E., is now in training at Camp Funston, Texas, having been examined and recommended for commission in the Engineer Reserve Officers Corps, United States Army, as first lieutenant. Mr. Hay has been for two years on duty in the office of the Department Engineer, Southern Department, at Fort Sam Houston and El Paso, Texas.

ED. HOLGATE, of the engineering staff of the Structural Steel Co., Limited, Montreal, has joined the engineering staff of MacKinnon, Holmes & Co., Limited, of Sherbrooke, Que.

J. A. JAMIESON, a well-known consulting engineer of Montreal, who was very badly injured some time ago in a street accident, is recovering nicely although still confined to his home.

HOWARD KELLY, vice-president of the Grand Trunk Railway Company, has been appointed acting president, E. J. CHAMBERLIN, president, having been granted leave of absence.

Lieut. W. G. McGHIE, a graduate of the Faculty of Applied Science and Engineering, University of Toronto, class 1911, has been awarded a medal by the Italian government for bravery. Lieut. McGhie was formerly with the Canadian Crocker-Wheeler Company, St. Catharines, Ont., and went to France with the 35th Battalion.

Capt. F. H. MOODY, formerly editor of "Canadian Railway and Marine World," Toronto, has been reported wounded on May 26th. He is a graduate of the School of Practical Science, Toronto, and a junior member of the Canadian Society of Civil Engineers. He went overseas last summer with an Ontario county battalion as major, but reverted in order to get to France.

Lieut.-Col. STRATTON H. OSLER, of Cobourg, Ont., has been awarded the Distinguished Service Order by the British War Office. Col. Osler attended the Royal Military College at Kingston and also McGill University, where he took a course in engineering. He went overseas with the Royal Canadian Engineers in command of a company in the 2nd Canadian Division and was promoted on the field to lieutenant-colonel for his efficient work.

Lieut. WILLIAM B. PENNOCK, a graduate in Civil Engineering of McGill University, class 1915, is reported wounded. After securing his degree, Lieut. Pennock qualified for a commission at Ottawa and, after reaching the front, was posted to a field company of engineers. Some months ago Lieut. Pennock was mentioned for bravery and it was reported that he had been recommended for the Victoria Cross in recognition of his gallantry. His home is in Ottawa.

T. E. PRICE, A.M.Can.Soc.C.E., for the past five years resident engineer on the Vancouver division of the Canadian Pacific Railway, has joined the Railway Construction Corps and has been given a commission as lieutenant. He is a graduate of McGill University.

Hon. ROBERT ROGERS, minister of Public Works, Federal Government, has been relieved of his duties at his own request, pending the report of the commission appointed to investigate the Galt findings.

Pte. ROBERT JOHN THOMPSON, who was a student of the School of Practical Science at the time of enlistment, and who was wounded last September, was again wounded by gunshot in the face recently. He is 20

Barrett Specification Roofs

Made in Canada

Long service at low cost—

MANY buildings have just "roofs." The contractor says, "I'll build you a pitch-and-felt roof," and he does so.

It may be a *good* roof or it may be a *poor* one, yet a pitch-and-felt roof is the best and most economical roof for any building, *provided it is built right.*

There is one sure way to eliminate all guess-work and chance—incorporate The Barrett Specification in full in your building plans and employ a responsible roofing contractor to do the work.

The result will be a roof which will give satisfactory service for twenty years and upwards. The unit cost (the cost per square foot per year of service) of a Barrett Specification Roof is lower than that of any other permanent roofing.

No other roof covering known can even approximate this figure.

Remember that a Barrett Specification Roof is not a ready-made roofing. It is constructed on the building and is recognized as *standard* by technical men generally.

These roofs take the base rate of fire insurance.

Our 20-Year Guaranty Bond

We are now prepared to give *without charge* a twenty-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.*

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.

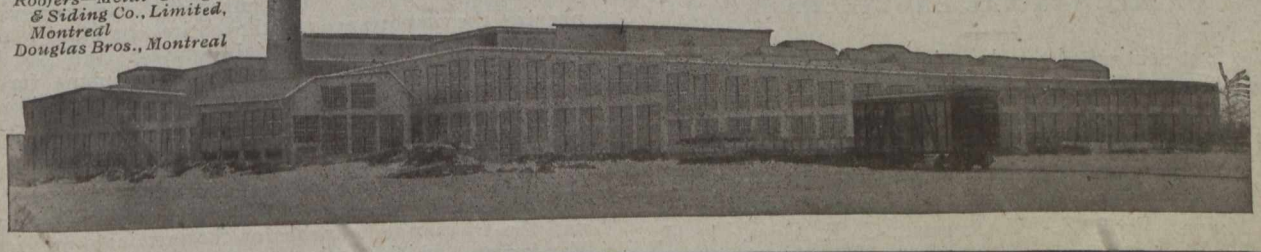
Write to our nearest office if you wish any further information regarding this Guaranty.

Barrett Specification Roofs on the ARMSTRONG-WHITWORTH COMPANY'S NEW TOOL STEEL PLANT LONGUEUIL, QUEBEC
Engineer—M. J. Butler, Montreal, Quebec
General Contractors—E. G. M. Cape & Co., Limited Montreal; John Quinlan & Co., Westmount, Quebec
Roofers—Metal Shingle & Siding Co., Limited, Montreal
Douglas Bros., Montreal

A copy of The Barrett 20-Year Specification, with roofing diagrams, free on request. Address our nearest office.

THE PATERSON MANUFACTURING COMPANY, LIMITED
MONTREAL TORONTO WINNIPEG VANCOUVER

THE CARRITTE-PATERSON MANUFACTURING CO., LIMITED
ST. JOHN, N.B. HALIFAX, N.S. SYDNEY, N.S.



years of age and a son of Mr. W. J. Thompson, 197 Wilton Avenue, Toronto.

JOHN WILLIAM SEENS, B.Sc., C.E., general manager of the Structural Steel Co., Limited, Montreal, has joined the engineering staff of the Canadian Bridge Co., Limited, of Walkerville, Ont., the plant of the Structural Steel Co. having been taken over by the Montreal Locomotive Works, Limited.

R. TALBOT has been placed in charge of concrete caisson work at Three Rivers, Que., for the Shawinigan Water & Power Co.

HENRY HAGUE VAUGHAN, M.Can.Soc.C.E., who was recently appointed to a high executive position with the Dominion Bridge Co., has now been made general manager of the company. Mr. Duggan, the former general manager, becomes chairman of the Board of Directors, and also retains the title of chief engineer of the company. Mr. Phelps Johnson is president of the firm.

Lieut. J. A. GORDON WHITE, mentioned in the last cabled list of those awarded the military cross, enlisted while employed on the staff of the Hydro-Electric Power Commission of Ontario. He is a graduate in engineering of McGill University and a student member of the Canadian Society of Civil Engineers.

JOHN WILSON, of the engineering staff of the Structural Steel Co., Limited, Montreal, has joined the contracting-engineering staff of the Dominion Bridge Co., Limited, at Lachine, P.Q.

OBITUARIES.

Lieut. CLARENCE HOBART McDOUGALL, who was killed in action early in May in the battle of Arras, was born at South Maitland, N.S., in September, 1878. He entered the Faculty of Science, McGill University, in 1900 and in 1905 was graduated in mining engineering. Previous to enlisting as a lieutenant in the Canadian Engineers he was superintendent of the Sullivan and St. Eugene mines at Marysville, B.C.

JAMES SPELMAN, aged 56, president of the John S. Metcalf Co., Limited, engineers and grain elevator contractors, died on May 27th, after a few days' illness, at his residence in Montreal. Death was due to pneumonia. Mr. Spelman was an authority on the design and construction of grain elevators, and his firm have drawn plans for several of the largest in Canada, notably in Montreal and St. John. The firm's activities also extended to Great Britain and Russia. Mr. Spelman recently returned from Australia, where he was in consultation with the government in reference to building a system of elevators. He was elected a member of the Canadian Society of Civil Engineers in 1902, and at one time read a paper on grain elevators before the society.

ONTARIO SECTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The first section of the American Society of Mechanical Engineers outside of the United States was established recently at Toronto. The council at its last meeting approved the petition of the members in the province of Ontario for permission to hold meetings. The executive committee of the Ontario Section, as it will be known, are G. V. Ahara, Prof. R. W. Angus, C. R. Burt, I. H. Fletemeyer and C. B. Hamilton.

Coast to Coast

Calgary, Alta.—In an effort to overcome the strike of the telephone plant men the Provincial Government has made a contract with the Northwest Engineering and Supply Co. to take over all the outside work for the provincial plants throughout the province. The company has now offered the striking men what they demanded of the government, but the men have not yet decided whether to accept this offer or not. They state they do not like the scheme.

Halifax, N.S.—The Halifax Shipbuilding Company has been incorporated with a share capital of $3,000,000.

Kitchener, Ont.—The newly-appointed City Planning Commission appointed W. H. Breithaupt as chairman, and N. Helmuth as secretary-treasurer.

London, Ont.—The agreements between the Utilities Commission and the Southern Ontario Gas Company for a supply of natural gas will be signed, and the laying of mains commenced shortly. The pipe has been ordered. The fact that natural gas is coming has given a stimulus to manufacturing here. Beattie Bros., Fergus, who have a big foundry on York and William Streets, will move their whole plant to London because of this fact. Plans for a $40,000 factory in Chelsea Green have been prepared, and others are planning to increase the capacity of their plants. It is expected that by November at least one million feet of natural gas will be used here.

Montreal, Que.—The Canadian Pacific Railway has 2,000 cars under construction at the present time. They will be distributed to all parts of the system. In addition, twenty-five new Decapod locomotives are being built for use on the mountain division.

North Toronto, Ont.—Work on the Leaside Aviation Camp will be completed within a few weeks. Another military aviation camp for Toronto will be laid out immediately at Ridley Park, North Toronto. The construction of this one is also to be rushed.

Ojibway, Ont.—It has been announced that the United States Steel Corporation has appropriated to date the sum of $9,000,000 for the building of the Canadian plant here, the information to this effect being given out by Judge Gary. The total investment which the steel company will make at Ojibway will certainly be $20,000,000, and it is believed that this large amount will be greatly exceeded within a decade.

Peterboro, Ont.—The municipalities between Trenton and Lindsay will petition the Government to open the southern section of the Trent Canal this summer. This would necessitate the construction of a new G.T.R. bridge at Campbellford.

Port Colborne, Ont.—According to President Monell of the International Nickel Company, the refinery being erected here will cost $5,000,000, and will be ready for operation by the beginning of 1918.

Toronto, Ont.—Hon. F. G. Macdiarmid, Minister of Public Works and Highways, together with W. A. McLean, Deputy Minister of Public Highways, and representatives of the daily and agricultural press, completed a tour of inspection over a large portion of the county roads systems which have been improved under the provisions of the Provincial Highway Improvement Act, in the counties of York, Simcoe, Peel, Wellington, Waterloo, Oxford, Brant, Wentworth and Halton. Two days were occupied by the inspection of over 300 miles of the good roads system and particularly the portions which link Toronto, Barrie, Cookstown, Alliston, Primrose, Orangeville, Guelph, Galt, Preston, Kitchener, Tavistock, Woodstock, Brantford and Hamilton, and the Hamilton-Toronto cement highway. The purpose of the tour was to emphasize the importance to the entire community of a well organized system of commercial highways, and to indicate the important part which an extensive programme for the construction and betterment of public highways within the province may have in meeting conditions which are likely to prevail after the war.

Victoria, B.C.—An order compelling the Canadian Northern Pacific Railway Company to complete the construction of its Victoria-Barclay Sound line on Vancouver Island, and the Okanagan branches or the terminals at Victoria and Vancouver, which under contract with the province, it promised to carry through.

UNDERGROUND CABLES

LOW OR HIGH TENSION

For

Lighting, Power, Street Railway, Telephone or Telegraph Transmission

ARMOURED CABLES
for street lighting

PAPER INSULATED CABLES
of all descriptions

RUBBER INSULATED CABLES
to every specification

BARE AND WEATHERPROOF WIRES AND CABLES

GALVANIZED IRON WIRE AND STRAND

MAGNET WIRE, FLEXIBLE CORD, Etc.

PHILLIPS' Wires and Cables are made in Canada. But we do not appeal to the "Made in Canada" sentiment in offering our products, because we feel that there is a much better reason why you should buy from us, and that is because no firm—in any country—is making wires or cables that are superior to ours. The reasons for this are:

1—Our experience of over a quarter of a century.

2—Our careful selection of skilled workmen, many of them sons of our older employes.

3—Our well-organized chemistry department, which closely co-operates with a skilled purchasing agent and permits no material, except the very best, to enter our works. We use the best of pure new English lead, the finest of Sea Island yarns and Italian silks, the highest grades of asbestos, etc.

4—Our modern machinery, which includes every known mechanical device needed to produce perfect wires and cables of every kind.

Prices etc. on request.

EUGENE F. PHILLIPS

ELECTRICAL WORKS, LIMITED

Head Office and Factory: MONTREAL

BRANCHES: Toronto Winnipeg Regina Calgary Vancouver

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
Del Bonita, Alta., erection of school	June 15.	June 7.	50
Dufferin, Man., construction of pile bridges	June 15.	June 7.	48
Perth, Ont., improvements to school building	June 23.	June 7.	52
Rumsey, Alta., erection of school	June 20.	June 7.	52
Swift Current, Sask., centrifugal pump	June 19.	May 31.	54
Toronto, Ont., construction of sewers	June 18.	June 7.	54
Toronto, Ont., construction of sidewalk	June 18.	June 7.	54

BRIDGES, ROADS AND STREETS.

+—Adamsville, Que.—Contract awarded by the Municipal Council to the DOMINION BRIDGE CO. for steel required for a $10,900 concrete and steel bridge.

Arranvale, Ont.—Plans are in progress for a steel bridge for the Grand Trunk Railway Superintendent, Mr. Fysh, Stratford.

Batiscan, Que.—Council plans macadam roads costing $16,000. Clerk, Jules Fugire.

Bertie Tp., Ont.—Tenders will be received by M. S. Pound, Clerk, Ridgeway, Ont., until 12 o'clock noon on Monday, June 18th, 1917, for the construction of a concrete flat top bridge 39 feet long, 14 feet wide with centre abutment, over Black Creek.

Burnaby, B.C.—The municipality has received a government grant of $15,000 for work on the Barnet Rd., but it is stated that nothing will be done on the road until an engineer has been procured.

East Williams, Ont.—Tenders will be received by the clerk, Wm. McCallum, Nairn, until June 23 for the erection of a 36-foot steel bridge.

Guelph, Ont.—City Council passed by-law for the paving with reinforced concrete of Liverpool St., between Norfolk and Dublin Sts. City Engineer, F. McArthur.

London, Ont.—Charles Talbot, Engineer of Middlesex County, reported that $12,000 will be needed for road maintenance this year.

Lucan, Ont.—Middlesex County Council granted $1,400 for the improvement of Main St. here. Clerk, Walter L. Gibson.

Montreal, Que.—City Council proposes to widen St. Denis St. to permit the construction of a new subway beneath the tracks of the Canadian Pacific Railway Co.

Peterboro, Ont.—City Council decided to construct sidewalks on the following streets: Chamberlin, Murray, Mark, Dublin and Monaghan Rd. City engineer, R. H. Parsons.

Port Dover, Ont.—Town Council plans swing bridge. Clerk, James Sloan.

+—Sandwich, Ont.—CHICK CONTRACTING CO., McDougall St., Windsor, have been awarded contract for reinforced concrete pavement costing $14,600 by the Town Council.

Ste. Genevieve de Batiscan, Que.—Municipal Council contemplate gravelling of roads at a cost of $30,000. Clerk and secretary, Tancrede Trudel.

+—St. Leon de Standon, Que.—WM. NADEAU has been awarded the general contract and the EASTERN CANADA STEEL & IRON WORKS, LTD., St. Malo, the steel contract for a $9,700 concrete and steel bridge for the Municipal Council.

+—St. Pierre, Que.—Municipal Council let contract to GEO. MADDEN, 822 St. Valier St., Quebec, for gravel roads costing $32,500.

+—Toronto, Ont.—Contract has been awarded to FOLEY & GLEASON, Ottawa, upon a percentage basis for the construction of three miles of asphaltic penetration roads at Leaside. This firm successfully carried out a contract last summer for between 2½ and 3 miles of similar roads at Camp Borden, where nearly 3 miles of concrete roads also were laid. About 2½ miles of asphaltic road were laid by the mixed method last March, but they were not so successful as were the penetration roads, probably due to the fact that they were constructed ostensibly over a broken stone foundation, but really over snow and ice, due to the urgency with which the roads were required.

Toronto, Ont.—Tenders addressed to T. L. Church (Mayor), Chairman, Board of Control, will be received up to noon, Tuesday, June 19th, 1917, for the construction of asphalt and granite block pavements, concrete curbing and concrete sidewalks. Specifications may be seen at the Works Department, City Hall.

Vancouver, B.C.—The executive committee of the Interstate Evergreen Highway Association has proposed the extension of the Evergreen highway, to run from Vancouver to the Mexican border at El Paso, Texas, a distance of 2,800 miles.

Winnipeg, Man.—Tenders, addressed to the Chairman, Board of Control, will be received at the office of M. Peterson, Secretary, Board of Control Office, up to 10 a.m., on Friday, June 15th, 1917, for the supply and delivery of 300 street cans, 22 gauge, either plain or corrugated galvanized iron. Specification may be obtained at the office of the Street Commissioner, 220 James Avenue.

(Continued on page 48.)

WATER, SEWAGE AND REFUSE.

+—Aurora, Ont.—Town Council let contract to G. E. HARTLEY, Oil Springs, for artesian well.

+—Belleville, Ont.—Contract awarded by the City Council to the TURBINE EQUIPMENT CO., LTD., Toronto, for the following: One De-Laval 6-inch two-stage centrifugal pump, direct connected to a 150 h.p. motor, having a capacity of 225 million gals. a day against 250 feet total head; 2 De-Laval 6-inch two-stage pumps. One to have a capacity of 1¾ million gals. a day, against 250 feet total head, and to be direct connected to 125 h.p. motor, and the other to have a capacity of 1,100,000 gals. a day, and to be direct connected to 100 h.p. motor.

Cap de la Madeleine, Que.—In connection with aqueduct, pumping station and reservoir for the Municipal Council, J. A. Grennon, Chicoutimi, wants prices immediately on hydrants, galvanized pipe, pumps, electric motors, cement, crushed stone and reinforcing steel.