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REPAIR OF INTAKE PIPE FOR CITY OF OTTAWA

RECLAIMING 40-INCH STEEL PIPE LINE LAID A QUARTER OF A CENTURY AGO IN THE OTTAWA RIVER—DESCRIPTION OF REMOVAL, REPAIR AND RELAYING.

By **L. McLAREN HUNTER, A.M.I.C.E.,**
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At the present time, when Ottawa is in the throes of a discussion of the pure water question, a short description, with illustrations, of the reclamation of the old 40-in. steel intake pipe in the Ottawa River might prove of interest. This pipe, which has lain in the bed of the river for approximately a quarter of a century, has been disconnected, raised, towed ashore, repaired and is now being relaid.

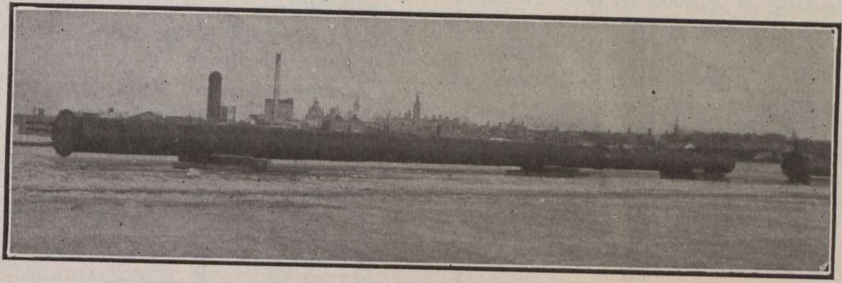

Fig. 1.—A Length of Pipe Ready for Relaying

The work was in two sections, the first of which was from the main pumping station to the shore of Nepean Bay, a distance of over 2,000 ft., and the second from that point across Nepean Bay and the Ottawa River to Lemieux Island, a distance of approximately 3,200 ft.

The first section presented comparatively few difficulties, as the pipe had been laid in an open aqueduct. This was emptied, after having been closed, by means of a coffer-dam at the one end and stop logs at the other. The pipe was then disconnected and each length of about 45 ft. was tested. The old cast iron flanges were then cut off and the rivets and seams caulked where necessary.

After this had been done the pipes were placed in the desired alignment and riveted together by means of steel sleeves so as to form one continuous pipe from the pump-house to Nepean Bay. Two cast steel manholes were placed on this section, to give access to the pipe, if necessary.

In order to overcome the buoyancy which such pipes, when empty, have in water, a series of arched reinforced concrete beams were placed at approximately 25 ft. centres.

At the river end of the aqueduct the old stop-log house, found to be in a dangerous condition, is being replaced.

On the river section more difficulties have been encountered. The first step was to raise the pipes, which

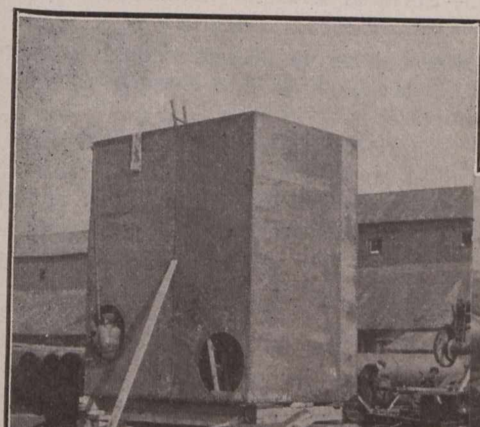

Fig. 2.
No. 4 Tank on Shore.

Fig. 3.
Launching 200 Ft. of Pipe.

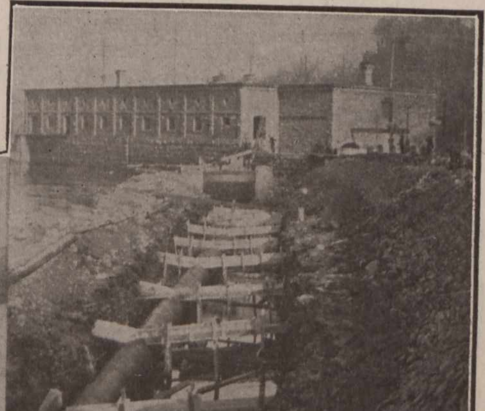

Fig. 4.
Pump House and Portion of Aqueduct

averaged 50 ft. in length. They were covered with bark and logs (from the lumber mills nearby) to a depth of 3 or 4 ft. Owing to inaccessibility it was found impossible to secure the ordinary floats or scows for lifting

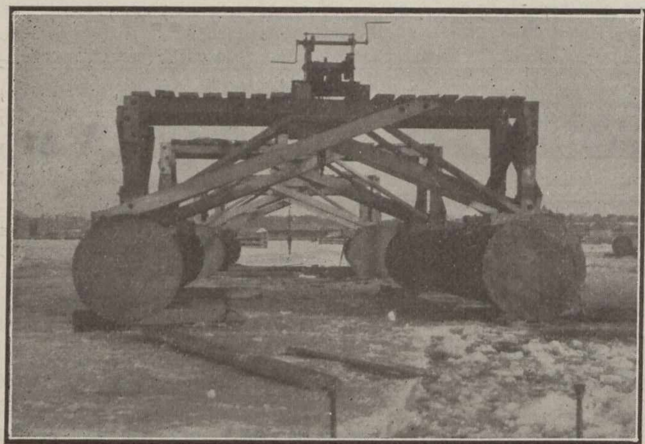

Fig. 5.—The Form of Pipe Float Used.

and taking the pipe ashore. The device used to overcome this difficulty was that of putting bulkheads on two lengths of pipe and erecting a gantry frame at either end, fitted with windlasses. This formed the pontoon

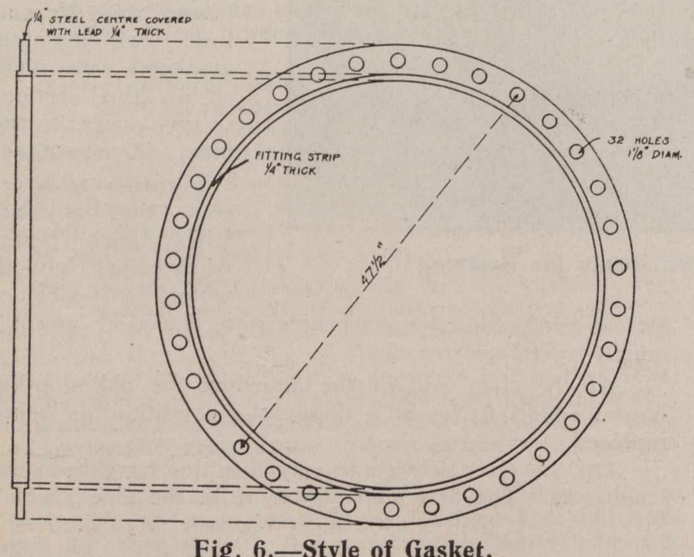

Fig. 6.—Style of Gasket.

illustrated in Fig. 5, 40 ft. in length, 15 ft. wide, with an open space between the pipes of 6 ft. It had a lifting capacity of approximately 13 tons.

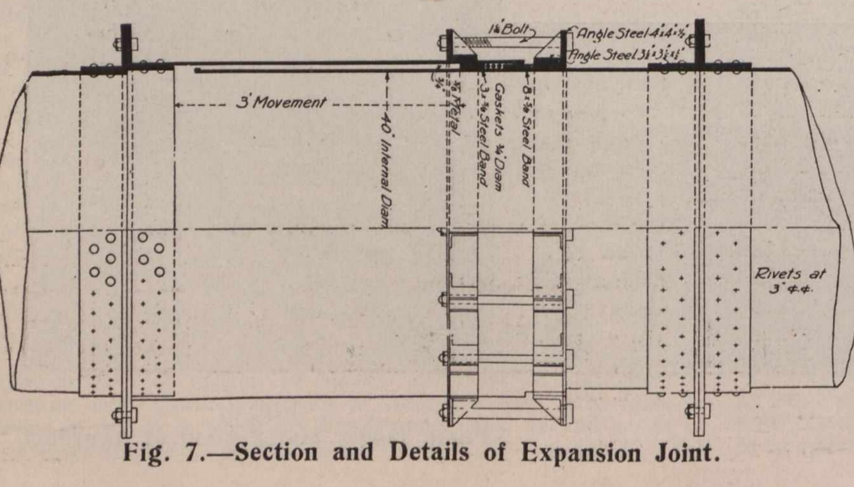

Fig. 7.—Section and Details of Expansion Joint.

This was then floated out over the old pipe, and divers disconnected the sections and placed a chain around either end. The pipes were then raised by the windlasses, emptied of water and a bulkhead put on each

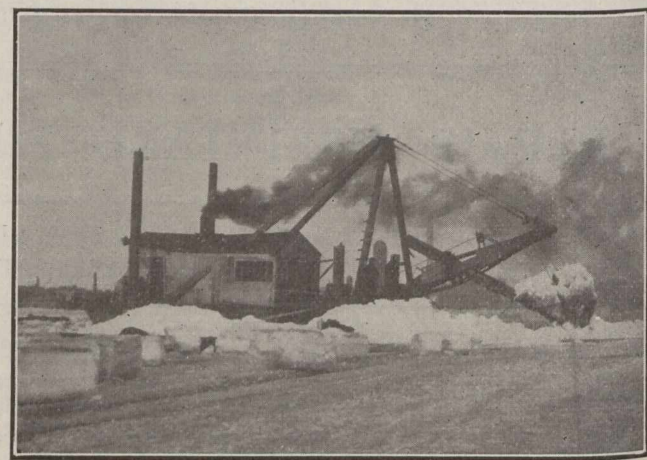

Fig. 8.—Dredging Anchor Ice.

end. They were floated ashore to a temporary repairing yard and repairs similar to those in the aqueduct were effected.

Four of these pipes were connected together by means of alternate plain and special flexible corrugated slews giving an approximate length of 200 feet. (See Fig. 1.) Then curved flanges were riveted on each end

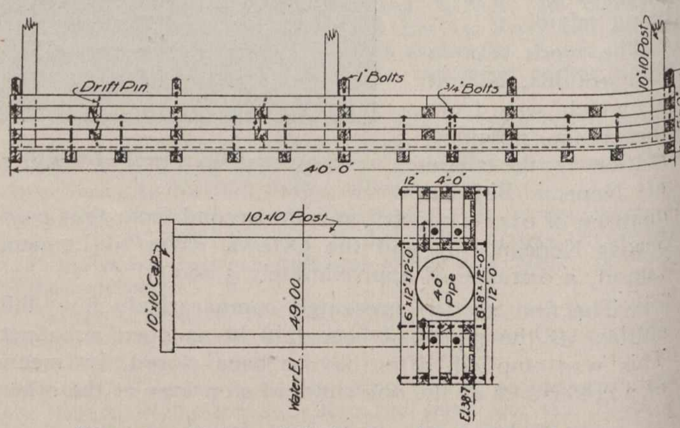

Fig. 9.—Form of Crib for Anchoring Pipes.

and the pipes tested to a pressure equal to twice the working head. All caulking and riveting was done by means of compressed air.

In the old pipe cast iron ball joints were used, but, not being found satisfactory, have been discarded altogether, and special angle pieces are being used instead.

There are 4 new piers being placed on the new pipe line, fitted with sluices. From piers Nos. 1 and 3 arrangements have been made to have cross connections between the 40- and 42-in. pipes. In the case of any accident one section of the pipe can thus be shut off while the remaining sections will be in commission. Pier No. 4, shown in Fig. 2 while under construction, from which there are four connections, was made-up on shore before floating out and sinking into position. This necessitated breaking into the 42-in. pipe, a length of which was lifted, cut to the proper length by the oxo-acetylene method, and then sunk and connected up. All such connections were made under water by divers. A slip joint fitted with graphite packing with a lead ring gasket was used in each connection. The type is illustrated in Fig. 6.

A special expansion joint with a free movement of 3 ft. is fixed on each section in the river. This will allow for any expansion or contraction, and will also be of great assistance at the pier connection. A section and detail drawing of this joint is shown in Fig. 7.

The new line is made so as to present an arch effect against the current in the river, thus relieving, as far as possible, the strain caused by anchor ice, etc.

Considering the length of time these pipes were in the river, their condition was marked, in that there was practically no corrosion. The buoyancy of the pipes in the river was overcome by means of wooden cribs, loaded with stone. Their general construction is illustrated in Fig. 9.

The work is being done by the Montreal firm of Loomis, McBean and Williams, at the contract price of $40,000, but with the extra work which has since been ordered this amount will be augmented by several thousand dollars.

The design and ideas of construction are those of Mr. Arch. Currie, city engineer of Ottawa, who recommended last July that the above procedure be undertaken, while Mr. A. N. Beer, assistant waterworks engineer, and Mr. Peter Carnochan are supervising the work of construction.

POWER DEVELOPMENT AT LONG LAKE, ALASKA.

Long Lake, which lies about two miles from the beach at an elevation of 727 ft., has an area of 3.1 square miles. It is situated near Speel River, between Ketchikan and Skagway, 35 miles southeast of Juneau, Alaska. A description of a project on foot to construct a 10,000-kw. plant appears in a recent issue of Western Engineering. Mr. E. P. Kennedy, assistant superintendent, Alaska Treadwell, G. M. Co., is the writer.

Water measurements for eight months and an estimate for the remaining four give a yearly run-off of 21,757 million cubic feet, and as the drainage area is taken at 32.4 square miles, the above run-off amounts to 24 ft., or an equalized yearly flow of 689 cu. ft. per second. The initial plant will use 300 sec.-ft., which is equivalent to a run-off of 10.4 ft. over an area of 32.4 square miles.

The power plant is to be situated near Second Lake, 2,000 ft. from and 535 ft. below Long Lake, and about 1½ miles from the beach. This plant will consist of two units, each of 5,000-kw. capacity and each to be direct connected to a water turbine utilizing 300 second-feet.

To be assured of a continuous flow of 300 sec.-ft., the lake will be drawn on by tapping with a tunnel or by a syphon to a depth of 12 ft., and the two spillways from the lake closed, thus raising the lake level 25 ft., giving an available storage of 37 ft. The cost of this power installation would be:

Power house with two 5,000-kw. units complete	$250,000
Pipe lines, two 60-inch with head-gates	93,594
Closing spillways from lake	10,000
Tapping lake	5,000
Contingencies and incidentals	3,000
Plant for construction	13,882
Total	$375,476

Or a capital cost of $37.54 per kilowatt or $27.95 per horse-power.

The cost of operating the above plant would be, per year:—

General expense	$ 6,000
Operating labor	6,000
Supplies, etc.	4,000
Total	$16,000
Operating cost per year per kilowatt	$1.60
Interest and depreciation, 8% on capital cost	3.00
Cost of kilowatt-year	4.60
Cost of horse-power-year	3.43

To be assured of a yearly average of 10,000 kw., the generators should be run at 25% above normal capacity for 6 months of the year while there is a large excess of water, and thus provide for unforeseen shut-downs.

Surveyed lake area is 3.1 square miles, or 86,423,040 sq. ft., requiring 20 ft. in depth at this area to provide for the required storage.

This storage is obtained by raising the lake level 25 ft. and drawing on the lake 12 ft. The increased area obtained by raising the lake will make up for the decreased area by drawing the lake and also provide sufficient storage below the 2 ft. of ice.

Power estimate is based on a pipe-line loss of 1%, water-wheel efficiency of 82%, generator efficiency of 93%; total efficiency of 75% from the water. Three hundred second-feet under 542-ft. head at 75% will generate 10,320 kilowatts.

From flow measurements the following figures are obtained:—

	Measured flow.	Required flow for 300 sec.-ft.	From storage.
January	324,187,200	803,520,000	479,332,800
February	283,046,400	725,760,000	442,713,600
March	374,976,000	803,520,000	424,544,000
April	352,512,000	777,600,000	425,088,000
May	1,154.390,400	803.520.000	....
June	2,947,104,000	777,600,000	....
July	5,340,729,600	803,520,000	....
August	4,860,492,480	803,520,000	....
September	4.473.792,000	777.600,000	....
October	803,520,000	803.520,000	....
November	518,400,000	777,600,000	259,200,000
December	324,187,200	803,520,000	479,331,800
	21,757,337,280	9,460,800,000	2,510,210,200

Detail of Construction Plant.

Horse tram from beach, 11,000 ft., 30-in. gauge, 20-lb. T-rail, 76 tons at $40 per ton	$3,040	
7,335 ties, 6 by 8 by 48 in., equivalent to 117,328 ft. B.M., at $14 per M.	1,642	
Labor and tools	3,000	
		$ 7,682
Gasoline tow-boat		2,000
2 barges at $3,000		6,000
1 donkey engine		1,400
2 horses		600
1 air-hoist		200
1 compressor with water-wheel and pipe for riveting		
Riveting hammers, etc.		2,000
Camp		1,000
Three cottages		2,000
Sawmill $600, cost absorbed in tram ties and cottages.		3,000
Total cost of plant		$25,882

Allowance for plant after 6 months 12,000
Charged to power installation 13,882

Detail of Pipe-Line for Long Lake 60-in. I.D.

Feet.	U.S. gauge.	Thickness, inches.	Safe lead.	Safe pressure.	Weight per ft.	Total weight.
500....	3/16	0.178	139	60	150.25	75,125
166....	1/4	0.250	185	80	197.50	32,785
166....	5/16	0.312	231	100	244.00	40,504
166....	3/8	0.375	277	120	291.25	48,347
166....	7/16	0.437	323	140	337.75	56,066
170....	1/2	0.300	370	160	385.00	65,450
331....	5/8	0.825	462	200	478.75	158,466
355....	3/4	0.750	555	240	572.50	191,787
Total						666,530

Velocity when carrying 300 sec.-ft., 8 ft. per second; loss per 100 ft., 0.225.

Weight of two lines, 1,337,060 lb.; and estimated cost erected is 7c. per pound.

The steel of which the above pipe is made will have an ultimate tensile strength of 60,000 lb. per square inch. Thickness of pipe is figured from the formula:

$$\frac{\text{Diam. in inches} \times \text{pounds pressure}}{2 \times 10{,}000}$$

which takes care of the efficiency of joints and allows a sufficient factor of safety. The weight of above pipe is obtained from the formula: weight in pounds per foot (12.5 times diameter in inches times thickness in inches) plus 10 lb. This weight takes care of laps, rivets, asphaltum, paint, etc.

RECLAMATION PROJECT IN CHINA.

It has been announced that the Chinese Government has authorized the issue of $20,000,000 of bonds for the future prevention of floods in the Huai River Valley in China, and that the J. G. White Engineering Corporation has been designated to undertake the construction of the works.

The project will require approximately six years to complete, and employment will be given to about 100,000 men. It will involve dredging the channel of the river and the Grand Canal; constructing dams and reservoirs to keep the Huai in its proper course, and to impound its surplus water and divert the streams flowing into the Huai, which, at the time of floods, greatly increase its overflow. The Huai River, for the greater part of its length, flows between banks that are elevated above the surrounding country, and in times past the river in overflowing its banks, has changed the geography of an entire province over night. During one of the flood periods, the Yellow River, which is a tributary to the Huai, switched the location of its mouth a distance of about 700 miles. Government records show that floods in this district have reduced the average number of crops from two in one year to two in five years.

Maps have been published recently at Tacoma, Wash., which shows that surveys for three railroads, starting at Grays Harbor and extending north into Olympic Peninsula, have been completed, the roads varying from about 110 to 125 miles in length. One survey was made for the Northern Pacific, one for the Union Pacific and one for the Chicago, Milwaukee and St. Paul Railway. The three surveys all parallel the coast and all touch the Quiniault Reservation.

PLANT, HIGHWAY AND LABORATORY INSPECTION OF BITUMINOUS MATERIALS.*

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BROADLY speaking, a comprehensive system of inspection of bituminous materials and pavements or roadways made from them may be subdivided as follows:—

1. Preliminary inspection of raw materials;
2. Inspection of materials and processes during construction work;
3. Inspection of finished work.

Preliminary Inspection of Raw Materials.—These are, or should be, assembled by the contractor sufficiently in advance of starting the work to permit of their being tested. They usually consist of refined asphalt or asphalt cement; residuum flux; crushed stone or gravel; sand; and filler. All of these materials should be sampled from deliveries actually on hand on the work. Except where the manufacture of the material is inspected at the refinery, this rule should never be departed from in the case of the bituminous materials themselves; i.e., the refined asphalt or asphalt cement and the residuum flux. In the case of the materials which constitute the mineral aggregate of the pavement or roadway, contractors are often unable to judge themselves whether or not a particular material passes the requirements of the specifications and before placing their order for them they frequently submit samples obtained from different dealers for approval. In the case of crushed stone or gravel, these samples usually fairly represent the kind of material which will be delivered. This is also true in the case of filler. With sands, however, samples submitted by the dealers frequently vary very greatly from actual deliveries. It often happens that the selection of sand has not been given sufficient attention or has been deferred until the last moment, with the result that no really suitable samples are submitted. In such cases it is frequently to the interest of all parties concerned, although perhaps not strictly the duty of the inspector, to personally visit and examine available sources of sand in the immediate neighborhood. In this way much better material may often be obtained than would otherwise be the case.

Sand and gravel banks are usually stratified and where the deposit has been made from comparatively still water the lower stratas will usually contain coarser material than the upper stratas. In every case the sand dealer should be impressed with the necessity of carefully stripping the top of the bank to remove deposits of clay, loam, etc., as this material is undesirable and will usually ball up in the heating drums. Where the stratas vary considerably and can not be dug separately, it will be necessary to take an average sample of the run of the face of the bank in order to determine what will be the composition and character of the average output of the deposit. In certain cases it is necessary to select definite stratas and have all the sand taken from them. In other cases the sand is dredged from river or creek beds and in order to obtain a satisfactory supply, it is sometimes necessary to go on board a dredge with a set of screens and a sand scale and sample the sand obtained from

*Public lecture delivered before the graduate students in Highway Engineering, at Columbia University on January 29th, 1914.

various portions of the river bed. When prospecting outlying country for available sand deposits, a small frying pan is a very convenient utensil to carry, together with the sand sieves and scales. By means of it, samples of sand taken from various pits can be dried over a small fire and sifted on the spot, which avoids the necessity of carefully marking them for identification and taking a lot of samples back to the laboratory or office. When securing samples of materials for examination, these should be carefully selected so that they really represent an average of the materials. The quantities necessary for examination are about as follows:

Refined asphalt or asphalt cement....	1 pound
Residuum flux	½ to 1 quart
Crushed stone or gravel	1 to 3 pounds
Sand	1 pound
Filler	½ pound

When these are sent to a central testing laboratory they should be plainly marked with the following information:

Kind of material,
Date material was received at paving yard,
Date when sample was sent,
Quantity of material represented by sample,
Name of manufacturer or from whom purchased,
Name of paving contractor who is to use the material represented by the samples,
Name of city or town in which work is being done.

Method of Obtaining Samples.

Refined Asphalt.—This is usually shipped in barrels containing from 300 to 500 pounds each. It will depend on circumstances and the quantity of material on hand how many barrels should be examined. Where the barrels are marked with the dates or batch numbers and different batches are represented, it will usually be sufficient to take a single sample from each batch. Certain specifications give a permissible limit of variation in the penetration or consistency of different shipments of asphalt. In such cases it will be necessary to test for penetration a sample from each batch number, in which case all of the samples taken must be kept separate. Where no such provision is included in the specifications and the inspector is assured from his past experience that the particular manufacturer from whom the material was purchased is careful in his output, a fewer number of samples will be necessary than under other circumstances. In some cases an average sample made up of different samples taken from the requisite number of barrels will be all that is required. The packages or barrels used by different manufacturers are very often characteristic of the product, and this is also true of the odor and general appearance of the material. A qualified inspector will often be able to determine from observation whether or not the contractor's statement as to the source of the material which he intends to use is correct. In taking the samples, material should be selected which is free from dirt, etc., and which has not been exposed to the air. In other words, a piece of refined asphalt should not be taken from the top or immediately adjacent to the outside of the barrel.

Asphalt Cement.—This is quite often shipped in tank cars and in such cases a single sample taken, preferably after the contents of the car have been melted, will be sufficient.

Crushed Stone or Gravel.—Various samples from different portions of the pile should be taken and mixed together, and from the mixed portion sufficient should be selected for test. It is always advisable to dig into the surface of the pile a little way in order to get material which has not been exposed to the atmosphere and which possibly has lost through the action of wind or rain, or both, a considerable portion of its fine material.

Sand.—It is almost impossible to secure a fairly representative sample of dry sand, as the coarser grains have a different angle of flow from the finer grains and are found in different portions of the pile. The pile should always therefore be dug into some distance below the surface until damp sand is reached. After sampling the pile in this way in a number of places, the samples so obtained should be mixed together and sufficient taken for test from the mixed lot.

Filler.—This is usually Portland cement or finely ground lime dust, and comes in bags. No particular difficulty attends the sampling of this material, but a sufficient number of bags should be opened and samples obtained from them and mixed together in order that the sample sent for test shall correctly represent the average quality of the material.

The examination of the samples so obtained is usually conducted in accordance with detailed specifications. As these vary somewhat in their requirements, it is impossible to lay down a general rule which will cover the examination of raw materials for paving work. After the materials have been examined in the laboratory and found to be suitable for the work and in accordance with the specifications, the inspector can frequently be of great service in suggesting to the contractor the best formula to use. All paving specifications allow considerable leeway as to the composition of the mineral aggregate and the percentage of bitumen required in the mixture. Sometimes the decision lies entirely with the engineer on the work and where he is fully competent to decide these questions it should, of course, be left to him. As the contractor usually has to assume a guarantee on the completed work, he naturally feels that he should be consulted as to the formula used. Sometimes his desire to reduce the cost of his work will lead him to employ a formula which, while complying with the minimum requirements of the specifications, is really not suited to the work in hand. Whenever possible, cooperation between the inspector and the contractor will always secure the best results and a little tact used in this connection will usually be all that is required. It frequently happens that two or more kinds of sand or stone have to be mixed together in order to secure a suitable mineral aggregate. Many contractors are exceedingly careless in keeping their different kinds of materials separated. Unless this is done it is impossible to make a uniform mixture of the various materials and provision for the piling in separate and convenient places of the different materials should always be made before they are delivered. This is a very important consideration and lack of attention to it will not only hamper the execution of the work but its quality as well. It is necessary and advisable to impress on all the dealers furnishing raw materials the necessity of a uniform supply. This is particularly the case with sand dealers, who are often small men who have been accustomed to supply sand to builders and parties requiring it in small amounts. Almost invariably, men of this type will not realize the great difference which a, to them, small variation in the mesh composition of the sand will make to the paving contractor.

Inspection of Materials and Processes During Construction Work.—These may be sub-divided into plant and street inspection.

Plant Inspection.—During the progress of the work additional quantities of raw materials will from time to time be delivered to the contractor's plant. These should be sampled and examined in the manner previously described for the preliminary inspection of raw materials and no deliveries should be used in construction work until after they have been examined and tested and found to be in accordance with the requirements of the specifications. Owing to delays in the arrival of shipments this may at times be difficult, if not impossible, but in such cases, if it is inadvisable to shut down the work temporarily, the inspector should make all the tests possible at the plant in order to convince himself that the materials are suitable for the work. If he is able to determine definitely that they are unsuitable, they should, of course, be rejected and work shut down until other suitable material is available. At times it may be necessary for him to assume the responsibility of passing the materials and permitting their use pending an authoritative report from the central testing laboratory. Sometimes there will be but little risk in doing this; under other circumstances it may be advisable to permit the contractor to proceed with his work with the distinct understanding that if the materials are found not to comply with the requirements of the specifications he will take it up. Such an arrangement should only be made in writing and with the consent of the resident or supervising engineer. Where sand is delivered by wagonload, it will usually be sufficient to take an average sample of the day's deliveries and test it. Where the sand is delivered by rail or barge, the contents of each car or barge should be tested, if possible before unloading it. These instructions apply also to stone and gravel. It is so extremely important that deliveries of various grades of stone, sand and gravel should be kept separate that the speaker again wishes to emphasize this point.

Generally speaking, the processes involved in the manufacture at the plant of bituminous paving material are:—

Preliminary mixing and heating of the mineral aggregate.

Preparation and heating of the asphalt cement or bituminous binder.

Mixing of the heated mineral aggregate with the hot asphalt cement or bituminous binder.

Preliminary Mixing and Heating of the Mineral Aggregate.—The proportions in which the various constituents of the mineral aggregate are to be mixed will, of course, depend upon their character and the specifications under which the work is being carried on. The method of mixing the different ingredients depends somewhat upon the feeding arrangements at the plant and the disposition of the raw materials. In certain large plants the raw materials are stored in bins. In some instances these bins have automatic feeding devices which deliver the contents of the bins upon a conveyer belt. In such cases the automatic delivery devices should be set at the proper points and during their operation should be watched from time to time in order to see that they are delivering the desired quantity of material. With certain mixtures a mere inspection of the mixed aggregate as it is being fed to the heating drums will enable the inspector to roughly determine whether or not the proportions are being adhered to. With other types of mixtures this is very difficult to regulate by observation at this point. In the majority of instances, plants are not provided with storage bins of the type previously described and the materials are dumped in piles on the ground. These piles are usually arranged so that the material from them can be easily conveyed to the feeding device for the heating drums by means of wheelbarrows or horse slips. Where the mixture consists of sand and stone of various sizes, with a considerable proportion of stone, it is advisable to have the mixture made in a pile adjacent to the feeding device. This can frequently be done satisfactorily by having the requisite number of wheelbarrowfuls of the various ingredients dumped on a certain spot, this pile to be roughly mixed by shovels and then shovelled over into the feeding device. Where a simple mixing of two grades of sand is required, this can frequently be done satisfactorily by building a small box or boot around the bottom of the cold sand elevator and having the fine sand placed on one side and the coarse sand on the other side. One man on each of the two sand piles can then shovel the material into the box above mentioned in accordance with the mixing formula determined upon. Assuming that two parts of coarse sand were required to one part of fine sand, the man on the coarse sand pile would have to throw two shovelfuls of sand into the box to every one shovelful thrown by the man on the fine sand pile. The feeding of the sand thus thrown into the box would be attended to by a third man, who would feed it to the buckets of the elevator by means of a hoe or shovel. Usually the fireman who is in charge of the firing of the heating drums is able to supervise the operation of the feeding gang and see that they feed a properly proportioned mineral aggregate. In mixtures of sand and large sized stone there is liable to be a certain amount of segregation of the material in its passage through the heating drums. Certain plants are provided with an overheat screen to separate the heated material after is comes from the drums into the various sizes and distribute them into different bins. The material contained in these bins is then drawn out into the measuring box in definite proportions according to weight. This, of course, is the most accurate method of making mixtures involving the use of a large proportion of relatively coarse stone.

The function of the heating drums is to dry and heat the mineral aggregate. Unless ample air circulation is provided for to carry off the moisture in the shape of steam, the drying will not be effectively conducted. It is essential to regulate the rate of feed and the temperature of the heating drums so that the mineral aggregate delivered from them will be dry and at the proper temperature. This operation is usually in charge of the fireman for the heating drums. The most modern plants are provided with a pyrometer inserted in the delivery chute from the heating drums. This pyrometer has a plain or recording dial which is placed at the feeding end of the drums, where it is under the observation of the drum fireman. This makes it easy for him to regulate his fires and the rate of feeding necessary to secure the desired results. Where no pyrometer is inserted, it is necessary for him to test the temperature of the material issuing from the delivery end of the hot sand drums from time to time, as often as may be required in order to produce satisfactory results. It is a comparatively simple matter to take the temperature of heated sand, but where the mineral aggregate consists of large stone particles, it is a much more difficult and unsatisfactory operation. Certain types of mixing plants are so constructed that it is very difficult to obtain samples of the hot mineral aggregate before it is mixed with the asphalt cement or bituminous binder. Regardless of the difficulty involved, it is good practice to test the temperature of every batch of mineral aggregate in plants of this type before it is mixed with the asphalt cement; otherwise regular work cannot be expected. Even when the greatest care possible is exercised, there will be considerable variation in the mesh composition and temperature of the mineral aggregate as delivered to the mixer. The permissible variations are usually set forth in the specifications and should be closely observed. Mixtures which vary very greatly in mesh composition will require different amounts of bitumen in order to make the best possible type of mixture. Within ordinary limits, no correction will have to be made for this, but, generally speaking, a mixture containing a large proportion of fine particles will require more bitumen to cover these particles than a mixture containing a smaller proportion of them. This is due to the fact that the finer the mixture the greater the surface area to be covered with bitumen. This can, perhaps, be most clearly shown by taking the case of a 1-in. cube which it is proposed to coat with bitumen. In its original state there will be six sides having an area of one square inch each to cover. If this cube be cut into two cubes, there will be the original six sides plus two additional sides to be covered, and every time that the cube is cut there will be an increase in the surface area to be covered with bitumen. In order to secure a satisfactory output from the plant, it is absolutely essential that the greatest possible care should be taken in the mixing and heating of the mineral aggregate. In order to insure the proper mixing of the mineral aggregate, it will be necessary from time to time to take samples of the mixed aggregate and sift them for mesh composition. Owing to the extreme difficulty of securing an average sample of hot, dry mineral aggregate, great care must be exercised in selecting the samples. The arrangement of the plant and the kind of mineral aggregate used will determine where and how often these samples should be tested.

The speaker is inclined to advise the obtaining of samples for test from the overflow of the feeding device used in conveying the cold mineral aggregate to the heating drums. This is usually done by a chain and drum elevator. Where these buckets dump into the chute at the entrance of the drying drums, there is almost always a small overflow which gradually piles up underneath this chute. Assuming this to be the case, the pile can be cleaned off at a given time and the material which accumulates during, say, half an hour's run can then be sampled, dried and sifted. It is much easier to sample the damp material than it is the dry, and this not only obviates some of the difficulties attendant upon sampling dry material but gives the inspector an average of the material fed into the drums during the half hour while the pile was accumulating. In this way much better average results are obtained and the inspector is not liable to be misled by temporary and unimportant lapses in the feeding of the material. In other cases, samples of the hot material are obtained from the delivery end of the drying drums. In such cases a number of samples should be collected and mixed together and the resultant mixture sifted.

Preparation and Heating of the Asphalt Cement or Bituminous Binder.—For the preparation of the asphalt cement or bituminous binder, the contractor may purchase a hard bituminous material and add sufficient flux to it to bring it to the proper consistency, or he may purchase an asphalt cement of the proper consistency for use without the addition of any flux. In the first instance the melting kettles will have to be charged with the proper proportions of flux and hard asphalt to produce the desired asphalt cement. In large plants this is generally done at the close of the day's run. The materials are then kept under a gentle heat during the night and brought up to the desired temperature in the morning. The contents of the kettles are then thoroughly agitated in order to insure complete mixing of the different ingredients and a sample from them is taken and tested for penetration before the contents of this kettle are permitted to be used. If it is too hard, more flux will have to be added to it. If it is too soft, more hard asphalt will have to be added to it. After the additions are thoroughly melted, the contents of the kettle must be again agitated and tested before using. Certain asphalts are more difficult to flux than are others and require a longer period of heating. Overheating of the kettles will result in undue hardening of the asphalt cement. If the flux or hard asphalt contains any considerable proportion of water, this will foam very badly in the kettles and frequently cause them to run over. No asphalt cement or bituminous binder should be used until the water has been thoroughly removed from it. Where the asphalt cement or bituminous binder contains a considerable proportion of mineral matter or impurities, the contents of the melting kettles must be kept thoroughly agitated during the time that they are being drawn upon for use. Suitable mechanical agitation is, perhaps, the most advisable, as in this way the bituminous material is hardened less than if a steam or air blast is used.

Violent agitation with steam or air will very rapidly lower the penetration of the contents of the kettles. In the case of asphalt cements containing a considerable proportion of mineral matter, unless the contents of the kettles are thoroughly agitated, the material drawn from them will vary in purity or bitumen contents with the result that the portion first taken from the kettle will usually run much higher in bitumen than the portions last taken from it. Assuming that the proportions of the mixture have been set to give the desired quantity of bitumen, based on the average bitumen contents of a thoroughly mixed kettle, the mixture turned out with the asphalt cement first drawn from the melting kettle will be too rich in bitumen and that turned out with the asphalt cement last drawn from the kettle will be too low in bitumen. It is impossible to estimate by observation the changes in weights of asphalt cements necessary to overcome this and the only proper way, therefore, is to so agitate the contents of the melting kettles that the supply of the bituminous material drawn from them will be uniform in bitumen contents. If for any reason the asphalt cement for a certain day's run is not entirely used up, it should always be tested for penetration before permitting its use on a subsequent day's run. There is, of course, no objection to filling up the balance of the kettle with new material and mixing it thoroughly with the portion left from the previous day's run. It should then be considered as a new batch of asphalt cement and tested accordingly. Where hard asphalt and flux are to be melted together, the contractor should never be permitted to draw any material from the melting kettles until their contents have been completely melted and thoroughly mixed. Even where the asphalt cement is purchased ready for use, it is not good practice to draw from a kettle containing lumps of unmelted bituminous material. Sufficient melting kettle capacity should be insisted upon to avoid the necessity of doing this.

With the exception of the fluxing, the foregoing remarks apply equally to bituminous binders, purchased by the contractor, of the proper consistency for use.

Mixing of the Heated Mineral Aggregate With the Hot Asphalt Cement or Bituminous Binder.—It is unquestionably the best practice to weigh out the various ingredients entering into the composition of the finished mixture. Where the different ingredients are measured by volume, much greater variations will occur than when they are measured by weight. If measured by volume, the contents of the various measuring devices must be carefully checked up before the commencement of the work and the gauges set at the proper point. It is advisable to check up the setting of these gauges from time to time to see that they have not been displaced, either intentionally or otherwise. In determining the volume occupied by the desired weights of the different ingredients, it is necessary to measure them at the temperatures and under the conditions used in actual work. In other words, heated dry sand or stone must be filled into the measuring box and the weight of the box when filled to the proper mark determined. This is also true of the bucket or measuring device used for asphalt cement or bituminous binder. If the asphalt cement should contain any water, this will produce foaming and it will be impossible to measure it accurately. If the foaming is at all excessive, it will be impossible to get the required amount of asphalt cement in the ordinary sized measuring bucket. This, by itself, constitutes a sufficient reason for not permitting the use of any asphalt cement which contains water. Where the materials are measured by weight, the tare of the empty measuring devices must be carefully obtained and this tare added to the weight of materials which it is desired to use. In determining the tare of the asphalt cement bucket, it must be borne in mind that after an hour's run there is a considerable accumulation, amounting to several pounds, of asphalt cement on this bucket which will increase its tare above that obtained by weighing the bucket in a perfectly clean state. After once determining the tares and setting the weights or gauges at the proper point, their position on the scale beams or elsewhere should be checked up from time to time to see that they have not been displaced. Occasionally the accumulation of surplus material on the scale platforms of the measuring device for the mineral aggregate will change the tare somewhat. Any such accumulation should be removed from time to time as often as necessary. Unforeseen happenings will occasionally influence the tare of the measuring devices. In the speaker's experience, he once found that the mixture being turned out was entirely too sloppy, although he had but a short time before carefully checked up the tare and gross weights of the various ingredients entering into it. Upon investigation, he found that the spout carrying the materials from the hot sand bin had been shifted by the vibration of the machinery so that it rested part of its weight upon the sand box, thus increasing its tare by approximately 200 pounds. Each batch of mixture turned out under these conditions, therefore, contained 200 pounds too little mineral aggregate, which, of course, accounted for its sloppiness.

The method of mixing varies in different plants. In the larger sized paving plants almost invariably the pug mill type of mixer is used, and this the speaker considers much the best type. The blades in this type of mixer should be examined to see that they are properly set and not unduly worn, thus producing an imperfect mixture at the bottom and sides of the mixer. Ordinarily they should revolve at a speed of from 60 to 80 revolutions per minute. In mixtures of the sheet asphalt type, one full minute should be allowed for mixing each batch of material. Where the mixture is a comparatively open one consisting largely or entirely of stone, this mixing time may be reduced somewhat. Whatever the type of mixer employed, the proper time for obtaining a thorough mixture should be determined and rigidly adhered to. The temperature of the mineral aggregate delivered to the mixer should be tested occasionally, as often as may be necessary. This, of course, will depend upon the type of plant used and is a check upon the drum fireman and the feeding operations of the mineral aggregate. The temperature of the asphalt cement in the melting kettles should also be tested as often as may be necessary in order to be certain that it is uniformly maintained at the proper point. Where the type of mixture permits it, frequent pat tests should be taken of the material delivered to the wagons. This test is made by placing a small quantity of the hot mixture upon a sheet of unglazed manila paper, folding over the paper and pressing down upon it with a wooden paddle. After it is thoroughly compressed, the paper should be struck a sharp blow with the wooden paddle and then opened for observation. An examination of the surface of the compressed mixture will clearly show to the trained inspector any marked variations in the mesh composition of the mineral aggregate. The depth of stain upon the paper will measure the amount of bitumen which it contains. The richer the mixture in the bitumen the heavier will be the stain. This stain is also influenced by the temperature of the mixture when the pat test is taken. For this reason it is necessary in comparing pats to know exactly the temperature. In obtaining the mixture for the pat test from the wagon, an ordinary mason's trowel will be found convenient. No time should be lost after obtaining the sample in putting it upon the manila paper and making the test; otherwise it will drop very considerably in temperature. The temperature of the material tested can be conveniently determined by inserting a thermometer at the place where the sample was taken from. Convenient and suitable arrangements for making this test should be insisted upon at the plant. This is a most important and valuable guide in the hands of a competent inspector and great attention should be paid to it. In the hands of a trained man, a variation of one-quarter of one per cent. of bitumen can be detected by means of the pat test. This pat test is, of course, not applicable to mixtures consisting chiefly of large particles of stone. The inspector should make careful notes of the various conditions surrounding the plant. He should take and record at least three times daily the temperatures of the asphalt cement and the mineral aggregate as delivered to the mixer. He should also record his siftings of the mineral aggregate together with the proportions used in making the mixture and of the asphalt cement.

All deliveries of material at the plant should also be noted and a record kept of any tests made on them. These records should be kept on properly designed forms and should state the name of the street on which the mixture is being laid, the kind of mixture and the kind and proportion of the various ingredients entering into it. He should also keep a record of the number of batches turned out from the plant, as this is a valuable aid in checking up the thickness of the pavement laid on the street. At the commencement of the day's run it is customary to send out mixture which is a little hotter than that sent out during the average operations of the plant. This is done in order to enable the workmen on the street to make a close and intimate joint with the pavement laid during the previous day's run. While safe temperature limits should not be exceeded at any time, the maximum limits should be approached in sending out the first few loads in the morning.

Street Inspection.—Prior to the delivery of any bituminous materials upon the street, the foundation must be completed in accordance with the requirements of the specifications. The finished foundation must then be swept clean of all dirt, etc. Knowing the type of mixture to be laid and the number of pounds used in each batch and the number of batches per wagonload, it is usually possible to determine in advance how many square yards should be covered by each wagonload. The best street foremen, before laying any bituminous material, measure the width of the street and calculate the number of lineal feet which should be covered or "pulled" by each load. A tape is then laid along the curb and a chalk mark made at the point where the raked material from each load should end. Where the foundation is reasonably smooth and in accordance with the contour of the finished pavement, this method is one of the best checks for determining the thickness of pavement laid. Ordinary sheet asphalt pavement 2 ins. thick will weigh 200 pounds to the square yard. Pavements containing a large proportion of good sized stone will vary somewhat from this weight, but the exact weight per square yard can easily be determined during the first day's run.

As soon as the material reaches the street, its temperature should be noted. The hot material should be dumped outside of the spot where it is to be laid in order that all of it will have to be conveyed to its final resting place by means of shovels. This results in a preliminary spreading of material of approximately the same density. Where the load is dumped on the spot on which it is to be spread it will inevitably be tramped upon and certain portions of the heated mixture will receive more compression than others, which will eventually result in an uneven surface to the finished pavement. In certain classes of bituminous mixtures, notably those containing large particles of stone, where the haul is long, the coarser particles may settle to the bottom of the load. If this takes place to any great extent, the load when dumped should be re-mixed by turning over with hot shovels. In shovelling the hot mixtures into place the shovellers should not dig into the top of the pile but should shovel from the bottom of it, cleaning up the loose material as they go. If this is not done, the lower layer of the pile, in cold weather, will have become chilled by its contact with the cold foundation and it will be difficult to remove it completely and uneven distribution and compression will result. The mixture, after having been deposited roughly in place by means of shovels, is spread by means of hot rakes. During this operation the rakers should not stand in the hot mixture any more than is necessary. Care should be taken to maintain a uniform and even grade so that there will be no depressions in the finished pavement which will hold water. Some mixtures compress very much more than others, so that it is impossible to establish any definite rule for the depth to which the hot mixture shall be raked.

As soon as possible after raking, the mixture should be rolled. Some mixtures are more tender than others and must be allowed to cool off somewhat before putting the hot roller on them. The hotter the mixture, the greater will be the compression and it is, therefore, desirable to roll it as soon as possible. In very cold weather, especially when a strong wind is blowing, the surface of the mixture will chill quite rapidly. With a tender mixture it is often advisable to use a light hand roller over it as soon as it is raked in order to close up the surface and then follow this with a heavy steam roller as soon as the mixture will bear it. Undue delay in rolling the mixture will result in a more or less honeycombed surface. Depending upon the contour of the street and its width, the rolling should be first done parallel with the curb. This should be followed by diagonal or cross rolling and the final finish of the work by rolling parallel to the curb again. The exact method of handling the roller can usually be left in the hands of the roller engineer if he is an experienced man, as he should know how to smooth up the finish of the pavement better than will the average inspector. At the finish of the day's work it is necessary to leave the pavement in such condition that a proper joint may be made with it when the next day's operations are commenced. There are a number of methods of doing this. Perhaps the best is the rope joint in which a length of rope is laid across the extreme edge of the pavement and rolled into it while hot. When this is taken up very little cutting back will have to be done and the edge will be left in such shape that a satisfactory joint can be made. The practice of painting these joints with hot asphalt cement before laying fresh pavement adjacent to them is to be avoided whenever possible, as the tendency is to put too much asphalt cement on the joint. This asphalt cement is absorbed by the hot mixture and softens it at that point and traffic is liable to displace it. For the same reason the painting of edges of curbs, manholes, etc., should be done with extreme care. A very convenient instrument for determining the depth of the finished pavement is a putty knife with a blade 2 in. wide which has been marked across the face of the blade at a point corresponding to the required depth of the pavement. This can easily be inserted in the warm mixture after it has been rolled and the broad point will bridge over any small depressions in the foundation and avoid the recording of a greater depth to the pavement than really exists.

The use of hot smoothers should be avoided whenever possible. With the proper mixture and one which has been rolled while hot, the surface should be entirely closed up. Under unfavorable weather conditions, in order to close up the surface, it may be necessary in certain places to use hot smoothers. Care should be taken to see that these are not too hot; otherwise they will burn the pavement and scaling will eventually result. The inspector on the street should, whenever possible, keep an accurate account of the number of loads delivered. Knowing the number of pounds of mixture per load and the weight per square yard, he can then check up the yardage which should have been laid with the material delivered on the street if it were raked to the proper thickness.

Inspection of Finished Work.—If the inspection at the plant and street during the construction of the pavement has been adequate, the final inspection of the work will be chiefly confined to an examination of the contour and surface of the street. During this examination careful note should be made of whether or not the mixture has been thoroughly compressed and is closed up on the surface. Where there has been no inspection during the manufacture and laying of the pavement, or where this inspection has been inadequate, defects will frequently develop in the pavement. Under these circumstances, it becomes necessary to examine the finished work in order to determine the reason for the defects or failures. In an inspection of this sort, careful note should be made of the condition of the surface and its contour. Frequently marked depressions occur where the pavement has been laid over a trench dug just prior to its construction, and in which the back-filling was not properly done. A thorough examination of the street will usually involve the cutting out of numbers of samples of the bituminous surface. These should be carefully marked as to location and a sufficient number of them taken to fairly represent the surface examined. They should be sent to a central laboratory for examination as to the per cent. of bitumen contained in them, the mesh composition and character of the mineral aggregate and the physical and chemical characteristics of the asphaltic cement or bituminous binder used in the pavement. Wherever these samples are cut out, careful note should be made of the depth of the pavement at this point. In many instances it will also be necessary to cut through the foundation to determine its character and thickness. Laboratory examinations of concrete foundations are usually not very valuable in determining the amount of cement which has been used in them, but a combination of physical and chemical tests of the foundation will often establish satisfactorily whether or not they have been defective. The method of examination used will, of course, have to be varied depending upon circumstances and the character of the defects which have been developed. The reasons for these defects have been fully covered by a previous lecture delivered by the speaker to which he would refer you for more detailed information on this point.

PANAMA-PACIFIC EXPOSITION CONSTRUCTION.

Rapid progress is being made on the construction work in connection with the numerous large wooden buildings for the Panama-Pacific International Exposition at San Francisco. Among the principal buildings already erected are the Palace of Machinery, covering three acres, the Fire House, the Education Building, the passenger station, and warehouses, ferry slips and oil houses. The framework has been started for the buildings for Mines and Metallurgy, Various Industries, Manufactures, Liberal Arts, Food Products and Agriculture.

Thirty-five states and territories and certain of the foreign governments have announced their intentions to secure space; 177 congresses and conventions have been arranged to meet in San Francisco during the fair, and an attendance of from 10,000,000 to 18,000,000 is anticipated for the exposition. It is said that neither Germany nor England will take exhibit space.

The cost of the exposition is estimated at $80,000,000, of which the state of California and the city of San Francisco will each pay $5,000,000, San Francisco subscribes $7,500,000 and individual exhibitors $25,000,000.

The Toronto Suburban Railway Company has just closed a contract with the Canadian General Electric Company, Limited, for substation apparatus and car equipments, for the new line which will run west from Toronto through Georgetown, Guelph and Berlin. A very interesting feature is that this will be the first interurban line in Canada to operate at 1,500-volts D.C. The catenary type of overhead construction will be used, and there will be three substations, viz., at Islington, Georgetown, and Guelph. 1,500-volt rotary converters, each of 500-k.w. capacity, will be used, power being transmitted to the substations at 25,000 volts. Provision will be made for the supply of power from a separate bank of transformers in each substation for distribution along the line for miscellaneous power and lighting purposes. The cars will be equipped with four 85-h.p. motors of the latest type, and fully ventilated. The control will be of the multiple-unit type. The cars will operate on 600-volt line at approximately half normal speed; and changing from 1,500-volt to 600-volt trolley, or vice-versa, will involve no loss of time in adjustment of control apparatus. The line with 1,500 volt operation will be about 62 miles long.

EFFICIENT WATER PURIFICATION IN SMALL PLANTS.

SEVERAL interesting papers and reports have recently appeared dealing with the operation of sewage disposal plants and emphasizing the necessity for more careful supervision of this kind of municipal work. It is well known to all who have investigated the matter that small sewage disposal plants receive as a rule little or no attention, and that their effluents could be greatly improved under proper operation.

As an instance of the application of this reasoning to water purification plants, one of our smaller cities operates a filter plant at an average efficiency of 79 per cent., and which was at one period as low as 50 per cent., whereas, according to a report just received from a consulting engineer, who has made a thorough examination of the system, an efficiency of 95 per cent. could be maintained if the plant was placed under proper scientific supervision.

Mr. H. P. Letton read a valuable paper on the subject, at a meeting of the New England Water Works Association recently. Mr. Letton was for some years in the employ of the New Jersey State Board of Health, engaged mainly in the supervision of the public water supplies of the state. He is now sanitary engineer to the United States Public Health Service. In his former position about 30 water purification plants were under constant inspection.

According to his paper, the main difference between the operation of sewage disposal plants and small water purification plants is that the former are usually built, not because there is a concerted demand for them, but for the eradication of a local nuisance, or by order of some higher authority. Because of this fact, and because the terms "sewage" and "sewage disposal" are distasteful to the average layman, the plant is generally put in an out-of-the-way place, and either forgotten entirely or placed in the charge of an underpaid, superannuated caretaker, who knows nothing of the principles upon which the design of the plant is based; while a water purification plant is generally installed as a result of a popular demand, and the consumer is directly interested in its operation in so far as furnishing a clear, colorless, and palatable water is concerned. These are the qualities that to the majority of people determine the purity of the water, and as long as they are maintained there is little or no question as to the efficiency of the plant in other ways. As a matter of fact, however, there are many plants which will usually meet the above conditions, but which are inefficient, both from an economic and a sanitary standpoint.

It is only on rare occasions that a filtration plant has been constructed at the time of the installation of the water works system. In most cases, when the purification plant is added to an existing system, the operation of it is intrusted to the engineer of the old plant. This man may be, and in many cases is, a stationary engineer who thoroughly understands the operation of boilers, engines, and pumps, but who has absolutely no idea of the principles which underlie the process of water purification.

There is also another point which in many cases affects the results obtained. When it is decided that some form of purification is advisable in connection with a small water plant, it is very rare, indeed, that a consulting engineer is called in for advice. Instead, the matter is taken up with one or more companies engaged in the business of installing purification apparatus. While these companies are usually competent to give reliable advice, their main business is the selling of equipment. Because of this fact and because the usual small water company or municipality is weak financially, the filter plant is designed to fit the available money, and the company offering the equipment for the least sum is generally given the contract, regardless of the quality of the material to be furnished. As a result of this practice, plants that are poorly designed, lacking in the necessary equipment for efficiency, or even wholly ill-adapted to the situation, are commonly met with. A few cases of this kind which have come under the observation of the writer will be noted. Probably the worst example was at a plant supplying about a million gallons per day. The supply was originally obtained from artesian wells, but on account of the high iron content of the water, a new supply was obtained from an artificial lake. This water was highly colored by its passage through cedar swamps. From the lake the water flowed by gravity to the coagulation basin. This was a rectangular wooden tank of such size that normally less than twenty minutes were allowed for coagulation and sedimentation. During periods of high consumption the time was considerably decreased. The basin was set at such an elevation that at times of low water in the lake it was impossible to obtain the normal supply except by by-passing some raw water. From the coagulation basin the water flowed by gravity to 4 rapid sand filters of the gravity, circular wooden tank type, without loss of head-gauges or rate-controllers. The agitating rakes were intended to be driven by a water motor, but the necessary power was lacking. The beds were, therefore, not agitated during washing. From the filters the water passed to a suction well which had been used in connection with the former well supply, and which provided less than 30 minutes' storage. Two solution tanks had been provided and connected with a small displacement pump driven from the line shaft to which the main water pumps were attached. The small solution pump was intended to force a solution of sulphate of alumina into the raw water just before it entered the coagulation basin. At the time of the writer's first visit to this plant the chemical pump was out of order and no chemical was being added. It was afterward learned that this was its chronic condition. Tests of the raw water showed it to be slightly acid owing probably to humic acid from the cedar swamps. Consequently the addition of sulphate of alumina would be an absolute loss as far as results are concerned. Analyses of the raw and filtered water showed no material difference, and the filtered water had at times a color as high as two hundred.

While the foregoing may seem to be an extreme case, conditions almost as bad were found in several instances. Two other plants were discovered treating acid water with sulphate of alumina only, rate-controllers and loss of head-gauges were almost unknown, and the methods of regulating the amount of chemical applied were very crude. Few calibrated orifice boxes were found in use. Two gravity, rapid sand plants, treating waters high in organic matter and often turbid, had no coagulation basins, so that they required too frequent washing with corresponding reductions in bacterial efficiency as well as increased costs of operation. Another large plant, using the pressure type of filter, was treating a turbid water with very little time for coagulation. The effluent was frequently turbid, and at times contained aluminum hydrate.

One plant of the slow sand type had less than a foot of filtering sand, and had a clear-water well holding about a half hour's supply. As a result of this combination, the rate of filtration fluctuated exactly as the demand, and purification was practically nil.

At one rapid sand plant the clear-water basin was so small that it was necessary to wash with raw water. Another plant had no arrangement for filtering to waste, so that whenever it was necessary to get at the strainer system the dirty water in the bed was drained into the clear-water well.

On the matter of operation, conditions were found to be as bad, if not worse. As has been said, the man in charge of a small water purification plant has usually little or no idea of the nature of the process. He operates the plant by "rule of thumb" methods in an endeavor to produce a good-looking water. Although efficient results depend so largely upon the use of the correct quantity of coagulant, the greatest ignorance was shown of this matter. At several plants the engineer stated that he put in a certain number of buckets of alum per day. He did not know how many pounds were used, and made no attempt to add it in the same proportion at all times. A few engineers said that they increased the dose "some" when the water was turbid, but did not know how much. In only a few plants was any attempt made to regulate the dosage by the aid of alkalinity and turbidity tests. As a matter of fact, few of the men in charge could be depended upon to make the necessary alkalinity tests. At only two plants, treating less than twenty million gallons per day, were laboratories maintained, and at these plants the tests, both chemical and bacteriological, were made under the direction of non-resident chemists. The engineers who made the tests were unable to interpret them or apply them in the operation of the plants. At one modern municipal plant, absolutely no records were kept. The chief engineer could neither read nor write, and could see no use in records of any kind, not excepting pumpage records. The president of the board of water commissioners in charge of the plant stated that the only reason he could see for filtering water was to remove turbidity, notwithstanding the fact that the sewage of over a hundred thousand people was discharged in the river, from which the supply was taken, about seventeen miles above the intake.

At one plant visited, it was found that through the laziness of the engineer the filters were not being washed enough, the deficiency of water due to clogging being made up by by-passing raw water. At another plant, the beds were washed too often, resulting in a low bacterial efficiency and a high cost of operation. Oven ten per cent. of all water filtered was being used for wash water.

It is not believed that such cases are confined to New Jersey. Reports of investigations in Ohio, Pennsylvania, New York, and Illinois show very similar conditions. Much as they are to be deplored, the fact remains that they do exist, and that a discussion of possible remedies is in order.

The most feasible remedy for poor design is a statute requiring the submission of plans for proposed plants or changes in existing plants to the state board of health, or some other state authority, for approval before construction can legally be carried out. Such a regulation is in effect in a number of states at the present time. Coupled with the appointment of a properly qualified engineer to pass upon all plans, it will satisfactorily care for new works. State supervision for existing plants will, if carried out, do much to remedy the more serious imperfections of construction and operation. This supervision cannot, however, be thorough enough to furnish definite information for the efficient operation of the plant, both from an economic and a sanitary standpoint. At best, the plant can be visited only about once a month, and this visit is merely to see that a safe and potable water is being produced. From the viewpoint of the state this result is sufficient, but from that of the consumer and taxpayer there are other matters of great importance. He wishes to know, first, that the water is healthful, and then, that it is not possible to obtain the same or better results at a less cost by some change in the method of construction or operation of the plant. This latter is out of the field of the state inspector, for it generally requires much experimenting and testing to obtain the point of maximum efficiency.

The plan of having the engineer at the plant make daily tests under the general direction of a consultant at a distance is a step in advance, but it is far from perfect. The engineer's results are open to question, since he is often hurried and makes the tests without knowing the reason for the various steps. Also, since he has but infrequent consultations with the consulting engineer or chemist and is unable in most cases to explain any seeming discrepancy in his results, they do not prove to be of as much value as might be expected.

The writer has had in mind for some time a plan for remedying this situation, and it has recently again been brought to his attention by a similar plan which Prof. Earle B. Phelps has put into operation in connection with local health administration in several small Massachusetts towns. The plan is this: For several water companies or municipalities located not too far apart to combine forces, fit up a laboratory at some central point, and employ a competent bacteriologist and chemist to give his entire time to the scientific supervision of their water plants. By so doing, each plant would have the benefit of expert advice at a small cost. It would be possible for the chemist to visit each plant one or more days each week, and by so doing to become familiar with its operation. He could instruct the engineer in charge of the plant how to make the necessary daily chemical tests, such as alkalinity, turbidity, etc., and since he visited the plant so often, these results could be checked up and would be reliable. In case of emergency he would be able to look after the sanitary quality of the water and thus protect the consumer. He would be able to carry on experiments upon the proper amount of coagulants to be used, and time of coagulation. There is a chance for much study in the manner of washing the filters to bring about efficiency and economy. This is a point not considered much in small plants, but which has a considerable bearing on the cost of operation. It requires many visits to a plant to become familiar with its operation and to suggest changes which will increase its bacterial efficiency without increasing the cost. It is believed that the scheme outlined would in many cases save money for the water company or municipality, besides giving them and their consumers confidence that the quality of the water was being safeguarded.

A group of English engineers were recently accorded the contract for bridging the Ganges of northern India, which issues from an ice cave at the foot of the Himalayan range of mountains. This bridge, which is over a mile in length, is to carry the Eastern Bengal State railway over the Ganges from Damukelia to Sara Ghat. Spanning the river, the bridge will be crried on steel trestles, which in turn will be supported on massive steel grilles in granite piers. The contract consists of fifteen main spans, each 359 feet long and 52 feet high, and weighing 1,300 tons, and will require an expenditure of about $1,250,000.

ESTABLISHING A RAILWAY ROUTE

By J. A. Macdonald, Ottawa, Ont.

Running the Preliminary Line.—Having, by reconnaissance, found approximately the location for the proposed road, the next procedure is to run a trial line with the transit, selecting what appears to be the best on the ground, staking out the centre line, and sketching in the topography on both sides.

In following the bed of a stream, we obtain, generally, a line similar to *A N C* upon the section (Fig. 1). The lowest line of the valley, though quite moderately inclined at first, may rise more and more rapidly towards the source of the stream, as shown by the closer approach of the contour lines on the plan. That the line may ascend at a uniform rate from *A* to the summit, the horizontal distance between the contour lines may be equal at all parts of the ascent. This condition is effected by causing the surveyed line to cut the contours at right angles during the first part of the ascent, and obliquely as the summit is approached, or as the contours become closer together. In this manner we obtain the profile *A M*, *M A*. The contour line is level; the line cutting the contour at right angles is the steepest line that the ground admits of; and as we vary between these limits, we vary the inclination.

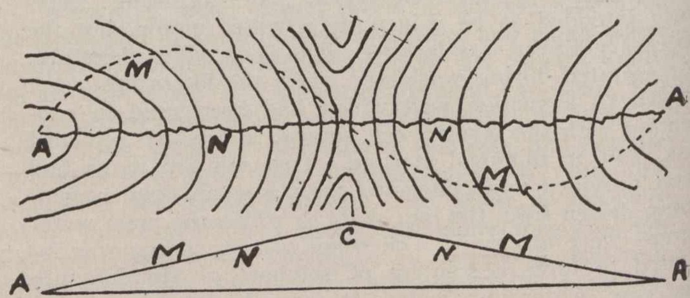


Fig. 1.

The effect upon the profile of cutting the contour lines in different directions is shown by Figs. 2 and 3. If we connect the points *A* and *B* upon the plan (Fig. 2) by the straight line *A B* we obtain the profile shown in Fig. 3 by the line *A L N M B*. If we follow the contour line around from *A* to *B*, we should have the horizontal line *A B* on the profile, and if we select a route upon the plan midway between the straight line and the contour line, as *A E F H B*, we shall have, as the corresponding profile, *A E F H B*, (Fig. 3). In connecting the points *C* and *D*, which are at different elevations, by the straight line, *C D*, we get the profile *C I P K D*. If we wish to descend upon the natural surface at a uniform and given rate—from *C* to *D*, knowing the rate of incline and the vertical distance between the contour lines, we get at once the corresponding horizontal distance from one contour line to the next, which, applied to Fig. 2, would give the required descent, as shown on the profile by the straight line from *C* to *D*. The line *A E F H B*, on the plan, is, of course, longer than the straight line *A B*; and the contour line is longer still. Such increased length is not represented upon the profile, as the object has been simply to show the general relation between the plan and profile, and the use of correctly drawn contour lines in adjusting any route to the ground.

General Establishment of Grades.—In the application of grades or inclines to the establishment of a railway route, we should bear in mind that between two points, which are at the same absolute elevation, there should be as little rise and fall as possible, and that between points at different elevations we should endeavor to have no rise while descending, and consequently no fall upon the ascent. These conditions can seldom be exactly complied with in practice, but we may approach them closely. In many cases we have to choose between two systems of grades—the one involving a long but gradual and uniform rise, the other a short but steep ascent, with the remainder of the line level, or nearly so. The total resistance upon the two systems, involving the same amount of ascent, will be the same; but a great difference may be made in the method employed in overcoming that resistance. If we have a grade 10 miles long, rising at the rate of 20 ft. per mile, we adapt our

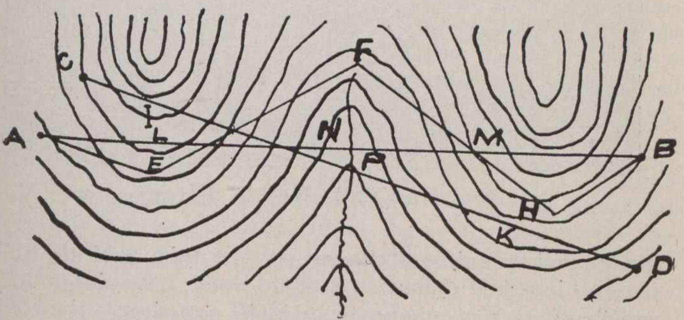


Fig. 2.

machinery to hauling its ordinary load up that incline, and we require from it a constant expenditure of power while ascending, and on the descent it is profitably aided all the way by gravity. If, however, the first 8 miles are level, and the remaining 2 miles ascend at the rate of 100 ft. per mile, an engine to work the incline would be too heavy for the level portion, and in the descent we should have more aid from gravity upon the incline than we required with none at all upon the level.

The effect of the arrangement in detail of the grades upon the amount of work to be done in reducing the natural surface of the ground to the finished roadbed, is shown in Fig. 4. The level grade from *A* to *B* involves a large amount of earth cutting at *D* and *E*, and a large amount of embankment at *C*. By raising the grade lines *D′* and *E′*, in the cuttings, and depressing the level em-

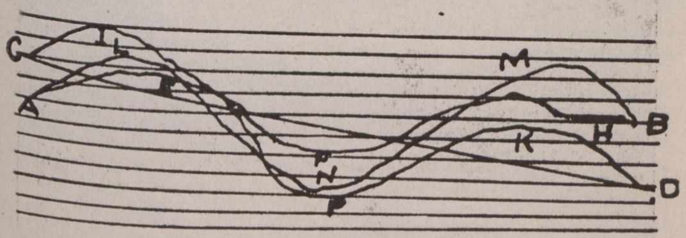


Fig. 3.

bankment from *C* to *C′*, we at once reduce both amounts of excavation and embankment, and by raising the roadbed more, to *D″* and *E″* in the cuttings, and depressing it to *C″* upon the embankment, we reduce still more the quantity of work to be done, but at the same time we render the road more difficult of operation.

There are many points that govern the rate of grade of a new railway. Probably first of all is the capital at disposal of the promoters of the road; for plenty of money will make possible an almost level line. But often the tremendous cost of such a level road would never pay dividends, notwithstanding this advantage. The country through which a road is to pass largely governs the most economical grade. If a comparatively level country, then there is no necessity at all for steep grades on the grounds of economy. If, on the other hand, the country is rough, the grade must be made to conform first with the amount of capital available, and, secondly with operating expenses.

The question of interest at which the money can be borrowed also enters very largely into that of grades.

It is doubtful if it were wise economy on the part of the C.P.R., when building its road across the continent, to make the grade limit so steep. Money was at a much lower rate at that time than now, and the vast sums of high-priced money that have been used in the past few years to ease the gradients might better have been used on the original work. This goes to show that faith in a railway enterprise also governs the gradient. When the C.P.R. line was being constructed a great many people had little faith in the successful outcome of the enterprise, while the problem of crossing the Rockies was

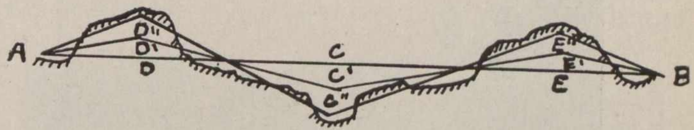


Fig. 4.

considered by many to be almost an impossibility. Money-lenders, not being greater endowed with prophetic powers than any other class of people, held the general view, and it was only with the greatest difficulty that the money could be found to construct the road on the original plan of steep grades. Faith in any enterprise is, therefore, of great importance, and particularly so in the building of a railway.

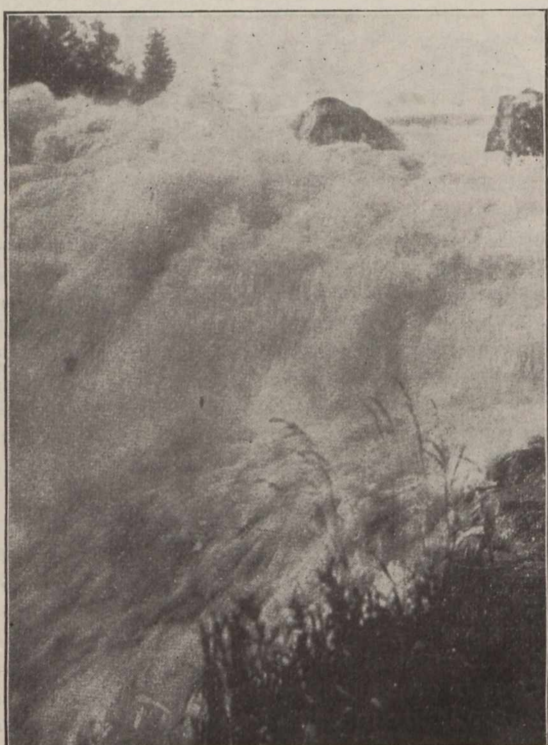
We think the reconnaissance line of a railway of considerable length is not generally given due importance in this country. Certainly, no decision as to suitable grades and curves should be arrived at before a full report of the exploration or reconnaissance survey has been received. We also think that these exploration surveys are not usually complete enough. Besides determining the most economical ruling grade, the possibilities of the country as to production, available freight and passenger service, contiguity to water transportation, are of almost equal importance with the gradient. These latter points, however, are usually neglected in the exploration line, the whole interest being centered in the grades.

A statistical report on the operation of electric railways throughout Canada in 1913 has recently been published at Ottawa. There are 56 electric railways in Canada, and during the year ending June 30th, they carried 598,662,801 passengers, exclusive of transfers, and 1,957,930 tons of freight. There was an increase in the number of passengers over 1912 of 108,998,119. The mileage of the railways increased during the year by 142 miles. The gross earnings of the electric roads in 1913 was $25,216,111, an increase over 1912 of $4,716,861. In five years the earnings of the electric railways have more than doubled. During 1913 the earnings from passengers was $19,794,400; from mail and express, $72,516 and from freight, $1,211,871. The operating expenses amounted to $17,765,372, leaving $10,450,738 as gross corporate income in addition to $1,318,909 of miscellaneous income, making a total income of $11,769,647. A surplus of $2,958,742 was carried after taxes, debt, interest and dividends were paid; and an addition of $554,324 was made to the reserve.

NELSON AND CHURCHILL RIVER BASINS.

A REPORT (Memoir No. 30) has recently been issued by the Geological Survey Branch, Department of the Interior, on the basins of the Nelson and Churchill Rivers. The information was compiled by Mr. Wm. McInnis and is largely the result of his own personal investigations. References are made also to the geological work of Bell, Tyrrell, Low, Cochrane, McConnell and Dowling, all of the Geological Survey.

Topography.—The region, broadly considered, forms part of the extensive Pre-Cambrian peneplain of northern Canada, encroached upon, to the northeast, south, and west, by more recent, flat lying, sedimentary rocks. The peneplain surface has an elevation, in the northwestern part of the area, of from 1,300 to 1,500 feet above the sea, but gradually diminishes in height eastward to the broad declivity through which Nelson and Hayes rivers,



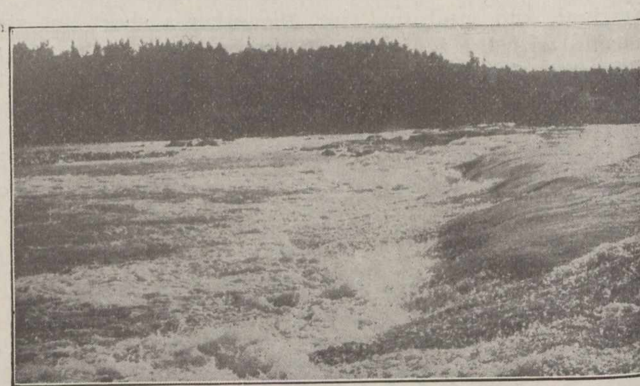
Fall on the Rapid River, Near the Churchill.

and, in part, Churchill River, flow to the sea. In the neighborhood of Sipiwesk Lake, which lies about in the middle of the depressed area, the elevation of the surface above sea-level is about 600 feet. There are no high elevations, and the general level of the interstream areas is not more than 100 to 200 feet above the level of the streams.

The plateau has a gently rolling surface characterized by rounded outlines which have resulted from long continued and profound erosion. It is intersected by rivers and streams innumerable and is dotted with lakes of all sizes. The river valleys are moderately depressed, and are made up generally of chains of rock-bound basins which form series of lake-like expansions along the rivers, the water spilling over the lowest part of the rims and flowing from basin to basin with swift current or over a succession of rapids and falls.

The surface is wooded throughout, though, except in the valleys of the larger streams, the forest growth is of small size. North of latitude 59° or thereabouts, the forest is mainly black spruce and tamarack of stunted growth, a growth which characterizes also the muskeg portions of the southern area.

To the northeast, where the horizontal limestones of the Hudson Bay basin overlie the older rocks, the surface is of the nature of a gently sloping, flat plain. The level character is due, in part, to the horizontal attitude of the rocks and, in part, to a covering mantle of boulder clay



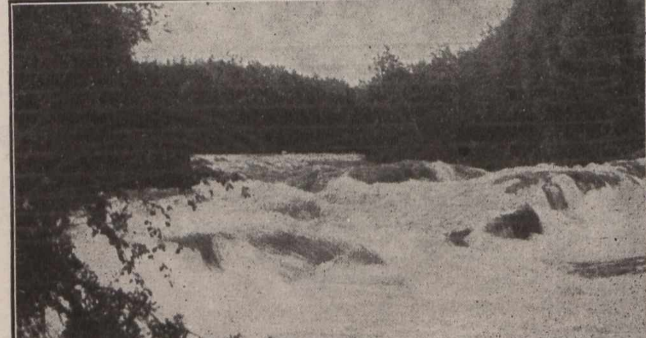
Sea-river Fall, Nelson River.

of somewhat uniform thickness. In this, and to some extent in the underlying, solid rock, the rivers have trenched narrow channels, which constitute the only breaks in the surface.

The overlap of the Cretaceous sediments to the south is marked for a hundred miles west of Lake Winnipegosis by the bold escarpments of the Porcupine and Paskwia hills, and farther west by the equally high but gently sloping outlines of the Wapawekka hills.

The country about Montreal Lake and east of it is characterized by heavy accumulations of drift, which form somewhat prominent hills that reach heights of over 2,000 feet above the sea.

Drainage.—The whole of the area under consideration, except a small tract in the northwest corner, is drained by rivers flowing to Hudson Bay; of these, the Nelson and Churchill are the largest, the first named taking rank among the half-dozen largest rivers of the continent.



Sturgeon-wier River, Saskatchewan.

The Nelson, which empties from Lake Winnipeg into Hudson Bay, is 1,660 mi. in length, measured to the head of its longest tributary, the Bow, and drains an area of 370,800 sq. mi., of which about 313,000 sq. mi. are in Canada. Its drainage basin embraces all the country, westward to the mountains, lying between the watersheds of Churchill and Athabaska rivers to the north and the Missouri to the south, and eastward to the head-waters of Albany River and to within 50 mi. of the head of Lake Superior.

Its volume is computed to be 118,400 cu. ft. per sec. at extreme low water, measured just below Sipiwesk Lake and above the inflow of the large tributaries, Clearwater, Grass, and Burntwood rivers. The river is made up, by the union in Lake Winnipeg, of the Saskatchewan, Red, Assiniboine, Winnipeg, Berens, and many smaller rivers, and is augmented in volume after leaving the lake by receiving several large tributaries.

The water of the river is somewhat murky from suspended sediment, but gradually clears as it passes through the numerous lake expansions along its course, thus the amount of matter in suspension is 2.565 gr. per Imp. gal. below Lake Winnipeg and only 0.552 gr. near the mouth. The water of the Saskatchewan, near Cumberland, was found to contain 16.60 gr. of solid matter to the Imp. gal., while that of the Nelson, below Sea-river falls, contained 17.1 gr., and at its mouth, 12.528 gr.

The Churchill is 1,000 miles in length and has a drainage basin 115,500 sq. mi. in area. The water along part of the river's course is slightly murky. It contains above the mouth of Reindeer River, 7.96 gr. of dissolved solid matter to the Imp. gal. As is the case with the Nelson, the many lake expansions serve as settling basins, and the water, before reaching Hudson Bay, becomes quite clear. Its largest tributary, Reindeer River, flowing from Reindeer Lake and draining, as it does, part of the Pre-Cambrian peneplain, has very clear water, containing 2.02 gr. of dissolved solid matter to the Imp. gal.

Hayes River, with a length of 180 mi. and a drainage basin about 28,000 sq. mi. in area, drains a belt along the eastern edge of the area mapped; its water is remarkably free from suspended sediment, and carries only 0.878 gr. of solid matter to the Imp. gal.

The tract to the northwest, above referred to, sheds its water westerly into Athabaska Lake, to finally reach the Arctic Ocean by Slave and Mackenzie rivers.

Water-powers.—The total amount of power capable of being developed from the many falls and rapids which occur on the rivers within the area, is almost incalculable. Some of the rivers are of great volume and all, along parts of their courses, have rapid descents.

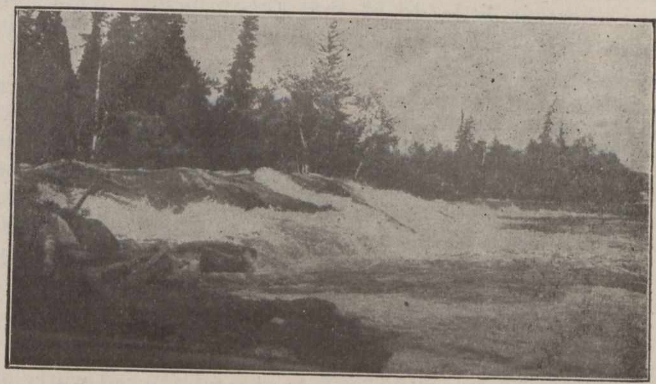
Of the rivers, the Nelson, by reason of its great volume and numerous falls, is the most important from the point of view of power development. Between Lake Winnipeg and Split Lake, a distance of about 230 mi., the river has a descent of 240 ft., and between Split Lake and the sea, 200 mi., a descent of 470 ft. The greatest fall occurs in the portions of the river between Cross and Sipiwesk Lakes, where there is a total descent of over 90 ft. in 28 mi., and between Gull Lake and the foot of Limestone Rapid, where the descent is 396 ft. in about 67 mi. There are a great many lake expansions along the course of the river, and between them, rapids and falls, to the number of fifteen or more, occur. Some of the falls offer excellent sites for water-power plants, and at several the vertical drop is considerable: at Ebb-and-Flow Rapid there is a fall of 11 ft.; at Whitemud Fall, 30 ft.; at Bladder Rapid, where the whole river flows in one channel for the first time after leaving Playgreen Lake, 11 ft.; at Over the Hill Rapid, 10 ft.; at Redrock, 10 ft.; at Grand Rapid, 20 ft.; at lower Gull Rapid, 50 ft. and at Kettle, Long Spruce, and Limestone Rapids, drops of 50 ft. within a mile or so of distance.

When the great volume of the river is taken into consideration, amounting to 118,400 cu. ft. per sec. at low water, or about four times the volume flowing over the Chaudière Falls at Ottawa and one and a half times that at Sault Ste. Marie, it will be seen that the total amount of available power is very great.

Other high falls are Missi Fall on Churchill River, just below Southern Indian Lake, where the vertical descent is in the neighborhood of 20 ft.; Grand Rapids, at the mouth of the Saskatchewan, with a descent of nearly 100 ft.; a fall 30 ft. in height on Rapid River near the Churchill, and Manazo Fall on Burntwood River where the vertical drop is about 30 feet. In addition to these, falls and rapids almost innumerable occur along the courses of all the rivers and streams of the region.

In a report on the water-powers of Canada, published by the Commission of Conservation in 1911, an estimate is made of the horse-power available at a few of the falls and rapids within the district. On the Saskatchewan the estimate is made for only two of the rapids, namely:—

Cole Rapid, minimum h.p.	14,700
Grand Rapid, minimum h.p.	80,000



Trout Fall, Above Knee Lake, Hayes River.

On the Nelson River the horse-power is calculated for eleven rapids, and aggregates 6,859,000, divided as follows:—

	Approximate head, in feet.	Estimated horse-power.
Limestone Rapid	85	1,140,000
Long Spruce Rapid	85	1,140,000
Kettle Rapid	96	1,290,000
Gull Rapid	67	900,000
Birthday Rapid	24	320,000
Grand Rapid	20	270,000
Rapids above Sipiwesk Lake	31	416,000
Whitemud Fall	30	403,000
Whitemud Rapid	30	403,000
Ebb-and-Flow Rapid	11	148,000
Rapids above Cross Lake	45	605,000

The report for 1913 of the B.C.E.R. Company of Vancouver, B.C., shows a construction of 36.07 miles of new line, as follows:—Vancouver and suburban system, 9.66 miles; and Victoria city system and Saanich interurban line, 26.41. The total single track mileage of the system, December 31, 1913, was 370.09. During the last year the company has made the following additions to its rolling stock:—Three closed passenger motor cars, 43 feet 4 inches long; two combination passenger and mail motor cars, 38 feet; 30 freight box cars, 60,000 tons capacity, 40 feet; 30 freight flat cars, 60,000 tons capacity, 41 feet; three sweepers for city service, 28 feet 3 inches; 15 logging cars, 80,000 tons capacity, 42 feet.

PURE vs. IMPURE DRINKING WATER

THE bearing which the impurity of water supply has upon the typhoid death-rate was indicated fairly well in an article by Mr. J. W. Ellms, filtration superintendent, Cincinnati Waterworks, in the December, 1913, issue of the American Public Health Journal. The article referred to conditions in Cincinnati before and after a purified water supply had been established.

For the three years preceding the installation of a purification system the typhoid death-rate averaged 53 per 100,000 population. For the five years following the purification of the water supply the death rates per 100,000 were 19, 13, 5.7, 11.4, and 7.1, respectively. This represents an average reduction in the number of deaths from this disease of nearly 80%. The reduction in the cases reported is very nearly 85%, when estimated for this same period. Whether other sanitary reforms approximately coincident with the purification of the water supply have not played some part in the diminution of cases from this disease, the writer is not prepared to say; but there is little doubt that the principal agency has been the substitution of a pure for an impure drinking water.

A study of the accompanying table with a view to establishing some relation between the fluctuations in the typhoid death-rate and the quality of the water does not lead to any very positive conclusions. It immediately raises a question as to whether we really obtain any direct measure of the purity of a water in the usual bacterial examinations which are made. So far as the total number of organisms removed is concerned these results indicate a water of high purity. On the other hand, the presence of fecal or gas-producing organisms likely to be associated with the typhoid bacillus, as shown by the presumptive positive B. coli figures, would lead one to believe that the entire absence of these organisms in a water is by no means absolutely necessary as an indication of what experience has shown to be a safe drinking water. The reduction in the number of B. coli effected by filtration alone is evidently in the same proportion as that obtained in the reduction of the total number of bacteria. No selective action takes place in filtration, although there appears to be some such action when the disinfecting agent, calcium hypochlorite, is used.

So long as bacteriology is unable to furnish reliable and rapid methods for the isolation of pathogenic organisms in water, it will be necessary to rely on circumstantial evidence, such as has been furnished by the remarkable reduction of typhoid fever in Cincinnati, following the introduction of a purified drinking water. Since all those cases, in which the source of the infection remains untraced, may have been infected through agencies such as flies, shell-fish, raw vegetables, fruits and bacillus carriers, it reduces the probability of our present purified drinking water being a source of infection to practically zero.

Comparison of the Typhoid Fever Death-Rate With the Hygienic Quality of the Water Supply of Cincinnati, 1909 to 1912.

	1909.	1910.	1911.	1912.
Typhoid-fever death-rate per 100,000 of population	13	5.7	11.4	7.1
Percentage reduction from average death-rate for three years preceding introduction of filtered water supply	75	90	79	89
Average number of bacteria per c.c.—				
In river water	9,300	8,900	13,790	11,130
In filtered water	75	75	39	26
Percentage reduction of bacteria by purification	99.2	99.2	99.7	99.8
Yearly percentages of presumptive positive B. Coli results obtained in various amounts of the river and filtered water—				
In river water in 1 c.c.	93.2	91.0	85.3	93.5
In filtered water in 1 c.c.	1.0*	7.9*	5.2†	3.0‡
In filtered water in 100 c.c.	66.0*	65.0*	84.3†	51.6‡
Percentages of presumptive positive B. coli results in 100 c.c. of filtered water for the period of disinfection—				
Before disinfecting filtered water	....	....	88.9	89.3
After disinfecting filtered water	....	....	12.8	27.7

*No sterilizing agent used. †Disinfection with calcium hypochlorite for first three months of 1911. ‡Disinfection with calcium hypochlorite for first six and one-half months of 1912.

The project is being advanced by the Conservation Commission of New York State, which is akin to that of the Hydro-Electric Commission of Ontario. It is proposed to conserve, own, and develop, all the water powers in New York, so that eventually every factory in the state will be operated by electric energy and every house illuminated. It involves the further use of the Niagara Falls on the American side, the use of the Long Sault Falls, on the St. Lawrence, the Genesee Falls and the surplus water of the barge canal between Troy and Schenectady. Power on every stream in the state, will be taken over, and connected with the general plant so that in time the state, for many purposes, if not for all, will be independent of the coal interests.

Some time ago the company which supplies Berlin, Germany, with electric current, acquired lands with extensive deposits of lignite or brown coal at Bitterfeld 83 miles south of Berlin, and decided to build a power plant there to generate electricity for Berlin. Upon further exploration, however, the deposit of lignite turned out to be so vast that the company determined to build a plant large enough to supply all the towns within a radius of about 100 miles. The company thinks that it has an ample supply of lignite for nearly a 100 years. It will turn the coal directly into electricity; and this it proposed to do so economically that electricity will be used even for cooking and heating, because no other kind of fuel will be able to compete with it in price.

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CONTENTS OF THIS ISSUE.

DEFECTS IN THE TORONTO BUILDING BY-LAW.

There is an annual waste of at least three-quarters of a million dollars in the construction of buildings in Toronto. This statement in Prof. Young's report to Judge Denton in connection with the investigation into the manner in which the work of the City Architect's Department is being conducted strongly substantiates the introductory reference to the structural features of the by-law being lacking in conformity with good engineering practice.

In May, 1911, a Citizens' Committee, composed of prominent representatives of Toronto's technical and business organizations undertook a careful study of the by-law which was then in force, and, after detailed comparisons with those of other cities, drafted a memorial to the City Council, urging a speedy revision, and outlining the important alterations, with proposals for their rectification. A year later the draft of a new by-law was completed by the city, in which a little of the undue severity of the old by-law towards reinforced concrete construction was removed. Much credit is due the Citizens' Committee for the modification of many of the restrictions. It is regrettable that the recommendations advanced in its memorial were not more extensively adopted.

During the past month the City Architect's Department has been under civic investigation, with a view to ascertain to what extent alleged inefficiency was founded upon fact. The investigation has included a consideration of the existing building by-law, and Prof. C. R. Young was retained as consulting engineer to interpret its chief unfavorable features. Some of the more important of them are enumerated in the article appearing on another page of this issue.

Striking among the defects of the present by-law is the discouragement which it presents to prospective industries. In addition to the remarkable lack of inducement held out to them to locate in Toronto, the high price of land and the unrelenting taxation are accompanied by another repelling force in this advanced cost of construction of buildings. Toronto, a most favorable location, geographically, barricades itself against desirable industries by measures that make conditions prohibitive to them.

PROMOTING EFFICIENCY IN SMALL WATER PURIFICATION PLANTS.

With our present development of the art of design and operation of water plants, and especially those plants which rely upon some form of chemical treatment, there exists an entirely inexcusable neglect of the equally important matter of daily operation. More particularly in the case of small plants do these discrepancies show themselves. In Mr. Letton's paper, appearing, in part, in this issue, some distinctive points are presented on the manner in which the typical small water purification system is inefficient, and some remedies worthy of note are suggested.

The operation of a small plant is undoubtedly a difficult problem. It requires the same class of skilled supervision that a large plant must have. Attention of this kind makes the cost of maintenance high, showing up very prominently when the operating costs of the plant are compared with those of another plant of 50 or 100 times the capacity. The appearance of excessive cost of supervision is prevented by employing untrained operatives, and the logical result is neglect of those vital points which make the plant efficient.

In discussing the paper Prof. Geo. C. Whipple, of Harvard University, expresses his opinion to be that the safety of such plants must lie in the education of the low-salaried attendant and in the selection of such sources of supply that irregularities in operation will produce less disastrous results than in the case of larger plants where a higher grade of supervision is possible. To secure the better appreciation by the operator of the general principles of sanitation, and a better understanding of the work which a particular filter is capable of doing, the supervision of the state authorities should be not so much punitive as pedagogical.

Another remedy that has been suggested is the establishment of laboratories at convenient points to serve two or more small plants. Another is the employment of a consulting engineer in connection with operation as well as with installation. A third advocates a capable supervising engineer over several small systems on a co-operative working agreement.

The importance of efficiency in a plant of small capacity is as great to that community as it is in the case of any other plant. The question of placing water supply problems in every case in the hands of those who can deal scientifically with them has not received the attention it deserves. It is becoming more and more evident that the engineer must work in conjunction with the chemist and the bacteriologist in solving them. For small municipalities, therefore, there appears to be much of value in co-operation, each contributing toward the maintenance of such services.

PRESERVATION OF REFERENCES.

The engineer who is seeking a new position and who is fortunate enough to possess a valuable set of creditable and convincing references should consider them in the same light as he would any other property which is of value. The man who finds himself out of employment hastens, too often, to launch applications promiscuously, enclosing with them his original testimonials, and when they thus pass out of his possession they do not always return.

There is no advantage to be derived from a transmittal of the original references with letters of application for positions. Carbon copies fully convey the desired information, and do not entail a serious loss if they are mislaid. Moreover, an employer whose custom it is to place dependence upon such evidences of ability, training, character, etc., will see to it that they are bona fide before converting the applicant into an employee.

At first thought this may appear a trivial subject, but we are prompted to impart the advice by the experience of our Employment Bureau. Letters are being received continuously with the original references enclosed. Other applicants regret inability to furnish references owing to their having been previously lost or to their being out "on duty" in connection with another application. Frequently inquiries are received as to the safe keeping of these commodities.

The Canadian Engineer Employment Bureau keeps a permanent record of the professional standing and experience of its applicants for positions. Testimonials are preserved therewith in order to render the service more complete. Carbon copies are all that are required, it being understood that the original of each is in the proper possession of the applicant in order that he may have immediate recourse to them when an employer is disposed to consider original references only.

LETTER TO THE EDITOR.

THE BILLING'S BRIDGE (OTTAWA) DESIGN.

Sir,—It was not the writer's intention to enter into a controversy with anyone about the Billing's bridge at Ottawa. My only intention was to draw attention to the all too prevalent practice of building light floors on highway bridges. Mr. Henham, in his letter in *The Canadian Engineer* of February 19th, has made several statements which are so far removed from the facts that I feel obliged to correct them.

In the first place, I cannot agree with him when he uses $\frac{w\,l^2}{12}$ as the formula for the bending moment. I have never seen a specification of any authority which would permit such use. The general formula specified for continuous beams is $\frac{w\,l^2}{10}$, or, as some specifications state, "$\frac{8}{10}$ of the bending moment figured as a simple beam." (See clause 14, page 9, of the General Specifications for Concrete Highway Bridges of the Ontario Highway Board.)

In the second place, he states that "dividing the bending moment by the moment of resistance of the steel gives the sectional area required per ft. of width as 0.6 sq. in." I fail to understand what Mr. Henham means by this.

If the slab were designed properly, the moment of resistance of the steel would equal the moment of resistance of the concrete, and also the bending moment in the slab. This condition of design is obtained when the bending moment, M, = 108 bd^2 (where b = width of beam and d = effective depth), and when .78% of bd is the area of steel supplied. The above figures are only true when the compressive value of the concrete is assumed at 650 pds. per sq. in. and the tensile value of the steel is 16,000 pds. per sq. in. These are the most common values used. The deductions of these formulæ are to be found in any up-to-date text book on reinforced concrete. The bending moment as given by Mr. Henham is 3,500 ft. pds., or rather 4,200 ft. pds. when we use the formula $\frac{w\,l^2}{10}$. For this moment we require a slab of 6¼ inches effective depth.

In the third place, I cannot see how Mr. Henham can figure the truck load as 3,800 pds. per ft. of width. Taking his distribution of loading, i.e., 1.16 ft. × 1.83 ft. (the 1.83 dimension at right angles to stringers), this gives, in my opinion, a loading of $\frac{8{,}000}{1.16}$ = 7,175 pds., and this load is uniform on the slab for width of 1.83 ft. The resulting bending moment is 4,630 ft. pds. and requires a slab of 6½ in. effective depth.

The loading Mr. Henham used is all right, the difficulty seeming to be in the design of the slab.

E. M. PROCTOR.

Toronto, February 24th, 1914.

DOMINION LAND SURVEYORS' ASSOCIATION.

The eighth annual dinner of the Association of Dominion Land Surveyors will be held at the Chateau Laurier, Ottawa, on March 3rd, at 8 p.m.

THE STRUCTURAL REQUIREMENTS OF THE TORONTO BUILDING BY-LAW OF 1913

BASED ON A REPORT SUBMITTED FEBRUARY 20th, 1914, TO JUDGE DENTON IN CONNECTION WITH THE INVESTIGATION OF THE CITY ARCHITECT'S DEPARTMENT, TORONTO.

By C. R. YOUNG, B. A. Sc., M. Can. Soc. C.E.
Assistant Professor of Structural Engineering, University of Toronto.

THE structural requirements of the Toronto Building by-law are in many respects not in conformity with good engineering practice. It is true that more conservative by-laws may be found, but these can in no sense be said to afford proper standards for the judgment of any building by-law under review. For the records of the best engineering practice one must turn to the published specifications of great engineering organizations, or of governments, or of railways, or to the writings of the leading structural engineers and to those of the more recent building codes which have been revised by structural experts or with their co-operation. It is entirely erroneous to regard building by-laws in general as expressive of good practice, for not only are they generally several years behind the times, but they have often been framed by one man and not infrequently show the handiwork of lay bodies who have the deciding voice in the inclusion or rejection of technical regulations. As compared, then, with what is best in modern construction, the Toronto by-law is faulty in many particulars.

No attempt has been made to present an exhaustive discussion of the shortcomings of the by-law. A few of the striking transgressions of good practice have been chosen for comment and an effort has been made to show in so far as possible, without undue labor, the practical outcome of the erroneous provisions.

FIREPROOFING OF EXTERNAL COLUMNS.

Sub-section 44, page 22.—An instance of undue severity is afforded in the requirement of *nine* inches of brickwork plus *one* inch of cement grout on the outside of iron and steel columns in external walls. No better proof of this is needed than the fixing in the same sentence of the protection for the inside of such columns at four and one-half inches of brickwork, or approximately one-half as much as for the outside, in spite of the fact that the temperature of a fire inside a building is much higher than that of a fire outside of it. If such were not the case, articles to be heated would be placed in an open fire rather than in a confined one.

A further admission of the sufficiency of four and one-half inches of brickwork for fireproofing is contained in the same sub-section, in specifying this thickness for the outer sides of beams or girders carrying the external walls. That there is no chance of a fire affecting steelwork situated 4½ inches from the surface of a brick casing is evident from the fact that the outer edges of the flanges of these beams and girders may project to within two inches of the outer surface. If 5½ inches of protective covering will not prevent a fire from softening the metal in external columns, certainly 4½ inches will not prevent the same fire from endangering the wall girders. With their collapse the lateral support of the wall columns would be removed and the columns would fail by buckling in the direction of the wall. The integrity of the building at one point thus depending upon 4½ inches of fireproofing, what reason is there for requiring 10 inches at a point subjected to the same destructive agency?

Perhaps the most convincing evidence of the sufficiency of 4½ inches of brickwork as fireproofing for external columns is seen in the adoption of a less thickness by the City of San Francisco in the revision of its building code after the great earthquake and fire and after having placed before it the conclusions of a special investigating committee of the American Society of Civil Engineers. For fireproofing all around such columns the requirement of the San Francisco code is but two and three-quarters inches of brick set in cement mortar, although the hazard in that city is much greater than in Toronto, due to the possible combination of earthquake and fire.

It is of interest to note further that Chicago, in its new building code, which was framed by a commission with large expert representation on it, permits four inches of brickwork all around external columns, while the City of St. Louis permits three inches.

The monetary loss involved in the excessive fireproofing of external columns would, for a 10-story building, say, 80x100 ft., amount to approximately $2,500.

CURTAIN WALLS.

Sub-section 44, page 23.—Since curtain walls carry only their own weight and usually for only one story in height, in certain cases it is absurd to require 14 inches of brickwork for them. In many industrial buildings where the curtain walls cover only 3 or 4 feet of vertical space immediately below the windows, the wastefulness of building in 14 inches of brickwork or plain concrete is apparent. In all buildings the space between the top of a window in one story and the bottom of a window in the next story above might safely be filled in with any material equivalent to wire glass in fire-resisting properties.

The contention that heavy brick walls are needed to prevent falling walls from breaking into a building is groundless, for no matter how heavy the curtain walls might be, falling walls could expose the interior of the building to flames by breaking through the windows. Nor is the relative smallness of the window areas any safeguard, for there is nothing to prevent the builder from constructing, and, indeed he often does construct, the whole space between columns from one floor to another of glass, but if he wishes to use brickwork at all it must be 14 inches in thickness. From this it follows that, according to the Toronto building by-law, one thickness of glass has a protective value as great as 14 inches of brickwork or plain concrete.

That a thickness of 9 inches of brickwork under and over windows is adequate should follow from the fact that 9-inch walls are permitted by the by-law for severer conditions of loading than exist in curtain walls. Perhaps the best example of this is the use of 9-inch walls for the external, load-bearing walls of dwellings two stories in height. While curtain walls sustain only their own weight for one story of height, these bearing walls carry the entire weight of the floors and roof in addition to their own weight, for two stories in height.

A further abuse in the matter of curtain walls exists in the requirement that they shall be increased by 4½ inches in thickness below the uppermost 75 feet of the building and by an additional 4½ inches for each 60-ft. section below that. For the same story heights, curtain walls in the lower stories carry no more load than those in the upper stories and the thickening is no guarantee that falling walls may not break through into the building. Windows are allowed on any side of a building and may fill entire panels of wall space, as they very often do for the first story or two above ground.

The practical effect of this indefensible curtain wall specification is to increase the weight and size of the wall girders, wall columns and wall footings, to add a great deal of unnecessary brick, concrete or tile to the walls and to reduce the available floor space. Actual estimates show a financial waste for this reason alone in representative buildings running into thousands of dollars. For a 10-story building, say, 80x100 ft., the waste, neglecting the value of lost floor space, is from $7,000 to $10,000. In a memorandum submitted by Mr. A. H. Harkness, of Harkness and Oxley, consulting engineers, to Judge Denton in the recent enquiry into the City Architect's Department, it was shown that the cost of the Dominion Bank Building was increased by $14,200 by reason of the requirement that curtain walls shall be thickened below the top 75 feet of the building. Of this, $9,200 was for extra masonry and $5,000 for extra steel. Mr. Harkness also calculated that the loss in *annual* rental value because of the reduction in available floor space is $5,900. Capitalized at 6 per cent., this amounts to an investment of approximately $100,000. For the Canadian Pacific Railway Building, the cost of excess masonry was $6,150 and of excess steel $3,900, making in all, $10,050. The loss in annual rental value is $5,150, which when capitalized represents an investment of about $85,000. In the case of a large building in another city where the same antiquated regulations are in force the waste of steel alone involved in the thickening of curtain walls below the top 75 feet was 800 tons with a value of $45,000, not counting the cost of the masonry nor the value of the lost space.

SAFE LOADS ON BRICK WORK AND MASONRY.

Sub-section 19, page 44.—According to tests made in the University of Toronto laboratories, the average crushing strength of ordinary brick masonry laid in lime mortar is 67 tons per square foot, and when laid in cement mortar, 122 tons per square foot. In view of these results it is interesting to note the following safe loads per square foot specified for brick masonry in the Toronto by-law:

Kiln run bricks laid in lime mortar	4 tons
Ordinary brick laid in Portland cement mortar..	6 tons
Hard brick laid in lime mortar	7 tons

It is thus evident that in Toronto the average factor of safety required for ordinary brick laid up in lime mortar is 17, and for ordinary brick work with Portland cement mortar no less than 20. For walls, piers or other like supports a factor of safety of over 10 or 12 is uncalled for and its requirement results in a great waste of material.

A striking commentary on the lowness of the allowable pressures on brick masonry is afforded by comparing them with the following permissible loads per square foot on soils established by the by-law:

Gravel and coarse sand, well cemented	8 tons
Dry, hard clay	4 tons
Sand, compact and well cemented	4 tons

From the above two tables it is evident that a well compacted gravel or coarse sand is considered to be capable of sustaining more load than any one of the three grades of brick masonry mentioned and twice as much as kiln run bricks laid in lime mortar.

It is of interest to note, too, that with respect to the load that would result in dangerous, crack-producing settlements, the factor of safety involved in the above permissible soil pressures is from 2 to 3, while the factor of safety required on brick masonry is from 17 to 20.

A study of the available records of tests of brick masonry indicates that the specified safe loads on brick work might, with perfect security, be increased 33 per cent., and still allow a factor of safety of at least 12. The waste in brick piers, as at present constructed, is therefore 33 per cent.

The safe pressure on walls and piers of concrete is also much too low and should be increased.

CAST IRON COLUMNS.

Section 16, page 74.—In view of the results of tests on full-sized cast iron columns, and the large element of uncertainty attending their manufacture and use, the safe loads specified for these columns in the by-law are undoubtedly excessive. A factor of safety of less than four, which the by-law permits in the case of the most heavily loaded columns is manifestly insufficient when it is remembered that with the far more reliable material, structural steel, the factor of safety demanded is four. No acknowledged authority known to the writer sanctions a factor of safety of less than 5 for cast iron columns and for this reason the safe loads allowed by the by-law should be reduced for certain columns by over 20 per cent.

PLATE GIRDERS.

Sub-section 4, page 77.—The provisions of the by-law respecting plate girders are not in accordance with good engineering practice. In order to satisfy them, girders must be made considerably heavier than would be required for the support of the same loads in most of the railway and highway bridges of the country. Thus, a plate girder constructed according to either the specifications of the Canadian Pacific Railway, the Grand Trunk Railway, the Canadian Northern Railway, the Dominion Government, the Ontario Government, or the Canadian Society of Civil Engineers would not be acceptable for use in a building in Toronto. The absurdity of this is still more apparent when it is remembered that a bridge girder must withstand large and uncertain stresses due to impact and vibration and is subjected to rapid corrosion from moisture and locomotive gases, while a building girder carries quiescent loads and is but little exposed to corrosion. Another remarkable fact is that plate girders in bridges built by the Works Department of the City of Toronto, and conforming as they do to the above-mentioned authoritative specifications, would not pass the city building by-law, and would be regarded as unsafe by the City Architect's Department. On the other hand, if all the city bridges are safe, there is an unpardonable waste of material in the girders which the by-law requires to be used in buildings.

Some indication of the unreasonable exactions of the by-law in this particular may be had from the following estimates made by the writer. A girder built in accordance with the by-law to carry a load of 100 tons would, according to the specifications of the great railways, the Dominion and Ontario Governments, the Canadian Society of Civil Engineers and the Works Department of the City of Toronto, be entirely safe for a load of 122½ tons. A girder designed for 200 tons according to the by-law would be safe for a load of 238½ tons. To put the matter generally, girders designed in conformity with the Toronto building by-law will carry with the factor of safety demanded by the railways, for example, from 17 to 35 per cent. more than they are at present permitted to carry.

The waste of material involved in following such an antiquated plate girder specification varies with the capacity and span of the girder but lies normally between 8 and 10 per cent. Plate girders as used in the buildings of Toronto thus cost from 8 to 10 per cent. more than they should. In the new Dominion Bank Building at the corner of King and Yonge Streets, $1,200 was absolutely wasted on this one item alone. In the new Royal Bank Building the corresponding loss will be $1,400, in the Toronto Technical School it will be $2,100, and in the new Methodist Book Room it will be about $2,200. From these, and other facts it is apparent that not less than $25,000 is expended every year in putting excess material into plate girders, which, as far as use is concerned, might quite as well be thrown into the sea.

SAFE LOADS ON TIMBER COLUMNS.

Section 18, page 80.—The safe loads on timber columns are much lower than are sanctioned by almost any good specification that might be named, and do not correspond at all to the results of actual tests. For example, a long-leaf yellow pine column 12 x 12 ins. and 15 ft. long and which would not be allowed to carry more than 52 tons by the Toronto by-law would be considered entirely safe for a load of 61 tons in Boston, Buffalo or Minneapolis or a load of 64 tons in Chicago, or a load of 70 tons in Baltimore or in a structure built by the Works Department of the City of Toronto 65 tons, or in any structure built in accordance with the requirements of either the Dominion or Ontario Governments a load of 68 tons. It is not remarkable that a column which a Toronto contractor must put into a building to carry a certain load, would, if put into a civic bridge in the same city, be allowed to carry a load of 24 per cent. greater, or if put into any bridge sanctioned by either the Dominion or Ontario Governments a load 31 per cent. greater? And this is not by any means the worst case, for with columns of greater slenderness the exactions of the by-law are still greater.

The practical result of this is that the cost of the columns of mill construction buildings, is on an average 25 per cent. greater than it should be.

FLOOR LOADS.

Section 23, page 86.—The specified live loads for which floors are required to be designed are in a number of cases greater than are at all likely to occur in the life of the buildings concerned, and in the interests of economical construction some reduction in such loadings should be made. A careful comparison of the prescribed loads set forth in the by-law with the results of actual investigations, with recent authoritative specifications and with such building codes as have been revised recently, indicates excessive requirements in the Toronto by-law. Two instances will suffice to show the need of careful consideration of the present specified loadings.

Paragraph d, page 87.—It has been clearly shown by careful determinations of the maximum loads on the floors of office buildings, that the loads in the offices themselves, above the ground floor, will ordinarily never exceed 40 to 50 pounds per square foot. A thorough investigation of this kind was made by Messrs. C. H. Blackall and A. G. Everett in three large office buildings in Boston. For each room the weights of the furniture and contents and of the greatest number of people known to have been in it at any one time were taken, and the greatest load thus found in any one office was 40.2 pounds per square foot. In only 12.4 per cent. of the offices was the maximum known floor load in excess of 25 pounds per square foot and in only 26 per cent. was it over 20 pounds per square foot.

In the light of these and other observations which might be cited, a floor load in offices of 75 pounds per square foot as is required in Toronto appears to be extravagant and should be reduced to 50 pounds per square foot. Partitions should be considered as an additional load.

As an instance of the adoption of rational floor loads for office buildings, the recently revised building code of the City of Chicago places the loads at 50 pounds per square foot *for all floors and corridors* with partitions extra.

Paragraph f, page 87.—A consideration of the character of the loading on school room floors and of the conditions existing in such buildings leads to the conclusion that 75 pounds in rooms and 100 pounds in corridors and lobbies are excessive live loads. A mixed throng of children averaging, perhaps, 75 pounds each in weight cannot impose upon a floor any such load as a throng of adults averaging 150 pounds each. Investigations will show that while children weigh on an average half as much as adults they occupy two-thirds as much space, and therefore the intensity of loading due to a throng of children should not be over three-quarters of that due to a throng of adults. If, then, a load of 75 pounds per square foot represents, as the by-law assumes, the probable weight of a mixed crowd in the main entrance halls of hotels, apartment houses, tenements and boarding schools and in the corridors and halls of office buildings, surely it should be an adequate allowance for the live load in the corridors and lobbies of schools where the typical crowd will weigh 25 per cent. less. Nevertheless, the by-law requires the latter to be figured for 100 pounds. In the school rooms, where the seats are generally fixed, a load of three-quarters of that specified for the corridors and lobbies, or, say, 60 pounds per square foot should be entirely adequate.

The propriety of these loads for schools is evidenced by the fact that the framers of the new Chicago code fixed the maximum loads for the assembly halls, corridors and stairs of schools at 75 pounds per square foot and for all other parts 40 pounds per square foot.

REDUCTION OF LIVE LOADS ON GIRDERS.

Since a girder can receive its maximum load only when the beams which it supports are fully loaded, it follows that a much larger area must be covered for the maximum load on a girder to arise than it is necessary to cover for the production of the maximum load on a floor beam. In an average case these areas are as three to one, and for many floors the area to be covered with the stipulated floor load before a girder can receive its maximum stress is six or seven hundred square feet. Manifestly, the probability of an area of this size being *entirely* covered with the full floor load is very small. Even in the case of storage warehouses, where the probability is greatest, a considerable percentage of floor space must be left for aisles. The requirement of the Toronto by-law that girders must be figured for the same floor load per square foot as beams are figured is therefore entirely indefensible.

The completely covered proportion of the area sending load to a girder is variously estimated. Mr. Gunvald Aus, the consulting engineer on the world's greatest building—the Woolworth Building—favors making it two-thirds. A considerable number of cities fix it as substantially less than the full area. Chicago, Boston Philadelphia, Pittsburgh, Cleveland, St. Louis and San Francisco may be cited as instances. The reduction fixed by the building codes of these cities for most types of buildings ranges from 10 to 20 per cent., with an average of 15 per cent. That is, girders in most buildings, according to the codes mentioned, would be figured for only about 85 per cent. of the full possible floor load. The only kind of building for which the full floor load is required to be figured in the cities named is the warehouse or heavy mercantile building, and not even for these in all cases. The writer is thoroughly convinced that the calculation of girders for more than 85 per cent. of the full live load, except in the case of warehouses, is an extravagant and unnecessary procedure.

The practical result of the severe requirements of the present by-law with respect to girders has been estimated by the writer for different types of buildings and is as follows: For office buildings the increased cost of girders is approximately 4½ per cent.; for stores it is about 5 per cent.; while for factory buildings it is about 5½ per cent. The effect upon the cost of the beams, girders and columns is to increase it by from 1½ to 2 per cent. For a building in which these structural parts cost $100,000, the waste involved by this regulation of the specification alone is from $1,500 to $2,000.

REDUCTION OF LIVE LOAD ON COLUMNS.

Section 12, Sub-section 1, page 38.—Since the live load borne by a column in any story is derived from an area very large in comparison with the area tributary to either a floor-beam or a girder, a smaller floor live load should be used for figuring columns than for figuring floor-beams or girders. Admission of this principle is made in the by-law, but the probable maximum load, particularly for columns a long way down from the top of the building, is greatly overestimated.

Thus, to illustrate, in a typical office building, a column in the 12th story down from the roof must be figured for 76 per cent. of the maximum loads to be carried by the roof and all the floors above while most structural engineers consider 80 per cent. of the full specified live load as adequate for girders and even many of the building by-laws require only 85 per cent. of the full floor load for girders. The absurdity involved is most evident when it is remembered that the area which must be covered for a *full* load on the column mentioned is 24 times that which must be covered for a full load on a girder. Surely if not more than 80 or 85 per cent. of an area delivering load to a girder is likely to be fully loaded, an estimate of a full load on 76 per cent. of an area 24 times as great is altogether illogical and unsound.

The unreasonable demands of the by-law in this particular may be shown in still another way. For the column in the twelfth story down from the roof, after allowing for a full snow load on the roof and the weight of furniture, office equipment, safes, etc., on all floors, no less than 5,000 people would, in an average case, need to be massed about this column on the area contributing load to it in order to realize the load for which the Toronto by-law would require the column to be figured. The writer has estimated that even in a building with first-class elevator equipment it would take 3½ hours to distribute these 5,000 persons to the various floors, with none descending.

While the exacting character of these regulations respecting column live loads is less striking for columns nearer the roof than for the one forming the subject of the illustration, the waste involved is considerable, and what is more, entirely indefensible.

Corroboration of the conclusions expressed above may be had in the investigations of Messrs. Blackall and Everett, to which reference has already been made. In the three office buildings examined, while the greatest live load found in any room on any floor in any building was 40.2 pounds per square foot, the average of the maximum loads for all floors did not exceed 17 pounds per square foot in any one of the three buildings. It thus appears that the average maximum for *all* the floors is less than one-half of the maximum probable load on any one floor, and that columns in the lower stories of buildings, except storage warehouses, need not be designed for more than one-half of the specified maximum loads on the floors above. The proportion should, of course, gradually increase to 100 per cent. as the roof is neared.

That a much greater reduction of live loads on columns than is permitted in Toronto is sanctioned by good practice may be gathered from a study of the opinions and specifications of eminent structural engineers, and of the most recently revised building codes. Some years ago a notable paper on "The Structural Design of Buildings" was presented to the American Society of Civil Engineers by Mr. C. C. Schneider, one of the three engineers who are rebuilding the Quebec Bridge, and from the discussion of this paper by the ablest structural engineers of the continent it was shown that engineers are unanimous in their approval of live load reductions for columns much greater than are allowed by the Toronto by-law. This opinion was embodied in the authoritative "General Specifications for the Structural Work of Buildings" subsequently published by Mr. Schneider. Turning to the building codes, it is found that Chicago, Boston, Baltimore, St. Louis, Minneapolis, Providence, and San Francisco all allow greater reductions than are permitted in Toronto.

As a result of the severity of the Toronto by-law in the matter of column live loads the cost of columns in buildings over five stories in height is increased from 3 to 10 per cent. and the effect on the cost of the beams, girders and columns of the building is to increase their cost from three-quarters of one per cent. to two per cent. For a building in which these parts cost $100,000 for this particular item alone the waste involved would be from $750 to $2,000, depending on the number of stories.

REINFORCED CONCRETE CONSTRUCTION.

Pages 154 to 183.—Objection is made to the provisions of the present by-law respecting reinforced concrete on the following general grounds:

(1) The strength and reliability of this form of construction is underestimated.

(2) The necessary assumptions of design are, in a number of cases, not in accordance with those adopted by the best authorities.

(3) The regulations are incomplete.

That the section of the present by-law under discussion is not in accord with the best engineering practice of the day might easily be ascertained by any impartial technically-trained person. To do this it would merely be necessary to consult the recent literature of reinforced concrete, for example, the so-called Joint Committee Report, the most authoritative statement yet made in America of what constitutes good practice in reinforced concrete design and construction. This document is the result of the deliberations for a period of ten years of a Joint Committee formed of committees of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association and the Association of American Portland Cement Manufacturers. So satisfactory and manifestly sound are the regulations of this report that other large technical organizations have adopted almost identical specifications. At the present time the Canadian Society of Civil Engineers has in course of preparation a specification for reinforced concrete agreeing, in the main, with that of the Joint Committee.

With the authority of the great engineering societies behind them many cities of the United States have quite naturally adopted regulations for reinforced concrete closely conforming to the recommendations of the Joint Committee Report. In one case a state—Pennsylvania—has taken such a step.

In judging the character of the Toronto building by-law, with respect to the regulations of reinforced concrete construction, it is possible, therefore, to make a comparison with the provisions of a number of other building by-laws, with the assurance that the relation of the Toronto by-law to good practice will thereby be fairly disclosed. Such a comparison shows that the Toronto regulations are much more exacting than those adopted by most of the cities that have recently revised their building codes. New York, Chicago, Pittsburg, Detroit, Cleveland, St. Louis, and Minneapolis approve as perfectly safe reinforced concrete structures which, in some cases, are considerably lighter than those permitted in Toronto, and these cities are by no means the only ones that might be named.

It is of interest to note, also, that reinforced concrete structures built according to the specifications of the Ontario Government and the Works Department of the City of Toronto are considerably lighter than those which would result if the Toronto building by-laws were followed.

On account of the difficulty of estimating the relative severity of reinforced concrete specifications by comparing them, point by point, the writer has made careful designs and estimates of quantities and costs for an interior panel of a reinforced concrete building in accordance with the Toronto building by-law and three other specifications. The panel and its loading were so chosen that as many as possible of the important provisions of the various specifications would be brought into operation. To effect this a panel 21 x 21 feet, with beams heading into the girders at the third points and carrying a superimposed load of 250 pounds per square foot, including the floor finish, was adopted. As a result, it is believed a fair indication of the average requirements of each specification is brought out.

The three specifications chosen for comparison, in this way, with those of the Toronto by-law were the Joint Committee Report, and the recently-enacted reinforced concrete regulations of the New York and Chicago building codes. More reinforced concrete structures in America are designed to the Joint Committee regulations than to any other, or perhaps to any half-dozen other specifications, and because of the size of New York and Chicago their regulations should be regarded as possessing some weight, particularly since they represent very recent work on the subject. Taking the Joint Committee design as the standard, and letting quantities and costs for it be represented by 100 for each item, the following statement represents the comparative results of actual detailed designs, the assumed unit costs being the same in all cases:—

Comparison of Quantities and Costs for a Typical Floor Panel.

Specification.	Volume of concrete.	Weight of steel.	Area of forms.	Costs.
Joint Committee, 1913.	100	100	100	100
Chicago, 1911	94.4	101.1	98.7	97.9
New York, 1911	95.1	109.9	95.8	100.5
Toronto, 1913	116.0	99.9	105.1	109.3

It should be pointed out that this table does not indicate the full measure of severity of the Toronto regulations. The figures given do furnish a fair comparison of the cost of reinforced concrete floors and one tier of columns, but when the effect of increased load on the columns below and on the footings is taken into account, the much heavier dead load applied to the columns at *each* floor results in further increased quantities and costs. It is, therefore, very close to the truth to say that the exacting nature of the provisions of the Toronto Building By-law with respect to reinforced concrete, apart from all other considerations, makes the cost of the reinforced concrete work in buildings at least 10 per cent. more than it should be. In this city during the course of one year there is probably a million dollars worth of such work done, and on this basis at least $100,000 is taken out of the pockets of owners to no useful purpose whatsoever. If the effect of other objectionable sections of the by-law on the reinforced concrete portions of buildings be considered, the waste is very much increased.

On the ground of incompleteness a number of criticisms might be made of the sections of the by-law relating to reinforced concrete. One of these is prompted by the fact that no specification whatever is included for a form of reinforced concrete construction which has found long and satisfactory use in the United States, and which possesses marked advantages for long spans and heavy loads. This is the girderless floor or flat-slab type of construction. As a result of the omission of any reference to it in the by-law, and the absence of definite regulations concerning it, little effort has been made to introduce the system here, to the financial loss of those who erect reinforced concrete buildings.

THE PRACTICAL OUTCOME OF THE DEFECTS IN THE PRESENT BY-LAW.

One obvious result of the exactions of the present by-law is the high cost of building. In steel construction, experience has shown that the *total* cost of buildings is from 3 to 10 per cent. more than it should be. Reinforced concrete buildings cost at least from 5 to 15 per cent. more than they would if designed to a reasonable and at the same time perfectly safe specification. The waste involved in mill construction buildings is from 5 to 10 per cent. of the total cost. Taking all classes of buildings into consideration, it is on the side of safety to say that *there is an annual waste in the construction of buildings in Toronto of at least three-quarters of a million dollars.*

Other results which follow the high cost of building are the location of industries outside of Toronto and the limitation of building projects. Of these the Citizens' Committee, which made a thorough study of the defects of the by-law in 1911, found a number of instances, some of which were recorded in the Memorial addressed to the Mayor and Board of Control in May, 1911.

A most deplorable result of the present objectionable by-law is the premium which, in effect, it places on non-fireproof construction. Under average conditions outside of Toronto fireproof buildings can be built for from 10 to 15 per cent. more than mill construction buildings, but in Toronto the difference in cost is from 15 to 20 per cent. Rather than pay this, therefore, owners prefer to erect non-fireproof buildings and pay higher insurance rates.

SHIPBUILDING IN 1913 IN GREAT BRITAIN.

The following table and comparisons showing the general progress in shipbuilding in 1913, and particularly the advance shown in the United Kingdom, are extracted from an article of considerable length in *The Contractors' Chronicle*:—

"For the year 1913 record productions are shown in the leading shipbuilding centres of the United Kingdom. Remarkable progress has been made in other countries, but British yards continue to provide their old-time proportion of the world's tonnage. Returns of vessels launched in 1913 show a total in number of 3,936, and in measurement of 4,267,166 tons, while there is recorded a total of 4,924,799 i.h.p. In all these figures there are increases as compared with 1912—in number of vessels 325, in measurement nearly 500,000 tons, and in machinery over 677,000 i.h.p. In the United Kingdom there were launched 1,474 vessels of 2,263,933 tons, and there were manufactured marine engines of 2,661,260 i.h.p. These figures show increases over those of 1912 of 120 vessels, 183,762 tons and 388,994 i.h.p. Of these increases the credit for the additional number of vessels is due wholly to England, and that for the increased tonnage and horse-power principally to Scotland. England produced 133 vessels, 95,071 tons and 135,460 i.h.p. more than in 1912, while Scotland produced 15 fewer vessels, but 121,523 tons and 233,485 i.h.p. more, while Ireland turned out 2 vessels more, 32,832 tons less and 20,050 i.h.p. more than in the previous year. Comparing the work of the United Kingdom with that of other nations, we find that the United Kingdom produced just about one-third of the total number of vessels, nearly 320,000 tons measurement more than all other countries combined, and nearly 420,000 horse-power more. The apparent discrepancy in the lower number of vessels is explained of course by the fact that the vessels built in the United Kingdom are of much greater average size than those built abroad. The following table shows briefly the shipbuilding work of the world for the years 1913 and 1912:—

	1913.			1912.		
	Ves.	Tons.	I.H.P.	Ves.	Tons.	I.H.P.
England ..	945	1,322,306	1,390,445	812	1,227,235	1,263,986
Scotland .	505	809,711	1,148,225	520	688,188	914,740
Ireland ..	24	131,916	113,590	22	164,748	93,540
U.K. totals .	1,474	2,263,933	2,661,260	1,354	2,080,171	2,272,266
Dominions .	280	59,025	20,662	208	36,578	17,922
Foreign ...	2,182	1,944,158	2,242,877	2,049	1,648,310	1,957,606
Grand totals.	3,936	4,267,116	4,924,799	3,611	3,765,059	4,247,794

By March 1st, the new factory built at Peterborough, Ont., by Henry Hope and Sons, Limited, will be ready for the manufacture of wrought steel sash, roof glazing and skylights. The building is all brick and steel, 200 feet long by 180 feet wide, and shows well the adaptability of steel sash and saw-tooth roof to the modern factory. Alex. Young, the vice-president and manager of the company, states that the machinery for this plant was specially designed, and embodies the latest improvements. The factory is fitted throughout with carrying tracks and travelling cranes.

REPORT OF THE TORONTO RAILWAY COMPANY FOR 1913.

Operation during 1913 was most favorable, according to the 22nd annual report of the Toronto Railway Co. The gross earnings of the company for the past year were $6,049,018; charges for operating, maintenance, etc., $3,123,308; and net earnings, $2,925,710. From the net earnings was deducted the sum of $2,158,472, distributed as follows:—Dividends, $879,958; and bond interest, etc., $188,806.

The gross passenger earnings show a big increase, these earnings amounting to $5,980,695, compared with $5,367,502 for 1912, an increase of $613,193. The various charges against these earnings for operating, maintenance, etc., amounted to $3,123,308 or 52.2 per cent. of the passenger earnings. The payments made to the city of Toronto shown in the report amounted to the sum of $1,089,708, which, when compared with the payments made during the previous year, shows an increase of $147,659.

Heavy expenditures on capital account were made amounting to $1,064,857. In addition to various extensions and improvements to certain of the company's shops, car houses, etc., the following buildings were erected:—A storage battery building was completed in connection with the Harrison Street sub-station; a sub-station (No. 4) was erected in Queen Street East, opposite Logan Avenue; and a paint shop was built on Queen Street East on property running from Queen Street to Eastern Avenue. Large expenditure was made in the installation of a storage battery plant in the Harrison Street building, in the construction of additional rolling stock and the purchase of electrical equipment for same and in the extension of the track and overhead system in different sections of the city.

The growth of the business of the company since 1903 is clearly shown in the following table:—

	1903.	1913.
Gross income	$2,172,087.85	$6,049,018.92
Operating maintenance, etc. ..	$1,200,823.39	$3,123,308.55
Net earnings	$ 971,264.46	$2,925,710.37
Passengers carried	53,055,322	151,236,925
Transfers	18,654,344	63,083,118
Percentage of charges, etc., to passenger earnings	55.3	52.2

Compared with 1912 also, all these items show a large increase, with the exception of the percentage of charges to passenger earnings, which decreased 1.2 per cent. Dividends at the rate of 8 per cent. per annum were paid during the year.

The gross earnings of the Toronto and York Radial Railway Company amounted to $584,490, compared with $492,922 for the previous year, an increase of 18.5 per cent.

CONSIDERATION OF ROADS IN TOWN PLANNING.

A road conference was held in London, England, late in December, which was called to consider the necessity in town planning schemes of co-operation between the various local authorities and the central authorities for the purpose of suitable and proper roads. Speaking on this subject, Mr. Burns said that there were signs in every direction that popular taste, executive desire, and administrative necessity were all tending toward a greater grip of the road and town planning problem. Now that the town planning act was available for roads, as well as for town planning, they ought to utilize the general sentiment and, in each particular case, unite the central and local authorities, so as to secure the best results. This was already being done in England and Wales, as was proved by the fact that 200 local authorities were town planning, whilst in Greater London there were 80 local authorities of whom 38 were at work on different stages of town planning and road making. To further local co-operation in the carrying out of these schemes of town planning and road making, Mr. Burns proposed that first of all local conferences of the authorities of adjoining districts should be held at once. To these conferences should fall the duty of deciding the character, the varying methods, and, above all, the alignment of local roads, and the cost and its division among the various authorities interested. To these local authorities co-operating among themselves would be given help, guidance, advice and perhaps some money for individual schemes from the central authority.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Elementary Graphic Statics.—By J. T. Wight, A.M.I.Mech.E., Lecturer in Machine Design, Heriot-Watt College, Edinburgh; published by Whittaker and Co., London, E.C. and New York, N.Y.; 227 pp., 5 ins. x 7 ins.; cloth; 135 illustrations; price, $1 net.

This is a text book specially written for students in search of a working knowledge of the application of graphical methods to the solution of the simpler problems met with in engineering and building construction. The writer presents the subject clearly and in language readily understandable. The symbols used are those almost universally adopted. The illustrations are recognized as having been carefully and specially prepared in connection with the points under discussion, while the subject matter of each chapter is well supplemented by carefully selected examples to be worked by the student.

The book begins with a very elementary treatment of the graphic representation of forces, proceeding to their composition and resolution. Chapter 3, deals with simple, practical problems of the foregoing, such as loaded platforms, frames, tripods, cranes, etc. Moments, followed by bending moment and shearing force diagrams, precede an entrance into the investigation of loads and pressures on beams, roofs, girders, retaining walls, etc. Chapter 9, takes up the study of centre of gravity and moments of inertia.

It is a book not to be merely read, but to be carefully studied with continual reference to frame and stress diagrams contained therein, and the conscientious working of examples. Thereby students can readily acquire a competent knowledge of elementary graphical solutions.

Economics of Interurban Railways.—By Louis E. Fischer, Consulting Engineer, Missouri; published by McGraw-Hill Book Co., New York and London; 116 pp.; 5 ins. x 7½ ins.; cloth; price, $1.50 net.

The lack of data of actual and proven information so compiled as to be useful to communities where electric interurban railways are being promoted or contemplated, evidently prompted the writer to produce a resumé of the actual economic results which have been obtained from the operation of such railways existing in the United States.

The subject is treated in the following manner:—

Chapter 1, Inception and Development of Electric Traction; Chapter 2, Classifications and Definitions; Chapter 3, Operating Revenue; Chapter 4, Operating Expenses; Chapter 5, Cost of Construction; Chapter 6, Economic Relations of the Foregoing; Chapter 7, a few concluding remarks based upon the statistics analysed. It brings out the fact that there are a great number of electric interurban railways now in operation that are not the commercial successes they are generally considered to be, due probably to an insufficient study of existing conditions and factors underlying success.

The author assumes the classification of operating revenues and expenses, etc., as prescribed by the Interstate Commerce Commission for electric interurban railroads; and from the operating records that are available, he selects indiscriminately a few cases, analysing them and making deductions respecting the relations of the various factors.

The book is well written and easily understood. A few ungrammatical expressions exist; for example, "there *are* such a variety of local conditions" is used on page 13. Again there are slight inaccuracies in numerical computations in one or two instances, but not of such a magnitude as to alter the potency of the conclusions drawn therefrom.

Those who are seeking to comprehend the fundamental conditions essential to an economically successful road, as well as investors trying to discriminate between fundamentally good or bad electric interurban railway securities, will find this book of great value and assistance.

Questions and Answers Relating to Modern Automobile Design, Construction Drawing and Repair.—By Victor W. Page, M.E.; published by the Norman W. Henley Publishing Co., New York City; 622+32 pages; 4¾ ins. x 7¼ ins.; cloth, price, $1.50.

As the title implies, the subject matter of this book is arranged in the form of lessons consisting of questions and answers. From very elementary topics the reader is brought progressively into the intricate study of features of design and construction. Every mechanical contrivance that has come into common use in automobile building seems to have been included. The numerous illustrations convey the impression that they are largely from the catalogues of prominent manufacturers, which the writer acknowledges at the outset.

Engineers who resort to the automobile in business or for pleasure will find this book worth many times its price for the suggestions it contains respecting the design, construction and repair of cars, equipment and accessories, as well as for the useful instructions respecting operation. The book is very carefully indexed and its diagrams are clear and not excessively reduced, many of them being in the form of inserts.

Cranes and Hoists.—By Hermann Wilda, translated from the German by Chas. Salter; publishers, Scott Greenwood and Son, London, E.C.; 158 pages; 399 illustrations; 4 ins. x 7 ins.; cloth; price, $1.

This book is a useful compilation on lifting tackle of all kinds. It is published in two chapters, the first being a study of the mechanics and theoretical design of chains, ropes, pulleys, hooks, brakes, bearings, couplings, etc., and the second being descriptive of the types of cranes and hoists ordinarily used. Although the book appears to be over-illustrated, and some of the illustrations are complicated owing to over-reduction, they are quite necessary, nevertheless, for a clear understanding of the text, the greater part of which is presented in a most condensed form, the translator apparently endeavoring to produce in a small book the information to which one often finds a book approximately twice the size devoted.

The calculations that are submitted may not be found of value unless a thorough study of the mathematics connected with each is made, and engineers in general might be disposed to consider the book as unbalanced both with regard to illustrations and mathematical computations. It is a subject nevertheless which demands a thorough treatment in the matter of design, and those who are interested in the construction of mechanical contrivances for the lifting and handling of all kinds of industrial machinery and apparatus will find the volume one remarkably concise and carefully translated.

Autogenous Welding, Oxy-Hydrogen and Oxy-Acetylene.—By R. Granjon and P. Rosenberg, translated from the French by D. Richardson, A.M.I.M.E., Lecturer on the subject at the Northern Polytechnic; published by Chas. Griffin and Co., Limited, Strand, London; 234 pp. + 12 pp. advt.; 257 illustrations; 6 ins. x 9 ins.; price, $1.25.

"Autogenous welding is certainly the one process of construction and repairs that requires, from top to bottom of its application most reflection, intelligence and conscientiousness."—Author's preface. This handbook on the use of oxy-hydrogen and oxy-acetylene blow pipes contains a great deal of practical information for the welder upon the scientific use of his apparatus and the most approved methods of operation. It presents a reliable, though simple, technique in the art of autogenous welding and is notable for the omission of intricate scientific considerations relevant only to a more advanced study of the subject. The fundamental principles serving as the base for all applications of the science are well brought out. The authors do not claim that it is in any way perfect or final as the science itself is only in its infancy. A very valuable feature of the book is its concluding chapter which deals with the cutting of iron and steel with the blow pipe and an oxygen jet.

The book will be warmly welcomed by engineers and manufacturers interested in the process, there being no other work on the subject in the English language at present.

PUBLICATIONS RECEIVED.

Cement Gypsum and Lime.—The 1914 directory of manufacturers. A 214-page leather-bound pocket directory, published by the Cement Era, Chicago, Ill.

Gas Analysis.—Errors due to assuming that the molecular volumes of all gases are alike. Issued by the United States Bureau of Mines, Washington. 16 pages.

Report of the Department of Public Works.—A 1913 report of the Minister of Public Works, Ottawa, including reports of Deputy Minister, Chief Engineer, Chief Architect, Accountant, etc.

Metal-Mine Accidents.—A booklet of statistics compiled by A. H. Fay for the United States Bureau of Mines, covering accidents of this nature which occurred in the United States during 1912.

Magnetite Occurrences Along the Ontario Central Railway.—By E. Lindeman, M.E., issued by Mines Branch, Department of Mines, Ottawa. 24 pages; illustrated by 9 photographs and 20 maps.

Clay and Shale Deposits of the Western Provinces.—Report by Heinrich Ries and Joseph Keele,: Geological Survey, Department of Mines, Ottawa. Memoir No. 25, 108 pages fully illustrated.

Geology of the Coast and Islands Between the Strait of Georgia and Queen Charlotte Sound, B.C.—By J. Austen Bancroft, issued by the Geological Survey as Memoir No. 23, Department of Mines, Ottawa. 150 pages; illustrated; additional maps.

Montreal Water Works.—By F. Clifford Smith. A 54-page illustrated booklet containing a historical description of the development of the Montreal water works system from the year 1800 to 1912.

Railway Statistics.—A report for year ending June 30th, 1913, of A. W. Campbell, Deputy Minister Department of Railways and Canals, Ottawa, compiled from returns furnished by the various railway companies of Canada.

Basins of Nelson and Churchill Rivers.—Memoir No. 30, Geological Survey, Department of Mines, Canada. Geological report by Wm. McInnes on the area west of Hudson Bay, embracing part of the Province of Saskatchewan and part of the Northwest territories.

Minutes of Proceedings of the 33rd annual convention of the American Waterworks Association, held at Minneapolis, Minn., June 23rd, 27th, 1913; 210 pp., 6 ins. x 9 ins.

Transcontinental Railway.—The 9th annual (1913) report of the National Transcontinental Commissioners setting forth the receipts and expenditures in connection with the eastern division and containing the reports of the Chief Engineer and District Engineers.

Variations in Results of Sieving with Standard Cement Sieves.—Technologic paper No. 9, of the United States Bureau of Standards, outlining the variations in determinations of fineness of cement that are liable to occur when the standard routine method of sieving is used.

Metallurgical Coke.—By A. W. Belden, United States Bureau of Mines. Containing statistics of coke production in the United States, development of methods, preparation of coal or coking, fiscal properties and chemical composition of coke, by-products, etc. 148 pages illustrated.

Topographical Surveys Branch.—Annual report of the Surveyor-General of Dominion lands for the year ending March 31st, 1912, containing reports of surveyors, maps, profiles and illustrations. The report contains, as appendix No. 51, an article descriptive of the copying camera of the Surveyor-General's office.

Austin Brook Iron Bearing District, New Brunswick.—A 16-page bulletin compiled by Einer Lindeman, M.E., for the Mines Branch, Department of Mines, Ottawa, covering the work done in, and the general characteristics of the iron-bearing district of Austin Brook, New Brunswick. Illustrated by charts and photographs, supplemented by maps.

Tests of Permissible Explosives.—By C. Hall and S. P. Howell, United States Bureau of Mines. A 310-page book with illustrations and tables describing apparatus and methods for physical tests of explosives and results. It contains a classification also of permissible explosives, their rates of detonation and useful suggestions in selecting explosives.

Coal Washing in Illinois.—Bulletin No. 69, Engineering Experiment Station, University of Illinois. A 108-page booklet by F. C. Lincoln, Assistant Professor of Mining Engineering, describing the purification of coal by mechanical treatment with water; containing sections devoted to history of coal washing, impurities in coal, crushing and sizing, methods of washing, arrangement and results.

Electrolysis in Concrete.—Technoligic Paper No. 18, United States Bureau of Standards, Washington. A 140-page treatise by E. B. Rosa, B. McCollum and O. S. Peters; containing investigations relating to the nature and cause of the phenomena resulting from the passage of electric currents through concrete; possibilities of trouble from electrolysis in concrete structures under practical conditions; protective measures, and conclusions.

Report of Transit Commissioners, City of Philadelphia.—A comprehensive report, dated July, 1913. Volume 1, of 267 pages, recommends a rapid transit system giving general design, estimates, present and prospective traffic, time saved by rapid transit, estimate of income account, effect of rapid transit on assessed values, examples, with statistics, in other cities; population and housing statistics, etc. 120 pages of tabulated statements of construction costs, etc. Volume II. comprises 69 maps and diagrams, devoted to comparisons of transportation facilities in different cities, traffic, plans, time-distance, charts, etc. A Merrit Taylor, transit commissioner.

CATALOGUES RECEIVED.

Portable-Mine Hoist.—An 8-page bulletin of the Chicago Pneumatic Tool Company, descriptive of this type of air hoist.

Indoor Cable Terminals.—Bulletin issued by Standard Underground Cable Co., Hamilton, Ont. 32 pages, illustrated, including dimension charts, etc.

Single-Phase Induction Motors.—A description of type K.S., manufactured by the Canadian General Electric Co. Fully illustrated. Bulletin A-4185.

Arm Improvements.—A 16-page pamphlet published by the Canada Cement Co., and devoted to the use of cement and concrete for rural roads and buildings.

Electric Fans.—A descriptive catalogue of the 1914 types of fans offered by the Canadian Westinghouse Co., illustrated with photographs, dimension diagrams, etc.

Plymouth Products.—A 12-page bulletin issued by the Plymouth Cordage Co., Welland, Ont., descriptive of Manila rope and including an article on rope deterioration.

Locomotive Ratios.—An article by F. J. Cole, Chief Consulting Engineer, American Locomotive Co., New York, issued as bulletin No. 1017, illustrated with charts and tables.

Air Compressors.—An interesting publication by the Canadian Ingersoll-Rand Co., Limited, Montreal, describing their steam and belt-driven, single and two-stage, air compressors.

Lackawanna Steel Sheet Piling.—A 48-page booklet issued as bulletin No. 106 by the Lackawanna Steel Co., illustrating numerous incidents of its use in caisson and cofferdam work.

Power and Steam Pumps.—Catalogue No. 9 of the Smart-Turner Machine Co., Hamilton, Ont., describing numerous types of reciprocating and centrifugal pumps. 32 pages, illustrated.

The Reid Incinerator.—A 16-page illustrated pamphlet descriptive of some of the Canadian installations of the Reid hot blast tube incinerator and its method of destroying garbage and refuse.

Q.E.F. Runways.—Bulletin A-12, issued by the Herbert Morris Crane and Hoist Co., Limited, of Toronto, descriptive of some interesting recent illustrations of the Morris overhead runways.

Portable Meters.—Circulation No. 1104 of the Canadian Westinghouse Co., Limited, Hamilton, Ont., descriptive of the Westinghouse types of portable meters for direct and alternating currents.

Micaspar Crystals (Formerly Granite Crystals).—A 46-page catalogue of the Crown Point Spar Company, of New York, descriptive of structures in which these crystals have been used in the coating of cement surfaces.

Heating and Ventilating a Large Factory, and **Heat Transmission Through Building Walls of Corrugated Iron.**—Reprint of articles from the Iron Age and Engineering News respectively. Issued by the Green Fuel Economizer Co., of Mattewan, N.Y.

Direct Current Generators.—Circulation No. 1156, the Canadian Westinghouse Co., Limited, Hamilton, Ont. A 28-page bulletin giving illustrated descriptions of type "R" and type "S" D. C. generators, containing also a section devoted to field rheostats.

Catenary Line Material.—Catalogue D.S. 843 of the Westinghouse Electric and Manufacturing Co., descriptive of and illustrating different types of insulators, hangers, strain cars, etc., together with spacing diagrams for wheel and pantagraph trolleys.

Water Towers.—A 24-page catalogue descriptive of steel water towers, stand pipes, etc., of the Chicago Bridge and Iron Works, Chicago, Ill. Contains many illustrations of structures in Canada and the United States. Contains also tables of frictional losses, fire stream data, etc.

Iron Ore Washing Plants.—Bulletin No. 1807 of the mining machinery department of the Canadian Allis-Chalmers, Limited, Toronto. This 16-page booklet describes several installations and contains, besides photographs, a number of plans and elevation drawings showing ore washer arrangements.

Mill Type Motors.—This bulletin, issued by the Canadian General Electric Company, describes motors for service in steel mills, etc., where they are subjected to severity of operation. Various types of mill motors are described, for instance, with open and enclosed, D.C. and A.C. Bulletin includes dimensions, etc.

Standard Reinforced Spiral Pipe.—A 36-page catalogue (No. 4), dealing with reinforced spiral pipe, forged steel flanges, valves, cast fittings and specialities used in connection with them. Fully illustrated. It contains complete price lists, and gives examples and uses. Issued by Standard Spiral Pipe Works, Chicago, Ill.

Alternating Current Motors.—A 24-page booklet issued by Bruce Peebles and Co., Limited, Edinburgh, Scotland. In two sections, the first dealing with open type polyphase induction motors, and the second with another form known as the self-contained type. The catalogue contains tables of dimensions, speeds, efficiencies, etc.

Sewer Failures.—A cleverly arranged and attractively printed booklet intended to show, by camera and laboratory, the relative advantages of various materials for sewer construction. Distributed by the Clay Products Publicity Bureau of Kansas City, Mo. "Sewer Facts" is the title of another interesting booklet published for the same purpose.

Alternating Current Signals.—A 52-page booklet issued by the General Railway Signal Co., Rochester, N.Y., descriptive of alternating current block signals on Southern Railway; written by W. J. Eck, Signal Electrical Engineer, Southern Railway Co. Well illustrated with photographs, diagrams of construction, details and wiring, interlocking, etc.

Excavators.—A well-illustrated 48 pp. pamphlet descriptive of the Shearer and Mayer Dragline Cableway Excavator. Numerous photographs are presented giving a clear conception of the uses of this class of excavating machinery in the mechanical handling of material under special conditions and difficulties. Issued by Sauerman Bros., Chicago, Ill.

Electric Mine Locomotives.—32 pages, devoted to an illustrated description of the Baldwin-Westinghouse type of electric mine locomotives and their equipment. Fully illustrated to show mechanical construction and performance of this locomotive, in the manufacture of which Baldwin Locomotive Works and the Canadian Westinghouse Co. are associated.

The Industrial Harbor.—A well-bound volume of 152 pages under the title of "The Industrial Harbor," is being distributed by Deutsche Maschinenfabrik, A.G., Duisburg, Germany, whose Canadian agents are Messrs. Gerald Lomer, Limited, Montreal. The book describes practically all the lifting and transporting appliances that might be required by any harbor for handling any sort of material whatever. It is abundantly illustrated with photographs of installations that have been made by the firm in all parts of the world.

Coast to Coast

Agincourt, Ont.—The huge water tank at Agincourt in course of construction by the C.P.R., was destroyed by fire on February 19. The loss is estimated at $15,000.

Berlin, Ont.—Another new industry has been opened at Berlin. The Dominion Tire Company, owned and operated by the Consolidated Rubber Company of Montreal, has completed and formally opened its new $1,000,000 plant.

Elderbank, N.S.—Work on the Halifax and Eastern Railway in the Musquodoboit Valley is progressing steadily; and it is stated that by spring the grading that is to be done by the sub-contractors will be completed, also that by July, rails will have reached the Valley.

Clinton, Ont.—Clinton is now using hydro-electric power, connection having been completed about the middle of this month. The Niagara Falls power is not only to be used for light for streets and buildings, but also for the town waterworks system. Connection with the street lighting and manufacturing plants is not yet entirely completed.

Calgary, Alta.—For the year ending December 31, 1913, the gross earnings of the Calgary Power Company amounted to $240,116.28; operating expenses, $52,055.69; leaving net earnings available for bond interest, $188,060.59. After paying interest of $100,034.33 a balance of $88,026.26 remained, equivalent to over 4¾ per cent. on the common stock.

Regina, Sask.—The new reservoir to be built at Regina, and for which a site is now being secured, will hold a reserve water supply of 5,000,000 gallons, will be 26 feet in depth, and will be constructed of concrete. The site which is likely to be recommended by the commissioners will necessitate the laying of a 42-inch main between the tank and the power house.

Fort William, Ont.—The incinerator at Fort William has been set in operation, two of the three cells being kept busy steadily. The incinerator is reported as working satisfactorily, the consumption being about one wagon load every hour for each unit, or approximately 48 loads per day. The additional air blast supplied by the new fan has made a great difference in the heat generated; and the clinker which is now raked out from the front of the furnace is hard and well burnt.

Smithers, B.C.—Extensive deposits of iron ore of great value in the Copper River district, a few miles west of Smithers, have been reported upon by Mr. John V. Rittenhouse, of New York City, consulting and mining engineer. The ore deposits are situated between the town and Copper City and are the property of the North Pacific Iron Mines, Limited. The company's locations cover 375 acres, and it is the engineer's estimate that there are 10,000,000 tons of iron ore on the property, which is brown hematite in character. The deposit is similar to the Alabama deposits of bog iron, and analysis shows it to be well within the Bessemer limit.

Brantford, Ont.—The annual report of the Dominion Power and Transmission Company gave the following facts concerning Brantford:—"At the present time the company is connected with 2,124 motors of an aggregate capacity of 55,199 h.p. Additionally, the railway capacities require 6,250 k.w., or 8,333 h.p., and our lighting systems 13,132 k.w., or 17,500 h.p. During the past year the work of reconstructing the 22 miles of street railway tracks has been continued almost to completion, and considerable work has been done in the construction of 11 additional miles for the accommodation of the rapidly increasing population in the easterly section of the city.

Montreal, Que.—According to authoritative report from Montreal, C.P.R. extension plans of last year and this year will involve a total expenditure of about $85,000,000. At the present time there are 133 miles of double track under way between Sudbury and Port Arthur, on the Lake Superior division, which alone will cost $6,000,000; 178 miles of double track between Brandon and Calgary to cost $5,000,000; 139 miles between Revelstoke and Vancouver, to cost $7,000,000. Before the C.P.R. has concluded its present programme of work in the west, including the irrigation works, double tracking, and new trackage, amounting to 1,200 miles, it will have spent approximately $450,000,000 since its inception.

Ottawa, Ont.—An interim report has been presented to the Dominion Government at Ottawa upon the construction work on the N.T.R. during the nine months ending December 31, 1913. The total expenditure during that period is shown to be $10,314,944, which brings the total expenditure from the formation of the commission in 1904 to $140,562,147. The complete mileage is given as 2,231 miles; and it is stated that at the end of last year, the bridges were 95.3 per cent. complete. The report, moreover, asserts that at the end of last year, trains were being operated on 1,160 miles of the total 1,804 miles between Moncton and Winnipeg, and could have been run on the remaining mileage had there been any necessity therefor.

Regina, Sask.—The city commissioners have adopted for this and future years the policy of laying storm sewers previous to paving. Hence, all the streets included in this year's paving programme will be provided first with storm sewers. It is proposed also to construct two new storm water mains, one of 57-inch diameter and the other, 45 inches; while in these will terminate laterals ranging from 9 to 22 inches in diameter. New later sewers will also be constructed to connect with the present main which has its outlet into the creek at Campbell Street in the northern section of the city. The proposed new sewerage mains will serve the southern portion of Regina. The estimate for the work to be carried out this year upon the above constructions—e.g., 8 miles of mains and laterals—is given by the city engineer as $170,140.

Fort William, Ont.—The laying of the new intake main across the dam at Current River has been completed. The double force main, 450 feet in length, was connected on the ice just as if it had been laid on land and then placed in a wooden frame while 14 bents were driven at equal distances across the stream to support the pulleys by which the mains were to be lowered. The ice, 3 feet in thickness, was sawed to open a channel for the main, and then the whole length was slowly lowered to the bed of the river. No supports nor flexible joints were required to prevent the pipe breaking on the bottom as the bed of the river consists of hard pan. The trench for the mains was prepared in the summer and the river bed was found so firm that blasting had to be done to remove obstructions.

Victoria, B.C.—City Engineer Rust has reported upon the recommendation, recently made by the city officials, in connection with procuring a municipal paving plant. Mr. Rust considered the advantages and disadvantages of alternative locations at Spring Ridge and Garbally road yards, estimated the cost of each, and concluded in favor of the Spring Ridge site. He reported that a quotation had been submitted from F. D. Crummer and Son for a semi-portable plant with a capacity of 2,000 yards of 2-inch top per 10 hours, for $12,000; that this with other necessary charges, would bring the cost of the plant to $20,000; and that the Crummer plant could be made ready for operation within four months. Before the question of location or purchase is decided, tenders are to be called and considered for necessary equipment.

Winnipeg, Man.—A preliminary report was made at the annual meeting of the Winnipeg Electric Railway Company, held recently, upon the possibilities of power development at Big Bonnet Falls. It was shown that these falls were capable of producing 150,000 h.p. of electrical energy at a very low cost per horsepower. In view of the fact that the Winnipeg Electric Railway Company's water power plant at Lac du Bonnet with a capacity of 30,000 h.p. and its auxiliary steam plants in the city of Winnipeg, with a capacity of 18,000 h.p., are being utilized to their full extent, the necessity of immediate development of the new falls was apparent and it was decided to commence exploration and preliminary work immediately. It is expected that if energetic measures are taken and the matter pushed, power can be obtained from the new site within two years.

St. John, N.B.—Mr. A. D. Swan, M.Inst.C.E., has reported to the Board of Trade upon the progress and general conditions of the harbor works being undertaken at St. John. Alterations of importance suggested by the harbor engineer are a change in the direction of the extension of the Negrotown Point breakwater to Partridge Island; a spur extension from the other side of the island as an experiment to note the effect upon currents, and as a protection to both the new wharves on the west side of the harbor, and to the entrance channel leading to Courtenay Bay; and a change in the direction of the channel to Courtenay Bay. In closing his report, Mr. Swan comments upon the detached nature of the wharf accommodation; and he suggests that some scheme be devised, such as a bridge at the head of the harbor, so that all the various railway companies have some direct access to the new wharves.

Nanaimo, B.C.—Without any cessation in operations, the entire plant of the Nanaimo Electric Light and Power Company has been replaced. During the past year, the company has installed a directly connected unit of 450 h.p., manufactured by James Howden and Company, of Glasgow. The new engine is connected to a Bruce Peebles generator of 300 k.w. capacity, in addition to which the company has put in a new 6-panel switchboard which now gives it three separate circuits throughout the city, whereas prior to this installation but one circuit was in operation. The company has also installed a Stillwell heater and a Worthington feed pump; has laid five miles of new line and erected over 100 new poles in the city. It is the intention of the company this summer to install a line throughout West and South Nanaimo. This work will be supplemented by an addition to the plant.

Halifax, N.S.—The contract which has been recently awarded to Foley Brothers, Welch, Stewart and Fauquier, for the construction of the first unit of the new harbor terminals at Halifax, calls for the erection of a pier and a landing stage, which will be unique in their solidity and massiveness. The landing stage will be of concrete and 2,000 feet in length; the pier will be 1,200 feet in length; and there will be a basin 300 feet wide built inside of an extensive filling in from the land. This will give a lineal distance for shipping purposes of 6,200 feet. The work is to be solid throughout, not a structure resting on piles. The pier foundations will consist of 2,500 celular blocks, 20 feet by 30 feet, and each weighing 60 tons. These will be laid one on top of the other. Then the celular apertures will be filled with cement and rubble, allowing for expansion and uniting one block on top of another, and steel rails also serving to reinforce the structure. The floor will be laid in concrete; and the front of the entire 6,200 feet will be faced with granite blocks from low water to the floor of the pier and landing stage.

Toronto, Ont.—The official statement issued upon road construction under the Colonization Road Department during 1913, shows a distance covered of 1,300 miles, and an expenditure entailed of $406,351. Of the three road districts of the province, the northern district received 292 miles of colonization roads and 205 miles of by-law roads. In the western district, 110 miles of colonization roads and 80 by-law roads were built; while in the rest of the province (excepting Timiskaming, which constitutes a separate district), 292 miles of colonization roads and 344 miles of by-law roads were constructed. In the Timiskaming district, the work of the Colonization Road Branch was confined to the region south of Englehart, the northern part being under the supervision of the special roads commissioner, Mr. J. F. Whitson. In the part of Timiskaming covered, 85 miles of colonization roads and 113 miles of by-law roads were constructed. Finally, extensive work was carried out upon trunk roads, the Sudbury-Sault Ste. Marie road being almost completed. It is expected that this road will be ready for traffic this summer.

Victoria, B.C.—The plans for a retaining wall along the harbor front of the old Soughees Reserve, as prepared by Engineer Valiquette of the Department of Public Works for the Dominion Government, have been approved. It is estimated that the work will cost $147,773. A considerable quantity of rock and earth will have to be excavated outside of what will be the face of the wall. An immediate start on the erection of a creosoted pile wharf and the gradings of the actual site on the Soughees Reserve to the north of the proposed Johnson Street bridge will be made as soon as the contract is awarded for which tenders are being called by the Dominion Government. The plans show a wharf fronting on the channel 420 feet in length and running shorewards 224 feet, giving an approximate total of 650 feet of piling; and which, when completed, will be 5 feet above high water level. The total area to be excavated and levelled off is about 4 acres. It is understood that by the time the preliminary contract is completed, tenders will be called for the erection of the new Marine and Fisheries depot which is to be located at the Soughees Reserve facing south on the proposed bridge.

Winnipeg, Man.—Some interesting data has recently been published, showing the excellent result of an experiment started in Winnipeg nearly 15 years ago—e.g., its civic owned paving plant. When that city decided to purchase the first asphalt paving plant from the contractors and proceed with its own work, it at first experienced much difficulty in securing a full supply of material, owing to what was known as the "asphalt trust." However, in 1910, the city secured its first portable plant with which "No. 2" pavement is laid; and to-day, about 3,000 square yards of paving can be done each day. As the system is operated, the plant is in the position of a contracting firm financed by the city. The pavement is inspected as it would be were a contracting concern laying it. While the initial cost is somewhat higher, the results have proven excellent, especially when the question of repairs is concerned, this work being done more rapidly and the disputes relative to guarantee being eliminated. The average cost to the city per yard, on business streets, has been about $2.65; but on the business streets a pavement consists first of 3 inches of gravel ballast, then 6 inches of concrete base, 1½ inches of binder course and 3 inches of asphalt wearing surface. Broken stone drains every 50 feet are also included in the cost. The city advertises every job as open to competition, the engineer putting in a bid; but the strictness of the specifications are such that contractors claim they cannot compete with the city.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 94, a directory of such societies and their chief officials.

ONTARIO LAND SURVEYORS' ASSOCIATION.

Annual Meeting Held in Toronto, February 17th, 18th and 19th, 1914.

The morning session on the 17th was devoted to meetings of standing and special committees and meeting of the council of management.

In the afternoon, the president, Mr. J. S. Dobie, delivered his address, which was a resumé of the past year's history on matters of interest to the association. It contained many useful suggestions for the future, all of which were heartily endorsed by the meeting.

Reports of council of management, board of examiners, secretary-treasurer, committees on legislation and on publication, were presented and dealt with.

Mr. H. T. Routly of Toronto, presented his paper on "Contour Survey on Abitibi River," which evoked considerable interest. The contents of the paper were made clear and described by means of a large copy of the plan of survey.

Mr. H. O. Dempster of Gananoque, Ont., gave an interesting description of survey work in British Columbia, the different systems of survey and the conditions under which these are made.

Mr. E. W. Neelands of New Liskeard, Ont., had a paper on water power development and the transmission of electric power in Northern Ontario.

8 p.m.—Professor L. B. Stewart, of the Faculty of Applied Science, Toronto University, presented a very interesting paper on the Inter-provincial Boundary between Ontario and Manitoba, describing the different astronomical problems and the calculations involved in the question, as well as the method of procedure in defining the line on the ground.

Mr. J. F. Whitson, entertained the convention for some time with lantern slide pictures of the work of road building and colonization in Northern Ontario, and also many pictures of natural scenery in the northern and western parts of Ontario.

Wednesday Session.—Mr. C. J. Murphy, Toronto, chairman of the committee on land surveying, presented his report including answers to the question drawer, which involved the solution of many intricate points regarding the legal method of procedure in certain surveys.

Mr. T. B. Speight, Toronto, read a paper on "Surveys in Certain Townships in the 640 acre Sectional System," and some of the difficulties to be worked out where the original survey was lacking in accuracy.

Mr. A. G. Ardagh, Barrie, read a paper on difficulties arising from surveys made in double front concession townships, and pointed out several cases where the procedure under the Survey Act was not definite.

In the afternoon, Mr. G. A. McCubbin, St. Thomas, chairman of committee on drainage, presented the report which outlined improvements necessary for the good of the public and the benefit of drainage engineers.

Mr. Alan M. Jackson, Brantford, read a paper on "Permanent Street Grades," which was heartily endorsed. He advocated the fixing of permanent levels in new subdivisions in order that a builder might rely on having a fixed level of street before constructing buildings on the adjoining lots.

Mr. E. D. Bolton of Listowel, presented a valuable paper on the "Working of the Ditches and Watercourse Act," describing the difficulties arising in proceeding and carrying out drainage under this Statute.

Banquet.—The annual dinner of the association was held on Wednesday evening, at the Engineer's Club, and was one of the most successful dinners in the history of the association. The guests included Hon. W. H. Hearst, E. Douglas Armour, Frank Arnoldi, R. F. Stupart, F. C. Mechin, J. S. Bach, E. J. Zavitz.

Responses to the different toasts were both eloquent and humorous, and the evening was enlivened with songs by Messrs. Boyd, Phillips, LeMay, Leigh and Bartram.

On Thursday morning the association concluded its meeting by pasing resolutions, vote of thanks to all those who helped to make the convention a success. Matters of new business and unfinished business were attended to and the election of officers. The following were elected:—

President, J. W. Fitzgerald, Peterborough; vice-president, E. T. Wilkie, Toronto; secretary-treasurer, L. V. Rorke (re-elected), Toronto; council of management (2 to be elected by letter ballot), J. M. Watson, Orillia; E. D. Bolton, Listowel; Jno. H. Shaw, North Bay; G. B. Kirkpatrick, Toronto; J. J. McKay, Hamilton; auditors, Jno. VanNostramd, Toronto; A. E. Jupp, Toronto.

The meeting of the association is held on the second Tuesday in February each year in Toronto.

TORONTO BRANCH, CAN. SOC. C.E.

Toronto branch of the Canadian Society held a very important and well-attended meeting, Wednesday, February 25th, in the Chemistry and Mining Building, University of Toronto. Mr. C. N. Monsarrat, C.E., chairman and Chief Engineer of the Quebec Bridge Commission was the speaker. He gave an illustrated address on the foundation work in connection with the construction of the new Quebec bridge. The paper was most interesting, and brought forth some very complimentary discussion.

The following meetings for the Toronto branch are announced:—

Thursday, March 5th—Discussion on the "New Specifications for Reinforced Concrete."

Thursday, March 12th—Luncheon.

Thursday, March 26th—Address on "The Proposed Terminal of the T. and N.O. Railway System on James Bay," by J. G. G. Kerry, C.E.

Thursday, April 16th—Luncheon.

Thursday, April 23rd—Paper on "The Clays and Clay Industries of Canada," by J. Keele, B.A.Sc., of the Geological Survey of Canada.

The luncheons will be held at 1 p.m., and the evening meetings at 8 p.m.

Members will be notified by mail as to the place of meeting.

VANCOUVER BRANCH, CAN. SOC. C.E.

At the meeting of the Vancouver branch of the Canadian Society of Civil Engineers on February 18th, there was a discussion of the proposed Second Narrows dam and the Pitt River Canal. The discussion brought out a variety of opinions, as to the desirability, cost and effects of the proposed works.

Mr. J. H. Kilmer, engineer of Coquitlam, opened the discussion, being familiar with both the projects and having at different times studied plans and specifications for the dam as well as much data dealing with the canal, having himself made one report on the latter. The canal, he said, was an historic enterprise, having first been broached by Col. Moody, over 40 years ago. The scheme was again resurrected some 20 years ago by Mr. David Oppenheimer and associates, a company was organized for the undertaking and full surveys made with complete details of construction. These unfortunately had been lost but sufficient data remained on which to base conclusions.

The canal could be constructed either with locks at either end or with the placing of a dam at the Second Narrows which would obviate the necessity of a lock at Port Moody. The completion of either or both would make available large areas suitable for industrial sites with rail and water shipping facilities.

Others took part in the discussion including Messrs. Cartwright, Cameron, Webster, Creer and Matheson. In references to the canal, excessive cost in relation to the benefits were spoken of, and also the danger of it filling up from silt from the Fraser. Cost, too, was a feature in the dam construction with added difficulty from the depth of water over a hundred feet in mid channel, and the debris swept down by the mountain torrent which the Seymour Creek becomes at times.

Its effect on the lower inlet was also regarded as an important feature. Opinion differed as to the effect the dam would have on the tides, but the preponderance of ideas seemed to favor the theory that the dam would lessen the scour of the outgoing tide through the First Narrows and consequently increase impediments to the channel there.

PAPER ON SUBSTRUCTURES.

On Thursday evening, 19th inst., John W. Doty, A.M.Can.Soc.C.E., M.Am.Soc.C.E., of the Foundation Company, New York, read a paper at a meeting of the general section in Montreal of the Canadian Society of Civil Engineers. The subject was "Building Structures, Built by the Pneumatic Method."

ENGINEERING SOCIETY—UNIVERSITY OF MANITOBA.

At its regular meeting on the 9th inst., papers were read by Messrs. J. R. McColl and F. V. Woodman, members of the society. The latter spoke on "Elevator Construction at Fort William" and the former on "Construction of the Canadian Pacific Railway Red River Bridge." Both speakers are members of the second year in engineering, University of Manitoba.

ORGANIZATION IN ROAD BUILDING.

The Sanitary and Highway Club of the University of Toronto, a club of fourth year men in these two courses in the Faculty of Applied Science and Engineering, were addressed at their semi-monthly meeting on the 21st inst., by W. A. McLean, C.E., Provincial Roadway Engineer and a member of the Ontario Public Roads and Highways Commission. Mr. McLean spoke on the essentials of organization in road building, outlining the duties of the various members of a road staff. Some time was taken up in discussion after the lecture. Mr. J. A. P. Marshall is president of the club.

THE DEFINITION OF "CIVIL ENGINEER."

A deputation representing the civil engineers of British Columbia waited on the provincial executive council a few weeks ago with a protest against that clause in the Municipal Act which practically gives the municipalities of the province the right of interpretation of the term "civil engineer."

They suggested that the definition of civil engineer should be one who is a member of the Canadian Society of Civil Engineers or of the sister organization in Great Britain, or some society for which the qualifications for admission to membership were recognized by these two parent societies. The Premier promised that the matter would receive the consideration of the executive council.

COMING MEETINGS.

CANADIAN MINING INSTITUTE.—Sixteenth Annual Meeting to be held at Windsor Hotel, Montreal, March 4th, 5th and 6th, 1914. Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

PERSONAL.

H. G. HUNTER, resident engineer for Canada of the New York Continental Jewel Filtration Co., has been elected to full membership in the Canadian Society of Civil Engineers.

ANGUS McDONNELL, who has recently gone into large contracting work on the Pacific Coast has, according to announcements, secured from the Dominion Government the contract for the harbor works at Victoria, B.C.

J. C. DUFRESNE, M.Can.Soc.C.E., M.Can. Mining Institute, at present field engineer for Cummins and Agnew, Vernon, B.C., has resigned from the latter firm and is re-establishing his private practice at Penticton, B.C.

P. B. YATES, of Toronto, has been appointed engineer and manager of the Hydro-Electric Power System of St. Catharines, duties to commence on March 15th. Mr. Yates has been connected with the Hydro-Electric Power Commission of Ontario for the past five years, previous to which he was in the employ of the Gould Storage Battery, Chicago.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., Professor in Charge of the Graduate Course in Highway Engineering at Columbia University, on February 14, 1914, delivered illustrated lectures at the University of West Virginia on the subjects:—"Park Boulevards," "Bituminous Surfaces and Bituminous Pavements," "Wood Block and Stone Block Pavements" and "Modern Developments in Highway Engineering in Europe."

GEO. D. MACKIE, formerly city engineer of Swift Current, Sask., has secured the long-deferred appointment of City Engineer of Moose Jaw, Sask. Some 40 applications were received last fall and the work of selection has been slowly, but carefully, proceeded with. Mr. Mackie has had some 13 years' experience in municipal work. He was with the John Galt Engineering Co., at Winnipeg and Calgary before taking office at Swift Current. A greater part of his municipal training was acquired in Creiff and Clydebank.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21351—February 12—Extending, until the 15th day of May, 1914, the time within which to complete the spur for the Renfrew White Granite Co., Limited, township of Ross, Ont.

21352—February 9—Ordering the C.P.R. to appoint a permanent agent at Millett Station, Alta.

21353—February 12—Extending, until the 21st May, 1914, the time within which to construct switching lead in the city of Toronto, Ont.

21354—February 12—Approving revision in the location of a portion of the C.P.R. Co.'s Columbia and Western Line at mileage 0.45, Granby Subdivision, through Lot No. 1494, Group 1, and Lot No. 332, Group 1 (Provincial Government Survey, District of Yale, B.C.).

21355—February 12—Authorizing the G.T.P. to carry traffic on the said portion of its main line of railway east of Prince Rupert, B.C., between mileage 301 and mileage 337.

21356—February 12—Approving, temporarily, G.T.P. Standard Freight Mileage Tariff, C.R.C. No. 21, incorporating and superseding C.R.C. No. 19, by an extension of the mileage thereof, to apply between stations in the Province of British Columbia, between Prince Rupert and Wordsworth, inclusive.

21357—February 9—Granting leave to the Hydro-Electric Power Commission of Ontario to erect, place and maintain its line across the wires and across the track of the C.P.R. on Main St., Chesterville, Ont.

21358—February 13—Approving Plan "A," showing G.T.R. bridge No. 63, mileage 152.51 from Black Rock, over public road at Golmesville, Twp. Goderich, Ont.

21359—February 14—Authorizing G.T.R. to reconstruct bridge No. 52, at mileage 127.75 from Black Rock, on the 20th District of its line of railway, Twp. Fullarton, Ont.

21360—February 13—Authorizing the C.P.R. to construct a highway diversion in the S.E. ¼ of Sec. 26, Twp. 3, Rge 29, W. 3 M., Sask.; and to construct, by means of a grade crossing, the tracks of its Weyburn-Stirling Branch Line across the highway between Secs. 25 and 26, Twp. 3, Rge. 29, W. 3 M.

21361—February 14—Authorizing the C.P.R. to construct highway diversion in Sec. 1, Twp. 23, Rge. 2, W. 4 M., Alta.; and to construct, by means of a grade crossing, the tracks of its Bassano Easterly Branch Line across said diversion at mileage 111.3.

21362—February 14—Authorizing C.P.R. to construct highway diversion in Sec. 9, Twp. 23, Rge. 1, W. 4 M., Alta.; and to construct, by means of a grade crossing, the tracks of its Bassano Easterly Branch Line across said Diversion at mileage 114.7 on said Branch line.

21363—February 13—Authorizing C.N.Q. Ry. to construct, maintain and operate siding into sand pit at mileage 16.90, west of Joliette, for E. Dupuis, St. Julienne, Co. Montcalm, Que.; and to cross with such siding the said public road to Bissonnette, at Station 66.70.

21364—February 13—Authorizing the C.P.R. to construct, at grade, the tracks of its Swift Current Northwesterly Branch Line, at mileage 169.89, across the tracks of the C.N.R. Co.'s Goose Lake Branch at Mileage 210.12, in Sec. 29, Twp. 28, Rge. 5, W. 4 M., upon certain conditions.

21365—February 13—Authorizing the Township of McKim to construct and maintain a highway crossing over the Algoma Eastern Ry. in Lot 11, Con. 4, Twp. of McKim.

21366—February 14—Authorizing the C.P.R. to construct, maintain and operate branch line of railway, or siding, for the Conger Lehigh Coal Co., Limited, Toronto, Ont., on subdivision Lots 12, 13, 14, 15, 16, 17, 18, 19 and 20, lying northerly of Vine St., Toronto, Ont.

21367—February 17—Amending Order No. 21172, dated January 7th, 1914, by striking out word "Broadview" in third last line of recital to said Order, and substituting word "Brandon."

21368—February 17—Authorizing Kettle Valley Ry. to carry traffic over portion of railway from Penticton Wharf, in westerly direction, a distance of 17 miles, B.C. And that portion extending northerly and northwesterly from Carmi to mileage 76.5, Prov. B.C., a distance of 30 miles.

21369—February 16—Rescinding Order of Railway Committee of Privy Council of Canada, dated Sept. 1st, 1899.

21370—February 17—Authorizing C.P.R. to construct spur for Henry Hope & Sons, of Canada, Ltd., in Park Lot 4, Tp. Lot No. 13, Con. 12, formerly Tp. of Monaghan, now City of Peterborough, Ont., subject to certain conditions, and rescinding Order No. 21232, dated Jan. 19th, 1914.

21371—February 17—Directing that C.N.R. reconstruct its station building at Aberdeen, Sask., work to be completed by first day of July, 1914.

21372—February 17—Authorizing C.P.R. to construct road diversion in Sec. 26-21-5, W. 4 M., Alta., at mileage 88.9 of Bassano Easterly Branch Line.

21373—February 17—Authorizing C.P.R. to construct diversions of East and West road allowance in Sec. 2-22, and Sec. 34-21-7, W. 4 M., Alta.; and construct, by grade crossing, Bassano Easterly Branch Line across North and South road allowance between Secs. 2 and 3, Tp. 22 and Secs. 34 and 35, Tp. 21, Rge. 7, W. 4 M.

21374—February 17—Authorizing C.P.R. to construct highway diversion, as revised, in Sec. 20-21-8, W. 4 M., Alta., and to construct Bassano Easterly Branch, by means of grade crossing, across said diversion at mileage 66.39.

21375—February 17—Granting leave to C.P.R. to carry party of mining students of McGill University at special rate of $40.00 per capita for trip from Montreal, Que., to Rossland, Phœnix, and Greenwood, B.C., and return, or at $50.00 per capita from Montreal to Vancouver, B.C., and return, including side trips to Rossland, Phœnix and Greenwood, B.C. 2. Granting leave to carry such party, if desired, over lines from Sudbury to Sault Ste. Marie and back at rate of $2.75. And that any other parties desiring to travel for same purpose to British Columbia or any other mining district, be granted equally favorable terms, until otherwise ordered by Board.

21376—February 19—Authorizing C.P.R. to construct Bridge No. 62.8 over Magnetawan River, near Byng Inlet, Ontario.

21377—February 18—Authorizing C.P.R. to use and operate Bridges Nos. 25.7, Laggan Sub. Div., Alta.; 92.3, Boundary Sub. Div., B.C., Div., B.C., and 176.9, Calgary Sub. Div., Alberta Div., Alberta.

21378—February 18—Making Montreal Warehousing Co. a party to application of Montreal Board of Trade for an Order directing G.T.R. to put into effect at its Montreal Elevator the same charges and conditions for elevation, storage, and loading of grain into cars as are in force at its elevators at Georgian Bay ports.

21379—February 19—Authorizing G.T.P. Branch Lines Co. to construct road diversion in S.W. ¼ Sec. 24-1-3, W. 2 M., Sask., at mileage 151.5 on Regina-Boundary Branch.

21380—February 19—Amending Order No. 21161, dated Jan. 7th, 1914, by striking out words, "and G.T.R. Co., as set out in letter of McCarthy, Osler, Hoskin & Harcourt to Chrysler & Bethune, dated Jan. 6th, 1913," in 3rd, 4th, 5th lines of recital to Order, and by adding at end of said recital words, "and the G.T.R. Co. of Canada, under a reservation of its rights, if any, as a riparian proprietor, not objecting."

21381—February 19—Amending Order No. 21139, dated December 31st, 1913, by striking out word "Saskatchewan," where it occurs in said Order, and substituting word "Alberta."

21382—December 12—Authorizing C.N.R. to construct across nine (9) highways on its Alsask Southeasterly Line in Saskatchewan.