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Volume 26. Toronto, April 16, 1914 Contents of this issue on page 605

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

COMMERCIAL DESIGNING OF STRUCTURES

MONEY CONSIDERATION NEXT IN IMPORTANCE TO THE GOVERNING FACTOR OF STRENGTH—SOME INSTANCES OF EXPENSIVE DESIGNING—A CRITICAL ANALYSIS OF COSTS.

By DANIEL J. HAUER
Consulting Engineer and Construction Economist

THE highest function of an engineer is that of designing. A man with limited ability and education may be able to carry out the plans and designs of another, but the broader and higher the education of an engineer, together with a well-balanced experience, the greater should be his ability in designing.

The world knows much of the structures and appliance of such greater designers and inventors as Sir Christopher Wren, Watt, Stevenson, Bartboldi, Eiffel, Roebling and Westinghouse, although it knows little of the men who carried out their designs. The names of the greater designers of engineering structures and machines live in the history of the world, but to few of those who carry out designs, i.e., the builders, does this apply. Goethals, of Panama, is an illustrious exception.

In all designing there is need for care and accuracy. The lives and welfare of many people are dependent upon the work of designers. There should be two standards of designing in every country. One should be for work done by the general government, in which the standard for excellence should be of the highest, represented by strength and artistic lines and finish.

Cost and service should not be the governing factors. Representative structures of this kind abound in the old world, in the many cathedrals, palaces, memorial arches, parks and boulevards, and in America the number of similar magnificent structures is increasing.

The second standard should be for commercial structures, for which the first consideration should be strength, the second cost and service or utility, and the last, art. However, art should not be sacrificed for a few cents, or when an artistic finish can be had for the same money for which an unsightly structure can be reared. In all commercial designing, all governing factors should give way to cost, except that of strength. This cost is not only that of construction, but also of service and operation, for it is manifestly wrong to design a structure for cheapness of construction that will not serve its purpose, or will cause a high cost for operation.

It is to be regretted that there are many instances occurring annually of engineers sacrificing strength for money considerations. Only a few years ago the sad spectacle was recalled in a paper before a technical society, of an engineer acknowledging that owing to money considerations, he had designed an important structure with such a low factor of safety that it had failed, wrecking very valuable property and causing heavy loss of life.

Buildings under construction fail, dams are washed out and many other engineering structures go down owing to faulty designs, insufficient strength being given to the designs through errors of judgment, lack of knowledge of designing, and sometimes to incomplete surface and sub-surface surveys, and data upon which to base the designs.

Such things are either directly or indirectly the fault of engineers. Directly, when they can control their work, or they undertake designing for which they are not fitted, and indirectly, when they cannot control their work, by not being furnished ample funds and time for surveys or are interfered with by governing boards and bodies, and they do not protest against such restrictions. Engineers under such circumstances should put their protests in writing and if conditions are not then remedied, they should refuse to go on with the work. Engineers should remember that in continuing under these circumstances, they are no longer living up to the high standards of their profession, but are injuring both their profession and themselves, for they suffer in reputation, while others escape all odium.

Beyond these considerations, money and service should be the guide of all commercial designing. Many designs will serve the same purpose, but some are much more expensive from either a construction or operation standpoint than others.

Some years ago, in designing some pile bridges for a railroad the plan called for a tenon on top of the piles to be mortised into the caps. This added to the cost of construction and of renewals, while it did not add to the strength. Drift bolts and lag screws formed the ordinary method and proved satisfactory for this purpose. Mortise and tenon work is used in frame structures, but owing to the extra cost the tendency is to substitute cheaper joints that will give the same strength and longer service, as a mortise is a hole to catch rain water and start decay.

A revolving drawbridge of the bob-tail type, i.e., with but a single span, was designed by an engineer, and to counterbalance the weight of the span, he designed heavy steel members on the end opposite to the span, as in the space provided for concrete he could not get enough of that material to serve as a counterbalance. A more experienced engineer cut out of his design several tons of high-priced structural steel, and substituted a like amount of scrap iron and steel to be mixed with the concrete, at a cost of only a few cents per pound. The utility of the structure was the same, the cost of construction much less.

A mechanical engineer designed an elaborate and expensive, but an ingenious and economical, set of cranes and devices for charging a reheating furnace and serving a steam hammer with ingots of a certain kind. It was afterwards found that it was not possible to work these ingots with that hammer. Here was a waste of money due to designing without having complete knowledge of the work in question. A few dollars spent on experimenting with the ingots in question with this hammer, would have prevented this error.

More than a decade ago a bridge being built in Canada failed owing to a pier sinking in the river as soon as the false-work was removed, owing to incomplete sub-surface surveys. This was a great waste of money due to faulty design of the foundation, based upon insufficient knowledge of the soil under it. Additional time and money spent in exploration would have prevented the failure.

Failure during construction does not always mean poor design. A few years ago an engineer had to build more than a mile of shore protection along a bay. He designed four types of walls and decided upon a design of concrete protection that was 50% cheaper than any of his other designs. He was severely criticized because about 200 feet of his shore protection failed, while being constructed under adverse conditions. Yet, this slight loss amounted to only a few hundred dollars, while he had saved more than $10,000 by the accepted design.

When the entire structure was finished it had ample strength to serve every purpose, and has proven this by some years of use.

Sewers are designed with many shapes, some of them extremely fantastic and expensive to build. Even with steel forms that are used over and over again for concrete sewers, some shapes make the cost of construction excessive. An odd shape does not add to the value of a sewer, but rather detracts from it, for the shape of the sewer should be designed for strength, available head room, and for the easiest flow of the sewage through it according to the gradient. This is also the case with conduits and aqueducts. If these considerations are followed in designing, then the costs are not likely to be excessive. When one considers the thousand miles of sewers that are needed in America, the need of an economical design of conduit is at once apparent.

Because concrete can be moulded into almost any shape, is not sufficient reason for making odd and expensive designs, not only in sewers, but likewise in any concrete structure. A railroad company asked for bids upon a number of concrete structures to replace stone masonry. The engineer had designed these concrete structures just as though they were built of stone, i.e., the wing walls had steps in them and the back of the walls and abutments had a series of steps and offsets varying from two inches to a foot, all of which meant extra costs for form work, adding nothing to the strength, as the same purpose would be served by a batter to the walls.

During the past year the writer made a visit to more than a dozen concrete bridges under construction, with a view to making economic studies of the work. It was quite surprising to note that only one engineer in designing his bridges had taken into consideration the methods of construction, and without sacrificing strength, had made his design so that thousands of dollars were being saved in construction, especially in forms. The centering timber used on one job had previously been used on three other bridges, to the superintendent's knowledge, and he stated that it was not new then. The cost of forms for concrete is always a heavy item. When their cost can be reduced it is the duty of the engineer to so design his structures.

This does not mean that graceful lines and architectural beauty should be excluded from the design. There can be ornamental panels, balustrades, columns and arches, as these structures are not only meant for service but to beautify. On the other hand, it is a waste of money to design and build ornamental panels, when they are to be covered over with vines, or the structures are so situated that they cannot be seen. A city once paid to have some bridges in a park made of ornamental design, only to allow their consulting landscape gardener to cover them with ivy. The ivy-covered bridges were pretty, but the costly ornamental panels were hidden, leaving only the graceful lines of the concrete bridges to be seen.

In designing structures the service of sewers, bridges and similar structures, is simple, i.e., they are for a single purpose. But it is not so with buildings and other edifices. Here the engineer must consider many things as regard to service, the problems being more complex. First of all, the purpose for which the building is to be used, should govern the lighting of the structure. The error in most cases is that of not having enough light, or having it enter at the wrong place or angle. Space that is too valuable may be given over to lighting, without obtaining the proper effect. At times the error may be to make the light too intense. These things apply to both sun and artificial light. A building to be used as a warehouse for storing goods does not present a difficult problem in lighting, but a school building, library, public hall, department store and factory gives the designer a very complex problem, and the success of the entire project may depend entirely on the lighting.

Money can easily be wasted in such cases. Few designing engineers and architects have given this subject study enough to solve such problems unaided, so they should call upon the services of expert lighting engineers, whose business is that of lighting alone.

In designing buildings for manufacturing, the various steps of the work to be done should be considered. The work should be planned first, and then the building designed to suit. Thus floors are generally built on the same level, while if different levels are used, chutes may carry the material from one machine to another by gravity, saving either machinery or the transferring by hand. The arrangement of rooms and floor space for machines should be in accordance with the sequence of the work so that material will not be handled unnecessarily. These arrangements should also be made in connection with the lighting system, for ample light means quicker and better work.

Store rooms for raw materials should be arranged at the place from which the material is to be worked up, and storage places for the finished products should be at the opposite end. This seems simple, yet it is a detail that is often overlooked, these store rooms being located with a view of easy handling, rather than for economical handling within the plant.

A few years ago a large manufacturing plant was to be rebuilt. The owners first employed a firm of economists to make a study of their methods of manufacturing and to devise a more economical method. This done, the engineer and architect drew up plans under the supervision of the economists. Many things were designed different from the ordinary standards and even a lighting engineer was employed. The result was that operating costs were cut nearly 25%, while the cost of building was reduced 10%. All waste room was cut out, and few later alterations had to be made.

This was in contrast to a large saw mill that was destroyed by fire and rebuilt last year on the same general plan as before. All the finished product has to be carried the entire length of the mill to be placed in the storage yard.

These examples illustrate how many engineers overlook the service feature of their structures, and how money is thus wasted in building and in operation. Both the old and the young man engaged in designing will do well to consider these important things.

MUSKOKA RIVER STORAGE.

THE sixth annual report of the Hydro-Electric Power Commission contains some information on the watershed of the north branch of the Muskoka River, lying in the districts of Muskoka, Parry Sound, and Nipissing, and comprising an area of about 560 sq. mi. above Port Sydney.

The report, which has just been issued, is for the year 1913. One of the important chapters it contains is that devoted to the hydraulic investigations that have been carried out during the year. The data on stream flow and storage possibilities of various rivers in the Province are steadily accumulating, and represent the acquirement of hitherto unavailable knowledge that is most important in the development of the water powers of Ontario. F. A. Gaby, B.A.Sc., is chief engineer to the commission, while H. G. Acres, B.A.Sc., and T. H. Hogg, B.A.Sc., are hydraulic engineer and assistant hydraulic engineer respectively. The following data relates to their work up to October 31st, 1913, on one of the many rivers under investigation, and outlines a projected scheme of improvement whereby storage and complete regulation of flow may be effected:

General Conditions.—Until recently, the paramount industry in the territory mentioned above has been lumbering, and for many years the north branch has been used for the transportation of saw-logs. Under ordinary conditions, log-driving seriously hampers power development, but a peculiar feature of the situation as regards the Muskoka River is that injury is now being caused not through the activity of the lumbermen, but through the cessation of their operations in the upper watershed. This is due to the nature and location of the lake areas.

In the lower portion of the watershed is a group of four large lakes, all but one practically on the same level. In the upper watershed is a large number of small lakes, which have in the past been controlled by lumbermen's dams. When lumbering operations were at their height, large quantities of water were held in these upper lakes, and they were flushed out more or less in succession in bringing drives down the main river and out of tributary streams. The water thus liberated discharged into the group of larger lakes above mentioned, and through their capacity for storage they reduced and equalized the various flood peaks, and discharged them more gradually into the lower river. As the lumbering industry waned, the quantity of water stored in the upper lakes was reduced, and the dams began to suffer from lack of maintenance, the result being that an increasing proportion of the spring run-off discharged naturally into the lower basin, and drained off in the early part of the summer.

The result has been that, while power has been developed upon the river on the basis of a minimum flow which existed 10 years ago, the minimum flow during the last three or four years has dropped as low as 120 sec.-ft. at High Falls, or less than half the flow which was ordinarily supposed to obtain 10 years previous. A large part of the capital invested has on this account become unproductive, and long and frequent periods of inadequate service have caused much trouble and inconvenience, as well as a serious loss of revenue.

The object of the investigation is to determine to what extent artificial storage can be used to improve present conditions.

The oldest established industry in the Muskoka River watershed is lumbering, but owing to the fact that practically all the pine has been cut, the waters of the north branch are now very little used for driving purposes, and in two or three years' time, the use of the waters for this purpose will practically cease.

The navigation interests are confined almost exclusively to the handling of local tourist traffic and through tourist traffic to the Lake of Bays. Open navigation exists between Huntsville and Peninsula Lake, and connection with Mary Lake is made by means of a lock.

Several passenger steamers are kept in commission during the tourist season. The largest boat on the Huntsville-Portage route is 125 ft. long, 22 ft. beam and has a maximum draft of about 7 ft. The largest boat on the Mary Lake route has a maximum draft of 6 ft., and has a length and beam specially adjusted for the dimensions of the lock.

As to the commercial use which may in future be made of these waters for navigation purposes, it would seem that the limit of their utility would be the bearing of a tourist traffic not very greatly in excess of that now existing. This opinion may be justified on the following grounds:

(1) That the cutting out of the pine timber has destroyed any lake commerce that has previously existed in connection with the lumber industry.

(2) That the desertion of farms in the townships bordering on these lakes indicates that they will be used less in the future, in connection with the commercial needs of agriculture, than they have been in the past.

(3) That the continual opening up of new tourist districts by the railways will tend to check any abnormal expansion of the tourist traffic out of Huntsville.

It will be assumed, therefore, that the requirements of navigation will be adequately met by providing for the permanent accommodation of boats similar to those now operating.

The minimum depth of channel between Huntsville and the Portage will, therefore, be 8 ft., and 7 ft. between Fairy Lake and Port Sydney.

Power.—In the year 1892, the town of Bracebridge put its No. 1 hydraulic plant in operation in the Muskoka River, a 16-ft. head being developed for lighting load only. This plant is now used exclusively for municipal pumping. In 1901, plant No. 2 was built, and a 250-kw. unit installed. In 1908 it was found necessary to add a 300-kw. unit. In 1909, the growing demand for power led to the building of No. 3 plant at Wilson's Falls. This site is now developed to full capacity, 600 kw. being installed. At the present time, the town has over 2,000 h.p. of wheel capacity installed, and a continuous market demand of 1,500 to 1,800 h.p. Under the low water conditions which have obtained during recent years, about 25 per cent. only of this installed capacity has been capable of use, and for weeks at a time the town has been obliged to carry a commercial load of 1,800 h.p. with a maximum plant output of about 550 h.p.

It is quite evident that the continued occurrence of these periods of power shortage would ultimately ruin the municipal system, as manufacturers would be forced to install a more dependable type of motive power.

In view of the above, it is unnecessary to emphasize the urgent need of improving the flow characteristics of the north branch of the Muskoka River. The obvious means of effecting such improvement is by the storage of surplus run-off in the navigable lakes, or in the smaller lakes of the upper watershed.

Storage Possibilities.—The choice of initial storage development lies between the group of four navigable lakes above Port Sydney, and a larger number of very much smaller lakes on the upper watershed above Lake Vernon.

As regards the latter, the complete development of the larger lakes would provide approximately 60,000 acre-ft. of storage. To obtain this, it would be necessary to repair and maintain seven to ten timber dams. Owing to the small storage capacity of the individual basins, more or less constant attention would be necessary for proper operation, and the inaccessible location of most of these basins would be detrimental to operation, both as regards cost and efficiency.

Another disadvantage consists in the fact that stored water from the upper system of lakes must pass through and be partially absorbed by the large lakes above Port Sydney. The influence of wind and temperature on these lakes will make it impossible to foretell with any degree of accuracy what effect the flushing out of a basin would have on the regimen of the lower river, or in what time the effect would become noticeable.

The obvious solution of this latter difficulty is, of course, to use the navigable lakes as auxiliary storage basins. This has actually been done through the agency of the government dam at Port Sydney.

Having established the fact that the navigable lakes must in any case be used to some extent in connection with any storage scheme that may be devised, the question arises as to whether the storage of these lakes could be developed sufficiently to dispense altogether, or in part, with the necessity of developing the upper system.

The combined area of the four lakes involved is such that about 10,000 acre-ft. of storage is available for each foot in rise. The importance of obtaining the maximum possible range of variation in level is therefore evident, and the whole point at issue is to determine a range of variation which will, on the one hand, cause no extensive damage by flooding, and, on the other, permit minimum navigable levels to be permanently maintained.

Results of Surveys.—The investigations of this problem necessitated the making of surveys covering a new site for a dam at Port Sydney; flood contours around Mary Lake; surveys, with soundings, of various channels. These surveys were of service in reaching certain conclusions which may be summarized as follows:—

(1) That the maximum regulated level of Mary Lake could be held 3 ft. above the ice level which obtained at the time of the survey, without causing undue damage.

(2) That the maximum regulated level above the lock should be held at, or slightly below, high-water level, corresponding to about 8.5 ft. on the upper sill of the present lock.

(3) That a 3-ft. variation of level above the lock, during the navigation season, will not injuriously affect navigation or riparian owners.

(4) That a 4-ft. variation of level below the lock during the navigation season will not injuriously affect navigation, and will not cause serious injury to riparian owners.

New Construction and Improvements.—The existing dam at Port Sydney is a wooden structure built by the Provincial Government for maintaining navigation between Port Sydney and the lock. This dam now requires to be replaced, and, in the interests of economy and efficiency, a permanent structure should be built. The lock between Mary and Fairy lakes is in a dilapidated condition, as is also the dam. The useful life of the dam might be prolonged by extensive repairs, but the lock requires to be entirely rebuilt. All new construction at this point, whether lock or dam, or both, should be permanent.

In the narrow channels between the lakes, the backwash of the boats cuts away the banks, and the consequent silting up of the navigable channels necessitates frequent dredging. This silting action could be effectively stopped by pile sheeting the exposed sections. The whole length of the channel between Fairy and Peninsula lakes should be treated in this way, and also certain portions of the channel between the lock and Mary Lake.

All of the above new construction is required in the interests of navigation, and any additional features of design in connection with these structures, which might be necessary in order to adapt them for storage regulation, would be insignificant from a cost standpoint. The surveys also indicated that the storage capacity of the lakes above Port Sydney could be economically increased by deepening some of the connecting channels between the lakes.

Details of General Scheme.—The dam at Port Sydney is to be designed so as to enable the levels of Mary Lake to be held between El. 23 and El. 27 during the navigation season, and to allow for an additional drop of two feet during the fall and winter. The bottom of the navigable channel between Mary Lake and the lock has been set at El. 16. A small amount of excavation may be necessary through the sandbar at the mouth of the river. Some soft dredging will also be required just below the lock.

At the lock, it is proposed to drop the lower guard sill to El. 15, and the mitre sill to El. 14. The upper guard sill is dropped to El. 23, and the mitre sill to El. 22. There will thus be 8 ft. of water on the lock sills under the minimum projected summer level.

With a tight permanent dam at Port Sydney, a permanent dam at the lock is not absolutely necessary, and present requirements will be met if the latter is repaired and alterations made which will enable it to hold the level above the lock within the extreme limits of variation, El. 34 max., and El. 29 min.

The general scheme provides for a navigable channel 60 ft. wide, with a minimum depth of 7 ft., between Fairy Lake and Port Sydney, with 8 ft. minimum on the guard sills of the lock, so that an 8-ft. channel could be provided in the future by dredging.

The adoption of the scheme would make 3 ft. of draft available in summer, and 2 ft. additional in winter, upon Vernon, Fairy and Peninsula lakes, making in all 5 ft. of draft available. Under similar conditions, 4 ft. of draft will be available on Mary Lake during the navigation season, and 2 ft. additional in the winter, making 6 ft. available in all. The combined area of Vernon, Fairy and Peninsula Lakes, is about 7,600 acres. The area of Mary Lake is about 2,600 acres. On the basis of the above figures for area and storage draft, the four lakes would provide 32,800 acre-feet of storage during the navigation season. The benefit to be derived from this volume of storage will be proportional to the length of the low water season, which will vary from year to year. The continuous supply from storage alone, for seasons of various lengths, would be as follows:—

107 days from July 17 to Oct. 31.......155 second-feet.
92 " Aug. 1 to Oct. 31.......179 "
76 " Aug. 1 to Oct. 15.......210 "
61 " Aug. 1 to Oct. 1.......271 "

Under the worst possible conditions that could be imagined the watershed of the Muskoka River above Port Sydney should produce a natural minimum run-off of one-tenth of a second-foot per square mile of watershed. This would mean a natural low-water discharge of 56 sec.-ft. at Port Sydney.

If the flow from storage under various conditions be superimposed upon this natural discharge, the figures given above will become 211, 235, 274 and 327 sec.-ft. respectively. These latter figures fairly cover the range of benefit to be derived from the utilization, during the navigation season, of 32,800 acre-feet of storage on Vernon, Fairy, Peninsula and Mary lakes.

As to winter storage, it has been assumed that 2 ft. additional could be drawn off the lakes after the close of navigation. Assuming no fall replenishment, there would be 20,200 acre-feet of storage available, to meet low-water conditions during the winter. Two months' use of winter storage would probably cover the worst condition; say, from January 15 to March 15. Over this period, the above specified volume of storage would provide a continuous flow of 169 sec.-ft., which, superimposed upon a natural minimum of 56 sec.-ft., would mean a continuous supply of 225 sec.-ft. under the worst winter conditions to be anticipated.

The outstanding points of advantage in the above scheme are the greater accessibility of the works, and the vastly greater degree of precision with which the flow can be regulated, if properly designed works are placed at the lock and at Port Sydney. The facilities thus afforded for efficient regulation would more than offset any advantage the upper lakes might have as regards aggregate storage capacity.

The complete development of the storage of the lower lakes will also allow the storage of the upper lakes to be properly utilized at very small cost, should the necessity arise. It would simply be necessary, in this case, to keep the wooden dams in a fair state of repair, and to flush out the various small lakes in rotation whenever the stage of the lower lakes was such as to permit the reception of the additional supply.

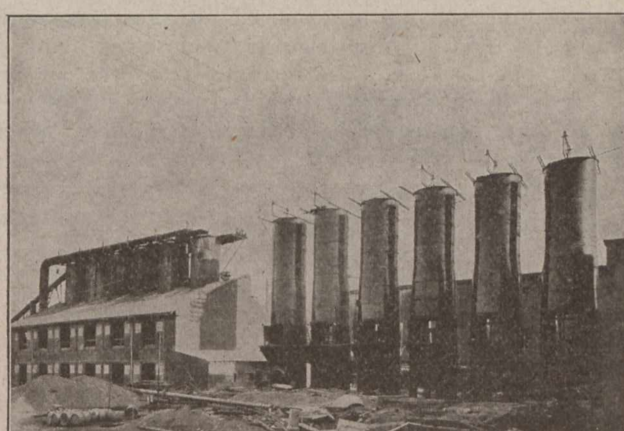
The cost of operating and maintaining the upper system under such circumstances would be comparatively insignificant.

In conclusion it may be noted that the development of artificial storage for power purposes on navigable lakes is not by any means a new idea. The navigable lakes on the Trent and Rideau systems have been used for storage purposes for years, and the range of level variation which obtains on the navigable lakes included in both of these systems is much greater than that contemplated in the case under discussion. Furthermore, in the case of the Trent Canal a through navigation route is involved, where the interests of shipping will be of vastly greater importance as compared to those of power than they can ever hope to be on the lakes above Port Sydney.

CYANAMID FACTORY AT NIAGARA FALLS.

THE problem of artificially fixing atmospheric nitrogen and combining it in suitable forms for plant food has been a difficult one for scientists and one which has had their serious thought and attention for many years. In 1895 two German scientists, Drs. Frank and Caro, found that when nitrogen gas is conducted through a hot mass of calcium carbide there is produced a compound known as Cyanamid, very rich in nitrogen.

This form of combined nitrogen was found to possess particular value as a fertilizer and its use for this purpose has developed an enormous industry. Cyanamid factories have been established all over the world. One of the largest of these is located at Niagara Falls, Ontario,



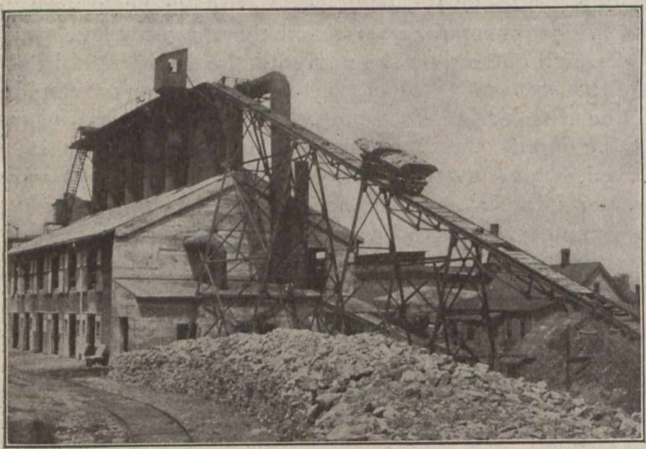
New Addition to the Plant, at Present in the Process of Construction.

where large quantities of electricity, required in this industry, can be obtained at low cost.

The American Cyanamid Company owns the sole right to manufacture and sell Cyanamid in America. Its factories at Niagara Falls began operations on January 1st, 1910. The original plant had an output of 12,000 tons a year, but this was increased during 1912 to approximately 32,000 tons a year and further extensions are under way to give an annual output of 64,000 tons.

From the very commencement of operations at Niagara Falls it was clear that a plant capable of producing 12,000 tons per annum was totally unable to meet the market requirements, but a policy was adopted to thoroughly prove the commercial practicability of, and demand for cyanamid before building a large plant.

After two years' experience they realized that the product could be looked upon as an undoubted commercial success. Methods of manufacture have been simplified and cheapened, and it is now necessary to double the existing plant in order to cope with the increasing orders.


View of Complete Plant, Showing Lime en route to Kiln.

Nitrogen is the most important of the plant foods. It is usually the first element to become deficient in cultivated soils, yet when good forms and proper amounts are furnished, crops respond to it with a more direct and immediate effect than to application of phosphate and potash.

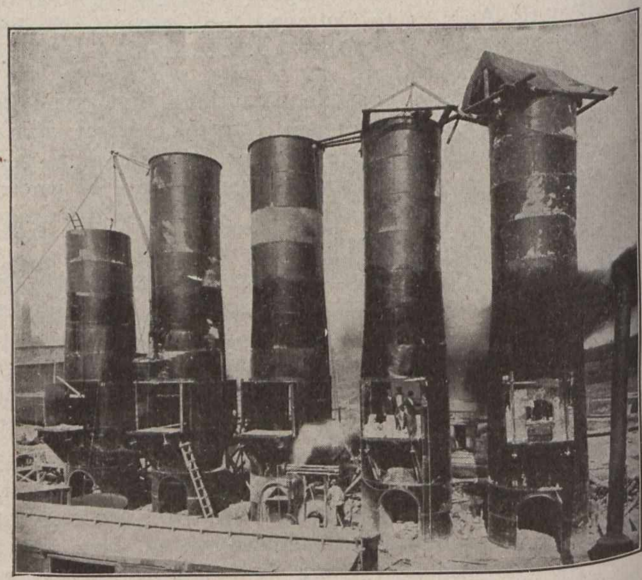
All the combined nitrogen now in existence on the earth's surface came from the atmosphere at some time. Previous to the discovery of cyanamid the only practical means of directly fixing atmospheric nitrogen was by the action of bacteria. These bacteria, themselves living on plants or plant refuse, take nitrogen from the air and combine it into chemical forms that plants can absorb. If plants were not removed, but were left to decay where they grow, the fertility of the soil would probably never decrease. When crops are removed, however, not only is the nitrogen carried away but also the plant matter on which the bacteria feed. Then, in order to maintain fertility, it is necessary to restore combined nitrogen to the soil from other sources.

Cyanamid is a bluish-black, odorless, powdered material. It contains from 18 to 20% ammonia, about 12% carbon, or lamp-black, and the equivalent of about 70 pounds of slaked lime. The material is shipped in burlap bags and can be stored indefinitely.

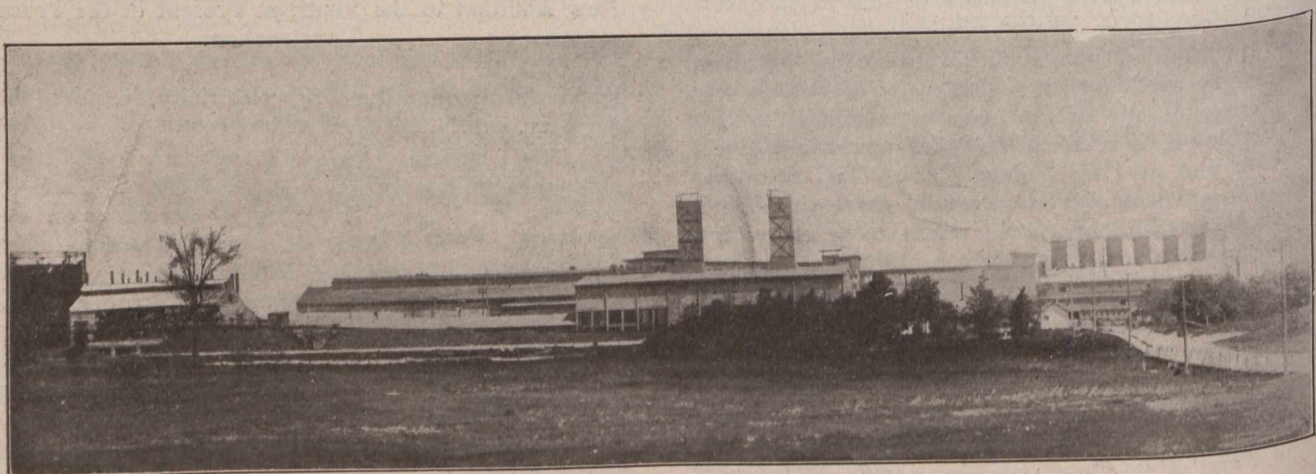
Cyanamid nitrogen is readily soluble. Ninety-six per cent. will dissolve out in cold water and is therefore available as plant food. On contact with the soil it reacts quickly and forms first the organic compound, urea, and then changes into the form of double ammonium compounds. These compounds are not leached or washed out of the soil, but are made available to crops by bacterial action and the solvent effects of plant roots. This action insures a slow, steady supply of nitrogen that has the advantage of not overfeeding crops a few weeks and then starving them, but of supplying this element throughout their principal period of growth. Since the soil duration of cyanamid nitrogen is from 60 to 80 days, crops are not fed when they should be maturing, and therefore ripen earlier and more uniformly.

Every 100 pounds of cyanamid contains the equivalent of about 70 pounds of slacked lime, which adds considerably to its value as a fertilizer. This line costs the farmer nothing—cyanamid is sold on the basis of the ammonia it contains as determined by analysis.

The beneficial action of lime is well known. Briefly its advantages are as follows: (1) It corrects soil acidity and produces conditions favorable for the growth and


Kiln Shells Being Erected and Fire Clay Lining Commenced.

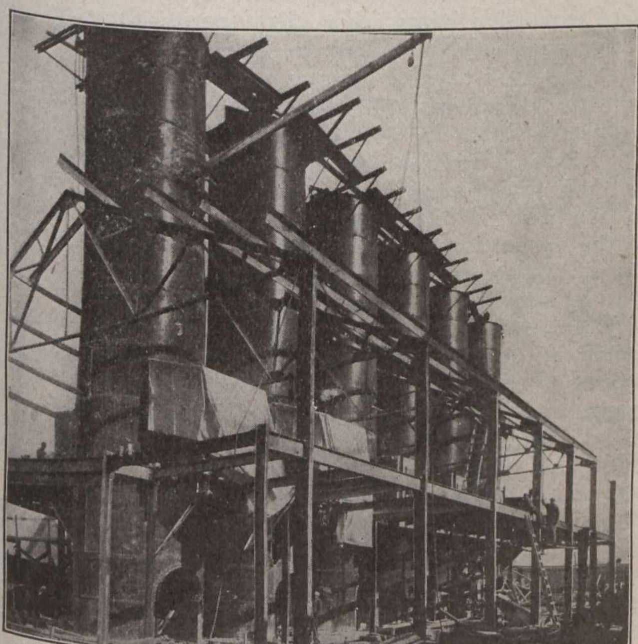
activity of nitrifying bacteria, which supply plants with much combined nitrogen. These bacteria are destroyed by acid conditions, but thrive in limed soils. (2) Lime


General View of Plant.

hastens the decomposition of waste products used as manures. (3) It destroys many injurious insects and soil diseases. (4) It makes available the phosphoric acid and potash often held too firmly in combination by some soils. (5) It improves the mechanical condition of all soils, making clay more porous and sand more retentive.

A regular application of cyanamid to soil in good condition should ordinarily neutralize the acids occuring therein. The ease with which the lime content of the soil is kept at a desired point makes this fertilizer especially valuable. Many other fertilizers tend to increase soil acidity until finally heavy liming is necessary. The yearly addition of lime as a part of the cyanamid fertilizer involves no extra expenditure of time, labor or money.

The manufacture of cyanamid depends upon the chemical fact that calcium carbide at a high heat combines with atmospheric nitrogen and forms calcium cyanamid. Calcium carbide is made by fusing together



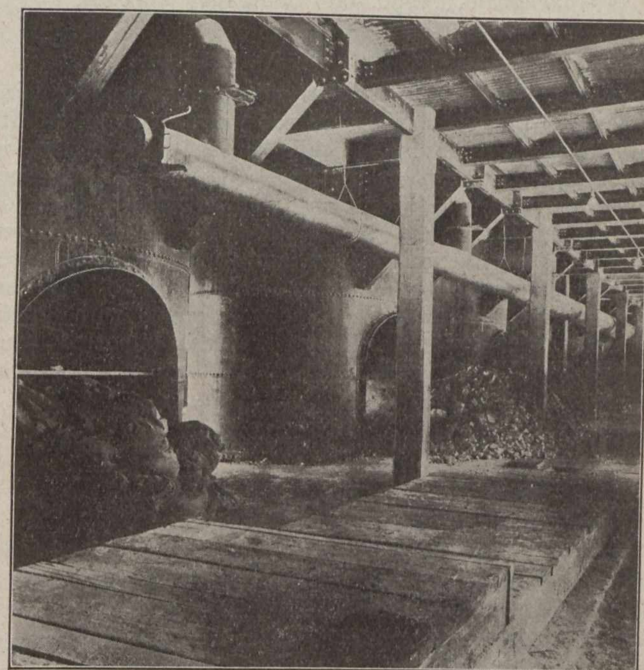
Kiln Shells Completed and Piping Being Installed.

lime and coke in an electric furnace. The carbide is placed in the ovens heated by electricity to a white heat and nitrogen is led into the ovens and is there combined with the carbide, forming calcium cyanamid. After cooling, this material is ground, treated with water and put through a mechanical finishing process.

It will readily be seen that for economical production of cyanamid the plant must be located where electricity can be secured at the lowest possible cost.

Before the installation of the cyanamid plant at Niagara Falls another matter of importance was to determine the kind of reducing gas to be used in the preparation of the nitrogen. After careful consideration a coal gas plant was decided upon as the entire output of coke could be used in the manufacture of calcium carbide and the coal gas gave the greatest amount of carbon content for use in the nitrogen ovens.

The nitrogen ovens consist of a series of vertical retorts heated by small individual furnaces. Copper oxide is placed in these retorts, and when the retorts are brought to the proper temperature air is forced through the retorts and the oxygen of the air combined with the copper and cupric oxide leaving the nitrogen free. The air is then shut off and as the oxide has gradually become foul during this cycle coal is then passed through the retort, which acts as a revivifier for the reducing agent. The nitrogen is then forced through pipes into the electric



Lime Discharge Floor, Showing Handling Arrangement.

furnaces where it combines with the calcium carbide and forms calcium cyanamid, or commercial cyanamid.

The lime plant for the manufacture of lime to be used in the cyanamid plant was designed and installed by the

Arrangement of Charging Doors of Kilns.

Improved Equipment Company. The original plant consisted of six Doherty-Eldred lime kilns equipped with the Eldred process and induced draft.

American pine, treated with 22 pounds of creosote oil per cu. ft., is used in Cuba for piling. Native timbers are sometimes given a coat of cement, ¼ to ½ inch in thickness, and these timbers are said to be hand-wrapped, but their usefulness has not as yet been fully demonstrated.

SOME GOOD ROADS, THEIR CONSTRUCTION AND MAINTENANCE.

By Robert C. Muir, C.E.,
Mackenzie, Mann and Company, Toronto.

(Concluded from last week's issue.)

Brick Pavements.—Brick pavements, though used extensively in Europe for over 100 years, have only quite recently come to be used in this continent, the first being laid some 20 years or so ago. At first failures were numerous, these failures being due to poor foundation or the quality of brick. In Europe this form of pavement has proved highly satisfactory, and found in many places to be superior to stone blocks. Rotterdam and Amsterdam being two cities almost entirely paved with brick, here the brick for extra heavy traffic is imported from England and local brick used for light traffic.

The advantage of brick pavements are:—

(1) Easily cleaned.
(2) Easily repaired.
(3) Makes traction easy.
(4) Good foothold for horses.
(5) Durable under all kinds of traffic, granted foundations are good.
(6) Little dust and no mud.

The chief defects are: (1) The lack of uniformity in the brick; (2) noise.

The clay that the bricks are made from must be free from lime; thorough grinding and mixing of clay is essential, so as to have no lumps on the brick. A solid foundation is here again absolutely necessary, a weak foundation being often the cause of failure in all pavements. The foundation in every case should be formed of concrete (1:4) 5 inches thick.

Methods of Construction of Brick Pavements.—*Pavement on Brick Foundation.*—The roadbed should be graded to 11 in. below finished surface, then rolled until thoroughly consolidated. On this bed should be spread a layer of ashes to a depth of 3 in., then rolled. A covering of sand is then applied of sufficient thickness to form a cushion to the proper shape for receiving the bottom or foundation course of brick. This being satisfactory, place the foundation course of brick, long side parallel with curb, laid close and all joints broken. Dry sand should be spread over this and thoroughly brushed to fill all crevices.

Another layer of sand 1 in. thick is laid on to form cushion for top course of brick. This course will then be laid with longest edge surface across street at right angles to curb, laying brick as close as possible and breaking joints, no half-bricks being used unless where necessary to break joints. The surface should be then covered with sand, well brushed, and then rolled. The bricks used to be of the best quality, uniform and regular in shape and free from cracks.

Brick Pavement on Concrete Foundation and Grouted with Pitch.—The roadbed should be rolled and thoroughly consolidated and prepared to receive a layer of ashes 3 in. thick. The concrete foundation is then laid, depth varying according to traffic (5 in. is reckoned to be sufficient for medium traffic). The surface is to be made parallel with the finished surface of the pavement by floating the concrete surface over with cement and using straight-edge. Traffic should be kept off while concrete is setting, and brick should not be laid thereon for at least 4 days. When foundation is ready to receive brick lay a cushion of sand 2 in. thick. On this lay bricks on edge at right angles to curb, as close as possible, joints to be broken and then rolled with a 5-ton roller. The bricks having been rolled to perfect surface, the crevices are then filled with pitch heated to 300° F. and entire surface covered with a depth of ¼ in.; upon this spread a layer of sand ¼ in. thick. Sand must be thrown evenly on boiling pitch, and with no delay as pavement is finished, the object being to make the pavement one solid mass, which when finished shall be watertight. The sand to be used must be clean, sharp and free from moisture.

The sizes of bricks commonly used are 8¼ x 4 x 2½ in. and 9 x 4 x 3 in.

Rumbling.—Rumbling is caused by open spaces between brick and foundation. If sand cushion is not properly compacted, the settlement will leave an opening between cushion and brick, also an opening may be caused by course of brick being forced up off sand cushion. This may be caused by the swelling of lime used as joint filler. To avoid this upheaval it is advisable to place expansion joints every 25 ft., across the street and along each curb, and filled in with pitch. This is only necessary in a case of lime or cement joint.

Tar Macadam.—This is a method used extensively in Britain within the last 4 years.

Mixing.—In making tar macadam the stones should be thoroughly dried and heated, care being taken not to overheat. While hot they should be mixed with tar in the proportion of 8 gals. per ton, and mixed by machine. Opinions differ as to size of stones for this method some holding that the stones should be from 2¼ to ¾ in., so that all crevices may be properly filled. This would be quite acceptable if it were possible to have stones so evenly mixed that a proper proportion of each grade would be evenly distributed in every square yard of roadway, but this perfect grading is seldom realized, with the result that the road surface is of unequal strength. The author adopted the system of using only one size of stone for one particular piece of work, the best results being got from stones of 2¼ in. size. The smaller stones are used for very light traffic, chippings being used as a binding coat, and also for gritting the tar-finished surface. The cost per ton of making tar macadam, including stone, tar, heating, wages and carting is $2.00. This will, of course, vary with the cost of stone, price of tar, and efficiency of tarring and drying plant.

Laying.—The existing surface is scarified, evenly raked and hard rolled; this surface to be perfectly dry. Then tarred stone is spread on 4 in. thick, if a 3-in. finished surface is required. Should weather be very hot, light rolling should be applied to get stones into position, otherwise the steam roller may push the stones in front of it, thus causing a wavy surface, which is difficult to cure. When rolled hard a small sprinkling of tarred chippings will help to bind surface. After traffic has been on road for a few weeks the surface should be carefully swept and painted with a prepared tar. This class of surfacing is perfectly satisfactory on a fairly well-bottomed road with a good subsoil. The cost of this method of surfacing for a 3-in. finished surface is 40 cents per square yard.

Another method which has given good results is by the use of "Tarmac," the aggregate of which consists of furnace slag. The slag is run in a molten state from the surface into suitable receptacles and is allowed to cool. When cool the slag is removed to a convenient location and broken to suitable sizes before being put into the crusher. Thence it is broken to the regular sizes and afterwards treated with the tar composition. The slag having had no opportunity of absorbing moisture is, therefore, perfectly dry, no extra heating being required. The slag breaks with a rough and uneven fracture and has great holding capacity for the tar composition. It is, moreover, sufficiently porous to absorb and hold a portion of composition.

The size of stone used is 2¼ to ⅜ in. chippings. The existing road surface having been prepared, spread a 4-in. layer of 2¼-in. stone and roll until thoroughly consolidated. Upon this spread a layer of 1½-in. stone, which is rolled and consolidated, making a total thickness of 4 in. This surface is thoroughly brushed over with ⅜-in. chippings, which are also coated with tar so as to fill all crevices, then rolled to a smooth surface, this finished surface to receive a covering of chippings.

Tarmac has proved satisfactory. It is almost dustless during summer and not unduly slippery during winter.

Bituminous Tar Macadam.—Where roads are subject to fairly heavy traffic something better than ordinary tar macadam is required. The author two years ago experimented on a road having a traffic density of 160 tons per yard width per day of 24 hours, which was unsuitable for ordinary macadam. With a bituminous macadam the surface in summer is excellent, but in winter the wear is pretty heavy as the protecting surface is torn off by wheels of large motor buses, especially with a thaw after a night's frost. The tar used was to the following specifications:—

Specific gravity	1.19 at 60° F.
Freedom of water	Practically free.
Fractionation	3% at 220° C., 15% at 300° C.
Free carbon	15%.
Viscosity	30 seconds at 70° F.

This was mixed with 20 per cent. of best Mexican bitumen, and after being down a few weeks, was surface coated with the same mixture and gritted with very hard chippings. Three different qualities of stone were used: (1) a very hard, keen stone, standing a great crushing strain; (2) a good, hard stone, but not so keen as first; (3) a good, moderate stone. By experience it was found that the keen stone had not taken a proper grip of the tar, and the suction of motor wheels tended to bare this stone by removing the particles of tar, which in cold weather had become pulverized by heavy traffic; the good hard stone holding the tar better, and the moderate stone being best of all, the more expensive being no advantage.

This roadway a year later was treated with tar and bitumen, part being treated with Mexican proprietory bitumen, which did not give such good results as tar and bitumen. This is the best tarred work the author has tried for a heavy traffic road.

The cost per square yard of this method worked out as follows:—

	Cents.
*Material and mixing	41
*Laying stone and binding	9
*Surface painting	5
	55

* Including labor.

Rocmac.—This binder is a silicate-saccharate-carbonate, the foundation of which is silicate of soda, sugar and carbonate of lime. The sugar is not used for adhesive purposes, but to assist the chemical action of the silicate on the carbonate, and secondly to assist the resistance of the matrix to frost.

A matrix is formed of the mixture in the proportion of ⅓ cu. yd. of crushed limestone to 5 gal. of Rocmac solution with an addition of similar proportion of water. This is mixed similar to the making of concrete, the limestone crushed to ¼-in. gauge and dust. This matrix is applied to existing road surface to a thickness of 1 in. for a finished 3-in. coat. The stone is then spread on and rolled until the matrix comes to surface. All superfluous material is swept off and surface left clean and hard.

The advantages of Rocmac are:—

(1) Repairable in almost any kind of weather, except hard frost.

(2) Cheaper than bituminous macadam (method above described).

(3) No yearly surface painting required.

(4) Dust not so obnoxious as from tar.

(5) Good foothold for horses, not so slippery as tar macadam.

(6) When laid, frost has not injurious effect on it as upon other road surfaces.

The defects of Rocmac are:—

(1) Dustiness in summer, though after superfluous limestone has been washed off dust is greatly reduced.

(2) Hard, metallic ring.

It is claimed that the life of Rocmoc road is 3 times that of an ordinary water-bound macadam road. The cost of Rocmac was 52 cents per square yard.

The author's experience has been that with roads laid upon a clay subsoil, imperfect drainage and under a medium heavy traffic tar in any shape or form soon gave out. After careful consideration he came to the conclusion that Rocmac, though not ideal in every way, was well suited to roads under said conditions.

Asphalt Pavements.—Asphalt is by no means a modern pavement, having been used in Paris about the year 1830 and introduced in London in 1860, or thereabouts.

Foundation is of the greatest importance with asphalt pavements, a solid foundation being absolutely necessary. Asphalt is commonly laid on a concrete foundation. 5 in. thick, though good results have been obtained from old macadam and brick pavement being used as foundation, which reduces the cost considerably. Foundation must be thoroughly dry before asphalt is laid, this being a most essential point in asphalt paving. Should asphalt be laid on a damp foundation it will break up as soon as traffic goes on it. Dry weather is, therefore, necessary for the laying of asphalt.

Asphalt cement pavement is composed of the matrix and the aggregate, success depending upon the selecting of materials, mixing and laying of pavement. The matrix is a cement prepared from asphaltum. The aggregate is composed of sand and stone dust, though in many districts Portland cement has been used in place of stone dust. When Portland cement is used more asphalt cement can be used, thus making a denser mixture, which tends to lengthen the life of pavement. The matrix and aggregate are heated separately to a temperature of 280° to 300° F. and are then thoroughly mixed.

The binder, which contains 5 per cent. more cement than finished surface, is then spread on foundation 1½ in. thick and rolled until consolidated. The finished surface is now applied and spread with rakes to a thickness of 4 in., if finished thickness is to be 2 in. This surface is covered with cement to prevent the roller lifting asphalt, and rolled to a perfect and uniform shape. When the road or street is curbed, asphalt should not be laid right up to the curb, but a gutter of brick or cement formed.

General Remarks.—Planning of Streets and Roads. —(1) New main roads should go outside rather than through towns, and where existing main roads are unsatisfactory for through traffic a new road should be substituted.

(2) Grades on new roads should be as easy as possible.

(3) The radii of curves, where possible, should give an unobstructive view.

(4) Street railway tracks should be placed in the centre of roads and space left on either side for separate tracks for vehicles going in opposite directions.

(5) Main traffic roads should be designed so that tracks be provided for street cars, fast and slow traffic and standing vehicles.

(6) In fixing building lines on what may ultimately become main roads, regard should be paid to future requirements.

(7) The planning of main road communication between towns should be undertaken and some initiative should rest with a central state authority.

Causes of Wear and Deterioration of Roads.—(1) Weather has the most powerful influence on the deterioration of roads. This can be minimized by effective waterproofing.

(2) The damage of heavy motor vehicles is principally caused by the balance, the ratio between propelling power and weight, weight of unsprung portions, continuity of brake action, system of springing, type of tire, diameter of wheel, width of rim, variation of speed and other factors.

(3) Heavy motor vehicles should have wheels of large diameter, with tires of a width adapted to the axle load.

(4) Light motor traffic does not cause damage to roads bound with tar or bituminous materials.

(5) In horse-drawn vehicles diameter of wheel, width of rim, and system of shoeing horses should be considered.

Finance of Construction and Upkeep of Roads.—(1) The upkeep and improvement of all main roads should be paid out of national revenues, whether or not such roads are locally administered.

(2) All tolls on roads should be abolished, but certain vehicles, on account of weight or combined weight and speed, which cause special damage to roads, should be subject to special taxation, the proceeds to go for the construction and upkeep of roads.

Experiments have proved that the binding material on roads under heavy traffic must be of a bituminous or asphaltic nature, prepared tar not standing heavy traffic. Pavements having curb and gutter on both sides give considerable support, prevent lateral thrust and enable better initial consolidation. It is advisable that all improved road crusts should be supported by a sufficient foundation, as the tendency is that the weight, speed and intensity of traffic will increase on roads. On all bituminous or tarry surfaces it is absolutely necessary to carry out repairs whenever the necessity arises, as in the case of water-bound macadam.

Instruction in Use of Tar, Bitumen and Asphalt.—

(1) The stones must be dry and heated.

(2) Top crust never to be laid on damp foundation, and the work should be carried out in dry weather.

(3) Only a sufficient quantity of binder to be used.

(4) Tar not to be overheated; if so, has tendency to cause weakness.

(5) Heating and mixing of stones and tar to be carried out on the work; this the author considers to be a very essential point.

(6) Heavy road rollers should never be used, 3 to 5-ton rollers being preferred.

PRESENT POSITION OF THE SEWAGE DISPOSAL PROBLEM.*

By Gilbert J. Fowler, D.Sc., F.I.C.

IN 1898 the Royal Commission of Great Britain was appointed to inquire and report on the whole question of the treatment and disposal of sewage. The present Royal Commission submitted its first interim report in 1901, and its eighth report, embodying final conclusions on some of the main issues involved, was published in 1912.

In the report of 1901 the commission state that, in their opinion, it is practicable to produce by artificial processes alone effluents which will not putrefy, and which might be discharged into a stream without fear of nuisance. A great part of the Royal Commission's work has consisted in the collection of evidence and the conduct of experiments, with the object of working out the conditions of efficiency of these various processes, and of standardizing the methods employed as far as practicable, so that an authority may have a fair idea what sort of a result is likely to be obtained for a given expenditure.

The fifth report of the Royal Commission and its appendices are a mine of information in this respect, and the appointment of the commission would have been more than justified by this report alone, introducing as it does the idea of quantitative accuracy into the operations of sewage disposal.

There is no excuse now for authorities to launch out on expensive works without any preliminary study as to the character and amount of the sewage to be treated. The commission show clearly that the design and extent of the works must depend on the concentration or "strength" of the sewage. This is roughly proportionate to the water supply per head, and the amount of subsoil drainage finding its way into the sewage system. The composition of the sewage is also affected, e.g., by the quantity and character of the trade effluents discharged into the sewers, and by the proportion of water-closets to pail-closets in the district sewered, and by other factors.

In the fifth report the commission indicate in general terms the kind of works necessary to obtain a satisfactory effluent from sewage of a given character.

This, of course, does not mean that in future all that a corporation or council has to do is to take a sample or two of the sewage, have it classified as strong, medium, or weak, and order a sewage works accordingly.

The chemical and engineering conditions are in no two places alike, and in order to obtain the maximum efficiency and economy under any given set of conditions, careful thought and study on the part of the engineer and bio-chemist will always be necessary.

The author has, e.g., on more than one occasion, recently found that the sewage to be dealt with in small installations in the country is rendered much more offensive and difficult to treat by the drainings from manure heaps which are allowed to enter the sewers. A creamery in a country district may also introduce unforeseen difficulties.

Dry-Weather Flow.—The question of what really constitutes the dry-weather flow is one of great importance and some difficulty. The actual water consumption may vary from 100 to 150 gallons per head, as in New York, to, say, 10 gallons per head or less in a country town or village.

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*Extracts from a paper read before the Liverpool Engineering Society on March 4th, 1914.

It does not quite dispose of the question to say that the strength varies in inverse proportion to volume, and therefore the provision of tanks and filters must be the same for all strengths, the rate of operation alone varying.

Obviously, as regards capacity of sewers the actual quantity to be dealt with must be considered, especially in reference to storm water. While it might be quite reasonable to construct sewers to take six times, say 30 gallons per head, the problem becomes enormous if 100 gallons per head is to be taken as what may be called unit flow. On the other hand, if the dry-weather flow is, say, 10 gallons per head strength, storm overflows set at six times the dry-weather flow would discharge at only twice the dilution of ordinary 30 gallons sewage.

The question of actual quantity, apart from strength, also has to be considered in the design of disposal works. Tanks, channels and distributing mains, have all to be larger if six times an originally dilute sewage has to be dealt with than if the original sewage is strong. There is also the physical limit of speed within which filters can be operated without water-logging. This question of what is to be taken as the dry-weather flow is, therefore of great importance in calculating the sizes and sort of works necessary to deal with a given sewage.

It is because so few towns give returns of what has actually been thoroughly dealt with at their works as compared with the total quantity received, and the cost of such treatment, that it is so difficult to make just comparisons between one method of treatment and another, or one town and another. It is comparatively easy to get constantly good results when filters are carefully nursed, the test comes when they are called upon to take the day-to-day fluctuations year in, year out.

It is to be hoped that reports giving full data of costs in reference to flow and population will be more frequently published in future by municipal authorities than is now the case. Their value cannot be overestimated.

Cost of Effective Treatment.—From such figures as are available, it may be roughly assumed that the total revenue and capital cost for the production of a good effluent will amount to at least 2s. 6d. per head per annum. For small towns it may be more.

The term "satisfactory effluent" has been used in this paper so far without precise definition. This definition has been given by the Royal Commission in their eighth report as follows:—

"An effluent in order to comply with the general standard must not contain as discharged more than 3 parts per 100,000 of suspended matter, and with its suspended matters included must not take up at 65 deg. Fahr. (18.3 deg. Cent.) more than 2.0 parts per 100,000 of discharged oxygen in five days."

Under certain circumstances they indicate that an even more stringent standard may be called for. Few will deny that if every inland town produced an effluent of the character defined above year in, year out, the condition of rivers, especially in the North of England, would be very different. It can be done at a price, and is done, the author believes by certain towns in the potteries and in the Midlands. The more reason that full statistics should be published for the encouragement of others.

Effect of Dilution.—Where the effluent is considerably diluted by the body of water into which it flows, the commission conclude that the standard may, under proper supervision, be relaxed or suspended altogether.

It is however, by no means easy accurately to judge of the effect of dilution. The problem is in the first place one of efficient mixing. Cases will readily be called to mind where sea-outfalls can become a source of serious nuisance if not carefully chosen. Bombay is an example where, owing to a clerical error, the tidal currents were wrongly marked on a map, the outfall site chosen in consequence has proved far from satisfactory, as the sewage lies in a still pool under Malabar Hill, one of the best residential quarters of Bombay.

Other Problems.—It has been shown that it is possible to dispose of sewage without causing offensive pollution in the body of water into which it is discharged. The outstanding problem remaining is the utilization of the sewage. This has been the dream of the sewage enthusiast ever since modern ways of living forced most people away from the simplicities and economies of the Chinaman. The city of Shanghai makes a handsome profit from the sale of night soil, and the water carriage system is unlikely to be installed there, at any rate in the immediate future, if ever.

With its greater convenience and cleanliness the water carriage system entails constant wastage of valuable fertilizing agents which should come back into the cycle of Nature. That they eventually do so to some extent as fish may be granted, but the world needs wheat, and the fact that the Manchester sewage works and others have been able to sell dried sewage manure at a profit in Canada, that Bradford has concluded a contract for its dried sludge with the intensive gardeners of Northern France, indicates that there is an almost unlimited outlook for properly prepared sewage manure, either alone or as a basis for enrichment by artificial fertilizers. This is the conclusion of Dr. H. Maclean Wilson in a recent report, and the author is quite in agreement with him.

In their conclusions as to the value of sewage sludge the Royal Commission do not appear very convincing. They seem to have insufficiently differentiated between sludges of different origin and composition, and it will be of interest to consider the possibilities of each of these in turn:—

Taking first sludge from sedimentation and chemical precipitation processes, which are very similar in character. The most successful utilization of sludge is carried on at Bradford, Yorks, where the whole sewage, containing as it does, a high percentage of grease from woolwashing, is treated and "cracked" with sulphuric acid, the resulting sludge hot pressed, the grease thus recovered sold at a profit, and the residual cake sent away, as has been said, to France.

At Oldham, Dr. Grossman finds a ready sale for the residue left after distilling away the grease from the sludge. It is largely the presence of soap and fat in sludge which precludes its use as manure, as if they are present it will not readily incorporate with the soil. Ordinary pressed sludge cake also contains seeds of weeds and undesirable plants. Thus, if the grease and these seeds are eliminated, a much more satisfactory product is obtained.

Other kinds of sludge than those referred to above are produced in modern sewage works either by anaërobic or aërobic processes.

The latest development of the anaërobic process is the Emscher tank, the first one of which in this country is now being erected at the Withington works of the Manchester Corporation. The Emscher tank consists of two parts, a settling chamber and a sludge digesting chamber. The sewage passes through the settling chamber, and the sedimentary matters (other than heavy grit, which must first be removed) fall through a slot in the sludge-digesting chamber, which is much larger than the settling chamber. Here the sludge remains and undergoes thorough fermentation, after which it can be run out, and, owing to the peculiar granular nature which it acquires by fermentation, can be readily dried in properly constructed draining beds. The residue thus obtained is quite inoffensive, and is useful itself as a light manure, and can easily be enriched.

In Dublin a process of fermentation of sludge by addition of yeast is in operation. A considerable separation of water occurs in the process, and the fermented and concentrated sludge is dried in an ingenious manner, and the resultant powder sold by itself for 50s. per ton and more, in proportion to added artificial fertilizers.

The mode of action of the yeast is not properly understood, but it has been suggested as the result of experiment that the yeast breaks down and the cellulose cuticle of the yeast ferments somewhat, yielding hydrogen and other gases which cause the solid matters to rise to the top of the fermentation tank, with separation of a considerable percentage of water.

Fermentation of sludge may also be aërobic, and this takes place in the Dibdin slate filter and the ordinary contact bed or percolating filter. The residuum in a Dibden slate bed has to be washed out from time to time, the filtering medium in a contact bed is taken out from time to time, and the humus from a percolating filter is generally caught in so-called humus tanks. These various products, though probably different in many ways, especially biologically, are at any rate generally free from grease, and are granular and inoffensive in character. They are therefore more readily dried than ordinary tank sludge, and in Manchester it is the "slurry," so-called from the washing of the contact beds, which is being dried, powdered and sold at a price which covers cost.

It will be seen that the function of the filter-bed, whether slate bed, contact bed, or percolating filter, is largely the collection and granulation of the colloidal matters in the sewage or tank effluent.

In an address given in November, 1911, as chairman of the Manchester section of the Society of Chemical Industry, the author made the following among other concluding observations:—

"I cannot forbear to mention also a most illuminating suggestion made to me by Dr. Maclean Wilson, that it might be possible to discover some kind of clotting enzyme, which should do the work which now apparently takes place in the surfaces of the medium of the filter-bed. If this could be done, there is a possibility of enormous saving in costly works." While considering the problem of New York, this question was anew forced on the author's attention. The idea, as an alternative to the scheme of sea-disposal already mentioned, of treating some 1,000,000,000 gallons of sewage daily on percolating filters appeared altogether impracticable in view of the possible nuisance from flies and odors. Chemical treatment of such volumes had also its special difficulties.

But experiments on various systems of forced aëration, and collection of the oxidized solids on surfaces seemed to offer possibilities, according to the experiments of Major Black and Prof. Phelps. At the Lawrence Experimental Station the author saw sewage in a bottle which under certain conditions had been completely purified by nineteen hours' aëration. This work is referred to in the recent annual report of the Massachusetts Board of Health. But the element of surface and consequent cost remained.

Since then it has been possible in the author's laboratory at the Manchester University to go further. The author's assistant, Mr. E. M. Mumford, discovered a bacillus in the water of the old colliery workings at Worsley which has the property of precipitating iron from solution in presence of organic matter. It was then found, as already reported at the congress of the Royal Sanitary Institute at Exeter, that if this organism is added to sewage effluent, together with a little iron salt, and air is blown through, complete clarification results, and the resulting deposit has a very high nitrogen content. Since then the engineering developments of the process have been the chief concern, but it has been possible successfully to inoculate about 5,000 gallons of sewage with a pure culture of the organism, and a plant is now being experimented with capable of dealing with 10,000 gallons per day.

Laboratory experiments are in progress at Davyhulme which indicate even more far-reaching possibilities, and the author looks forward with confidence to the time when it will be possible completely to purify sewage in a tank with production on the one hand of inoffensive sludge, which can be readily handled and disposed of as manure, and of the other on a well aërated effluent, in which aquatic plants and fish will make final use of the nitrogen and phosphates in solution. The problem in its present stage is largely one of engineering, but granted the possibility of applying large quantities of air economically to sewage, the saving in space and capital cost may be very great.

It should be practicable even for seaport towns to purify their sewage without great difficulty before discharge, retaining the insoluble matters in an inoffensive form, easily disposed of as fertilizer. A sewage works will then no longer be a source of nuisance and trouble, either from decomposing offensive sludge, or from flies and odors from percolating filters.

Need for Research.—In conclusion, it is necessary to emphasize again that real advance in the art and practice of sewage disposal must come through the avenue of scientific research of the highest order. It is well to remember that the modern developments are only the practical application of principles discovered long since by men like Pasteur, Warington, Frankland, and many others, without whose work sewage disposal would be mere empiricism.

Such research work necessitates well-equipped laboratories and large staffs of highly trained workers. The author realizes the responsibility in having at his disposal the resources of the Manchester University and the Manchester Corporation for this purpose, but the work is a national one, and it is to be hoped that the present Royal Commission will not be concluded before its work has been put on a permanent footing in the establishment of a national research department which could carry out work of a wider scope than is possible for any one local authority, and could correlate the work done by such authorities to the general benefit of all.

In what has been said the author is not for a moment forgetting that for the practical application of the discoveries of the bio-chemist the close co-operation of the engineer is necessary. It is through this harmonious working together of two great professions that advances may be looked for in the future adequate to the demands of complex modern life.

THE EUGENIA FALLS POWER INVESTIGATION.

In the annual report for the year ending October 31st, 1913, of the Hydro-Electric Power Commission of Ontario, the progress which the engineers of the Commission have made on a scheme for the supply of electric power to Owen Sound, Ont., and surrounding district has been described.

In the 1911 report of the Commission it was stated that the best local source of hydro-electric energy for this district was Eugenia Falls on the Beaver River, and owned by the Georgian Bay Power Company, and a report was prepared based on such data as was then available, demonstrating the value of this source of power. This report indicated that the site had a commercial capacity of about 2,000 h.p. under natural conditions, and about 4,000 h.p. if the total run-off of the watershed could be artificially controlled.

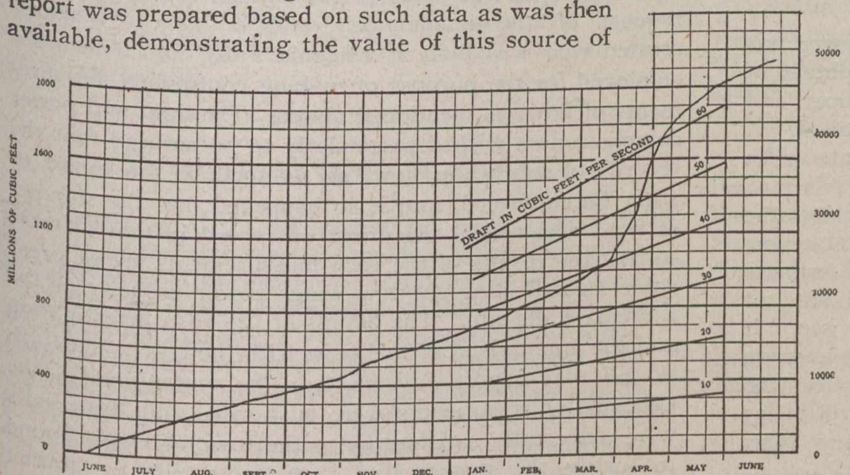

Fig. 1.—Mass Curve, Beaver River, June, 1910, to June, 1911, Inclusive.

Data on River Flow.—With respect to the hydrology of the Beaver River, the present report contains some very interesting data, derived from weir records of the river flow at Eugenia.

To compute the amount of yield of the watershed from the series of daily gaugings for the year ending June 30th, 1911, and to determine the volume of reservoir storage required to store the flood waters in order that any constant rate of flow may be maintained, the mass curve method has been used. Fig. 1 shows the curve obtained.

This method consists of totalling the daily discharges of the watershed from day to day for the whole period, which quantities are then plotted as an irregular line, or "mass curve." Any desired rate of draft may then be assumed, and the amounts necessary at different times plotted to the same scale. If a uniform rate, this draft curve forms a straight inclined line, and if it is made to start coincident with some point or summit on the "mass curve," the ordinate between the two curves at any point serves to show the volume of storage that would be required at this date to have maintained the required rate of draft up to that time. (For further explanation of the mass curve in determining stream flow yield the reader is referred to *The Canadian Engineer* for June 6th, 1913, page 819.)

The mass curve, plotted as above outlined, for the period of June, 1910-June, 1911, gives the reservoir capacities necessary to insure certain uniform rates of flow, beginning with 23 cu. ft. per sec., the minimum flow for the year. These rates of draft, with the required reservoir capacities obtained from the mass curve, are shown in the diagram of required capacity of reservoir for varying rates of draft, Fig. 2. This diagram shows that to secure a uniform flow equal to the mean annual flow (or 65 cu. ft. per sec.), it will be necessary to provide a reservoir capacity of 600 million cu. ft., or about 14,000 ac.-ft. To secure 50 cu. ft. per sec., 245 million cu. ft. of storage or about 5,700 ac.-ft. will be required.

The scheme of development at Eugenia, most economically feasible, is one involving the building of a dam above Eugenia Falls, a diversion canal from the reservoir thus formed, and about 5,000 feet of pipe line for an effective head of 500 feet. The initial development of 2,000 h.p. can be obtained with a dam 23 feet high. When the load builds up sufficiently to warrant extension of the plant, the water to operate an additional unit of 1,000 h.p. can be secured by raising this dam 10 feet. For the final development or full capacity, additional storage can be secured by a dam at Feversham, about 8 miles above Eugenia.

A study of the curves of storage capacities for different contour elevations that have been plotted for dams at Eugenia Falls and at Feversham, when analyzed in connection with the reservoir-draft curves, gives the necessary height to which the dams must be carried for any required amount of flow. The results are shown in the report, together with curves of storage capacities for different contour elevations for Eugenia which are more or less approximate, and which may be changed when further data are obtained from the surveys now in progress.

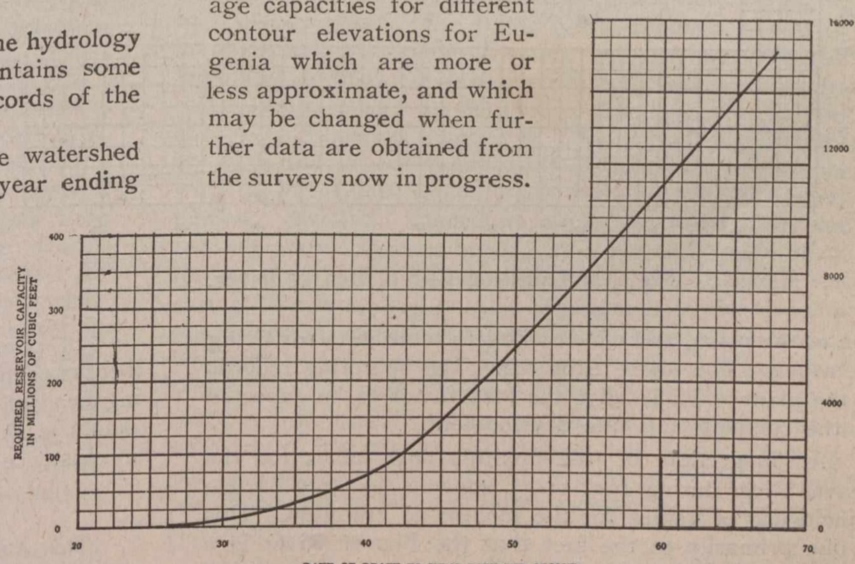

Fig. 2.—Required Reservoir Capacity for Various Rates of Draft, Based on Weir Records, Beaver River, 1910-11.

A reference to the mass-curve (Fig. 1) indicates that the fall replenishment of storage is very limited for this watershed. This conclusion is borne out by the discharges taken during 1913. Thus the storage reservoirs must impound sufficient water during the months of March, April and May to carry over the rest of the year, since it is impossible to depend on a fall filling.

The problem of determining the proper turbine capacity to install at any power-site is a difficult matter, depending to a great extent on the judgment of the designer. One method of obtaining the economical capacity of a river, to generate power, is by means of a "duration curve." The duration curve is plotted by ranging the several daily discharges in order of their size; i.e., the maximum quantity for any one day in the year is placed as an ordinate over, say, the first day in the year, and so on down to the smallest daily quantity for that year, placed as an ordinate for the three hundred and sixty-fifth or last day of the year. This gives a smooth regular line, as may be seen in Fig. 3, the duration curve plotted for June, 1910, to June, 1911. From this curve the duration during the year of any given river flow may be directly read off.

Experience on rivers used for water power has shown that, in general, the quantity found to obtain at ordinate 182½ on the curve represents the proper and most efficient turbine capacity that may be installed. A variation of 30 days either side of this ordinate is in cases admissible.

The duration curve for 1910 and 1911 represents the flow of a minimum year, as was noted in the 1911 report of the Commission. On the ordinate 182½ the flow is 43 cu. ft. per sec., at 152½ the flow is 48 cu. ft. per sec. It is reasonable to expect that the average flow ordinate at 182½ will be at least 50 cu. ft. per sec., and at 152½ will be 55 cu. ft. per sec. for an ordinary year.

The development will therefore be planned to use the most economic turbine capacity represented by this flow. The ultimate capacity will, of course, be controlled by the later discharge records which will be obtained during the operation of the plant, and which will give more data for fixing the average flow to be expected. The operating records of the plant will also give the load factor to be expected on the complete ultimate development.

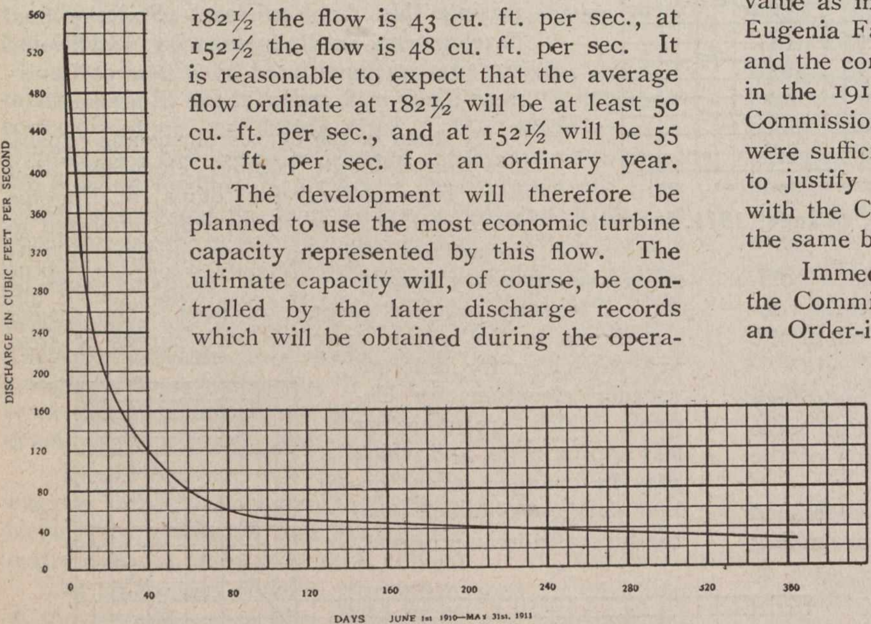

Fig. 3.—Duration Curve, Beaver River.

An inspection of the monthly flow tables for the Beaver River during 1910-11-13, shows a very remarkable coincidence of values for the months of low flow. This is due primarily to the fact that the Beaver River is a spring-fed stream in the fullest sense of the term, ground storage capacity existing to an unusual degree. This condition is in turn influenced by the existence of large tracts of undrained and uncleared swamp throughout the watershed.

Feasibility of the Project.—The success of any scheme of development at Eugenia Falls was dependent, to a large extent, upon the amount of power which could be used in Owen Sound, and upon the willingness of the municipality to enter into a contract for the supply of same. The town took no definite action in connection with the matter until early in 1913, when the light and power commissioners of Owen Sound opened negotiations with the Commission, with a view to ascertaining under what conditions they could obtain a supply of power, having special reference to the possibility of obtaining it from Eugenia Falls. After considerable discussion it was finally agreed that the town of Owen Sound would enter into a contract with the Commission, if it could be proved to the satisfaction of the municipality that Eugenia Falls was capable of supplying the necessary quantity of power. In this connection, the light and power commissioners asked for further confirmation of the data submitted in the report of 1911. While the Commission was satisfied to base its findings upon the 1911 report, it was nevertheless decided to accede to the request of the municipality, and to this end a sharp-crested weir was built at Eugenia Falls, and a recorder employed for the purpose of making continuous measurements of flow, as mentioned above. The light and power commissioners wished particularly to be assured that the records of low water flow, as set forth in the report of 1911, be confirmed, and it so happened that the summer of 1913 was one of the driest on record in that district, so that the results of the 1913 measurements are of great value as indicating the low water power capacity of the Eugenia Falls site. The details of the 1913 investigation and the comparison of the same with the results set forth in the 1911 report indicate that the contentions of the Commission's engineers were sustained, and the results were sufficiently satisfactory to the town of Owen Sound to justify the municipality in entering into a contract with the Commission for the initial supply of 1,200 h.p., the same being executed under date of October 27, 1913.

Immediately following the execution of the contract, the Commission made application to the Government for an Order-in-Council authorizing the Commission to purchase the works, assets, real property and rights of the Georgian Bay Power Company, together with such additional rights as might be necessary, and to develop power at Eugenia Falls and distribute same to the various municipalities in the Owen Sound district. The required Order-in-Council having been issued, the work of making a final survey of the site was commenced immediately and preparations made to proceed with the design of the plant. This work is in progress.

In connection with this development, it may be mentioned that the projected scheme calls for an operating head of 500 feet. With the exception of one or two plants in British Columbia, this will be the highest head in existence in Canada.

The American Institute of Electrical Engineers has authorized the formation of a Panama section There are some 30 members of the Institute now on the Isthmus.

The first railway in Iceland will be under construction in the near future. Plans have been completed, and it is not doubted that these will be accepted by the Althing, or the national assembly of Iceland. The new Icelandic railway will be a narrow gauge line running from Reykjavik through the Thingvalla district—the most fertile part of the island—to Rangavalle, a distance of about 64 miles, with a branch line to the port of Eyrarbakki, an additional 12 miles. Although the track will run through hilly country, the boring of tunnels will be avoided; but a great many bridges are necessary to carry the line across numerous streams. These bridges have to be of especially solid construction, owing to the floods which come down in raging torrents from the mountain sides in the brief Icelandic summer.

AMERICAN ROAD BUILDERS' ASSOCIATION.

At a meeting of the Board of Directors of this association, in New York City, February 24, it was decided to hold the eleventh annual convention and exhibition at Chicago in December, 1914.

The detail for arranging the meeting and exhibition will be in the hands of the Executive Committee, which was re-elected at the last meeting and consists of George W. Tillson, E. L. Powers and R. A. Meeker.

James H. MacDonald, former State Highway Commissioner of Connecticut, was elected a director to fill out the unexpired term of Chief Engineer A. W. Dean, of the Massachusetts Highway Commission, who was elected second vice-president at the annual election of officers last month.

CANADIAN PAVING IN 1913.

The figures in the accompanying table convey an idea of the activities of Canadian cities during the past year in the matter of street pavements. Last year *The Canadian Engineer* published a general summary on the extent and wear of Canadian pavements, classifying the data collected from civic officials and outlining their opinions, as derived from their observations and experience, of the various types that had been laid under varying traffic, climatic conditions, construction, etc. The reader is referred to our issue of September 25th, 1913, for this information, including the mileages of pavements that were laid prior to 1913.

Of course, the financial stringency which enveloped municipal activities in 1913 is reflected somewhat in the extent to which paving work was carried on. Among the cities reporting upon the season's work, Cranbrook, B.C.; Lethbridge, Alta.; Medicine Hat, Alta.; Moncton, N.B.; Portage la Prairie, Man.; Prince Albert, Sask.; Prince Rupert, B.C.; Revelstoke, B.C.; Rossland, B.C.; St. Hyacinthe, P.Q.; Sydney, N.S., and Trail, B.C., report no permanent paving at all, and are, therefore, withdrawn from their respective places in the table. The statement that they did no paving should be modified slightly, however. In Moncton, N.B., the streets were subjected to considerable opening during the season owing to the laying of natural gas and water mains. All that has been done in Prince Rupert, B.C., in the matter of street work has been a rough grading with a covering of about 3 inches of broken stone, unrolled. All its sidewalks and outlying streets are paved with wood plank. Prince Albert, Sask., and Revelstoke, B.C., have no pavements of any kind. The only work done in Sydney, N.S., was in the nature of repairs. Trail, B.C., carried on operations to the extent of laying about 1,050 square yards of wood plank.

Among the cities included in the table it will be noticed that a few have shown a very small increase for the year. For instance, the extent of paving in Moose Jaw for 1913 consisted of 5,000 square yards of vitrified brick in a subway under railway tracks. It might be mentioned that a very satisfactory pavement was obtained by careful grading, a 5-inch concrete foundation, sand cushion, and the use of 1:1 cement grout. Its cost was $3.53 per square yard.

Reflecting upon the monetary situation, the small showing of some cities in the matter of improvements was naturally to be expected. It should be stated, however, that the extent of paving done is no criterion of the status of the municipality in the eye of the investing public. It is not the desire of *The Canadian Engineer* to show up any lack of activities in paving or to reflect in any way to the difficulties which some cities experienced in selling municipal bonds. Other lines of municipal work were, in some cities, much more needed than paving and asserted their plea for immediate consideration. Again, the indefiniteness of the duration of lull in financial activities prompted economy in the matter of civic expenditure. These and other factors, all of whch have been dwelt upon from every conceivable viewpoint during the past year, brought about a condition in pavement work throughout the Dominion in 1913 that is well illustrated in the returns published herewith.

There are many interesting points to be noted in 1913 paving returns, some of them indicating a decided trend towards uniformity throughout the country, in the matter of general construction, bonding of contract work, withholding of percentage of contract, etc.

Macadam and gravel roads have been included in the list as they form the wearing surface on over half of the paved streets of the cities of Canada and United States, predominating on pleasure drives, in parks and purely residential districts. Eliminating gravel and water-bound macadam from the total, it is found that 93% of the three million square yards has been laid on a concrete foundation of thickness varying from 4 to 6 inches. The adoption to this extent of concrete for foundation work shows its general acceptance in the majority of our cities.

Winnipeg is the only city to report the laying of untreated wood block during the year. Using two 1-inch boards under it, 2,285.35 square yards were laid by city day labor.

More uniformity shows itself in the term of years through which a pavement is bonded, than had been noted in previous years. St. John, N.B., requires a 20-year bond. Guelph, London, Ottawa, Toronto and Windsor stipulate 10 years. Of the remainder, twenty cities require only 5 years. In the case of London, on a 10-year guarantee a bond is taken over 5 years from a guarantee company for 50% of the amount of the contract together with the contractor's bond over 10 years with a 6% retention. Montreal bonded its stone and wood block for one year only. Quebec bonded its stone and Scoria block for two years. St. Catharines made it three years in the case of Rocmac, used on hilly approaches to the city and on residential streets with grades. Toronto bonded its Rocmac and Dolorway for three years. Vancouver bonded its creosoted wood block for one year by the contractors and required a 10-year guarantee from the manufacturers of the blocks. Winnipeg had some 4,800 sq. yds. of concrete pavement laid by contract without bond, and Woodstock laid a small amount under the same conditions.

In their contract work Edmonton, Guelph, Montreal, New Westminster, Ottawa, Quebec, Regina and St. Boniface withheld 10% of the amount of contract. St. John, Saskatoon, Stratford, and Windsor kept back 5%. Toronto withheld 15%; St. Catharines withheld 33% on asphaltic concrete and 35% on Rocmac work. Westmount had 20% of the amount of its sheet asphalt contracts covered by bond by the contractor, put up for 5 years. In Westmount during the progress of the asphalt work, progress certificates are issued monthly to the amount of 80% of the work completed, a final payment of the whole amount of the contract being made immediately after the completion of the work.

Extent of Paving in Canadian Cities during 1913

CITY*	Asphalt Block	Bitulithic	Brick	Concrete (Plain or Tarred)	Gravel	Macadam (Asphalt or Tar)	Sheet Asphalt	Stone Block	Wood Block (Untreated)	Wood Block (Treated)	Water Bound Macadam	Asphaltic Concrete	Total in sq. yds.
Belleville, Ont.					12,000	15,000							27,000
Brandon, Man.	16,539					14,000							30,539
Brantford, Ont.					23,000	8,000					13,000	7,000	51,000
Charlottetown, P.E.I.											2,166		2,166
Chatham, Ont.				6,000									6,000
Calgary, Alta.		41,650						9,721				171,497.9	222,868.9
Edmonton, Alta.		116,351.6					82,579.4					115,738.9	314,669.9
Fort William, Ont.					32,408	4,816							37,224
Guelph, Ont.				3,500		6,500							10,000
Halifax, N.S.		15,000						470					15,470
Hamilton, Ont.			3,540				134,876	1,541		43,473	65,000	31,067	279,497
Hull, P.Q.												10,000	10,000
Kingston, Ont.	12,486					9,675							22,161
London, Ont.			799	5,482	30,690		13,998						50,969
Montreal, P.Q.		40,053	2,811			71,166	267,368	136,816		2,047			520,261
Moose Jaw, Sask.			5,000										5,000
Nelson, B.C.					1,000						2,180		3,180
North Vancouver, B.C.											81,000		81,000
Ottawa, Ont.						6,027	81,721	2,409		2,640			92,797
Peterborough, Ont.			318		18,500							8,400	27,218
Port Arthur, Ont.						3,552					61,405		64,957
Quebec, P.Q.	4,513.66						51,699.69	28,702.06					84,915.41
Regina, Sask.		82,874.8					60,992.6	1,287				421.1	145,575.5
St. Boniface, Man.		27,800		2,380									30,180
St. Catharines, Ont.		27,634	2,600			18,004						23,509	71,747
St. John, N.B.		10,686	478	586		4,703		2,590				6,800	25,843
Saskatoon, Sask.		27,085					18,947	7,307		6,085			59,424
Sherbrooke, P.Q.											10,000		10,000
Stratford, Ont.			3,911			10,396					6,450	3,119	23,876
Toronto, Ont.	2,986	65,083	26,432	23,855		68,065	378,466	8,188		25,783		5,418	604,276
Vancouver, B.C.		6,255	4,847	302				9,071		10,587		26,474	57,536
Victoria, B.C.				26,366			52,411						78,777
New Westminster, B.C.		40,854	5,955							1,418		5,890	54,117
Westmount, P.Q.						13,225	16,293				32,097		61,615
Windsor, Ont.	16,410			96,269									112,679
Winnipeg, Man.				16,412.44		15,143.08	112,139.68		2,285.35		1,205.43		147,185.98
Woodstock, Ont.				1,230							10,600		11,830
Total in sq. yds. (38 cities)	52,934.66	501,326.4	56,691	182,382.44	117,598	268,272,08	1,271,491.37	208,102.06	2,285.35	92,033	285,103.43	415,344.9	3,453,554.69

*Cities reporting no paving in 1913, and therefore not included in the above:—Cranbrook, B.C.; Lethbridge, Alta.; Medicine Hat, Alta.; Moncton, N.B.; Portage la Prairie, Man.; Prince Albert, Sask.; Prince Rupert, B.C.; Revelstoke, B.C.; Rossland, B.C.; St. Hyacinthe, Que; Sydney, N.S.; and Trail, B.C.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of
CIVIL, STRUCTURAL, RAILROAD, MINING, MECHANICAL MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

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HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 1008, McArthur Building. Phone Main 2914. G. W. Goodall, Western Manager.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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Published by the Monetary Times Printing Company of Canada, Limited, Toronto, Ontario.

Vol. 26. TORONTO, CANADA, APRIL 16, 1914. No. 16

CONTENTS OF THIS ISSUE.

A MOVEMENT AMONG ENGINEERS FOR BETTER PUBLIC SERVICE.

Engineers who have at heart an altruistic desire for the betterment of public service will find it very encouraging to review the work during 1913 of the American Institute of Consulting Engineers. With a membership of 70, the majority of whom reside in New York State, and six of whom, it may be added, reside in Canada, the Institute is doing the country, and the profession as well, a great deal of good.

Perhaps no better examples of the justification of its existence can be presented than those outlined in a brief review of its 1913 activities. From time to time committees were appointed from its membership to urge the appointment of engineers as members of commissions and as heads of departments of public service having to do with engineering matters. The opening arguments of these committees are, in themselves, quite characteristic of the motives of the Institute.

In January, 1913, a presentation was made to the Governor of New York State for the appointment of engineers on public service commissions, which began: "We have no personal or individual ambitions to serve and no candidates to present, but as citizens, however, and expressing the sentiment of a body of professional men who, more than any other understand the problems involved in the execution and management of great public works, we may be permitted an altruistic viewpoint and speak for what we believe to be the best interests of the city and State."

In April, a communication to the Interstate Commerce Commission, recommending the creation of an advisory board of engineers in connection with the valuation of railroads, maintained the same viewpoint, as follows:

"It is perhaps not understood by the general public that the results of this great work will be of vital import to all classes of citizens, investors and non-investors alike, and that the general well being of a vast community is indissolubly bound up with the outcome."

Similar purposes were expressed on another occasion in advocating the organization of an engineering commission to act with the consulting architect of New York. And, later, in urging the appointment of engineers on public service commissions of the state, expression of the views of the Institute of the standard to which these appointments should conform was given as follows:

"In thus urging the appointment of engineers on the public service commissions, we recognize that their selection should not be based on their technical attainments alone, but also on the same degree of business and administrative acumen that should be possessed by appointees from other walks of life." Again, "That high character, tact and business and administrative ability are absolutely necessary qualifications for anyone competent to fill these positions, and we believe that these departments cannot be administered with the efficiency and economy that you desire unless they are under the leadership of such types of engineers."

In a communication to the President of the United States, advocating the appointment of an engineer on the Interstate Commerce Commission, it was observed: "The Institute has no candidate to present for office and is therefore enabled to address you from an impartial standpoint, free from personal ambitions and solely in behalf of the public interests."

This brief summary of the aims and activities of the organization, recalls our need in Canada for the performance of a similar duty to the public. It may often be disagreeable, and sometimes misinterpreted, as there is at times the semblance of a pronounced unbelief that any act of man can be unselfish. But, every province and every city has instances of its own as evidence of the fact that sound engineering knowledge and ability is not always called into service when it should be. The public at large is unaware of the existence of this strength. It is common knowledge only among those in direct touch with efficient engineering service. It is the duty of engineers themselves to advocate its inception into public affairs, in the face of injustifiable criticism of selfish motives, and the blowing of trumpets. The American Institute of Consulting Engineers has attacked the problem in a manner that is safe and sane and certain to bear creditable fruit.

EDITORIAL COMMENT.

Previous to its deliverance on April 7th, the budget speech of the Minister of Finance at Ottawa maintained live interest in the Canadian iron and steel market—interest that remained curiosity with some had engendered anxiety on the part of others, the latter being chiefly those associated with the iron and steel industry from a manufacturer's point of view. It was not generally expected that the Government would extend further assistance, except a possible revision in the nature of protection to wire rods, for which several important corporations had so long and vigorously contended.

As noted in next column, wire rods received a duty of $3.50 per ton under the general tariff and $2.25 under the British preferential. As but a small proportion is brought in from England, the industry will practically get the advantage of the $3.50 tariff.

The Dominion Iron and Steel Corporation and the Steel Company of Canada are the chief companies affected by this change. Managers of both companies have expressed themselves pleased with the new duty.

As for the structural steel industry, also affected by new duties, it is not easy to acquire a general opinion at such an early date. Some structural men have discussed the tariff and the effect it will probably have on the cost of building, which, they claim, is already too high.

* * * *

Mr. Geo. A. Janin, City Engineer of Montreal, recommends the appointment of a board of technically trained engineers to assist in the execution of duties pertaining to the various departments under his direction. It is stated that he also advises that a deputy chief engineer be appointed.

The department of roads, bridges and tunnels is temporarily in the charge of Mr. J. H. Dubuc, by appointment of the late Board of Control. Mr. G. R. Macleod is in charge of railways, while for the third department, that of sewers, waterworks and municipal buildings, no member of the board has yet been appointed. One of the first duties of the new board of control will be to consider the appointment of this complete staff.

CHANGES IN THE TARIFF SCHEDULE.

THE changes effected by the new tariff schedule submitted by the Minister of Finance in his budget speech to the House of Commons on April 6th, comprise a number of items of interest to readers of *The Canadian Engineer*.

The following items have a direct bearing upon engineering construction, particularly in the case of the iron and steel industry:

Rolled iron or steel angles, beams, channels and other rolled shapes and sections of iron or steel not punched or drilled or otherwise further manufactured, weighing over 120 pds. per lineal yd., not otherwise provided, not square, flat, oval or round shapes, and not being railway bars or rails, changed from $2, $2.75 and $3 to $2, $3 and $3 per ton under British preference, intermediate and general tariffs, respectively.

Galvanized hoopsteel changed from 30% to $7 per ton, general tariff.

Wrought or seamless iron or steel tubing, from 4 to 10 in. diam., changed from 10, 12½ and 15% to 20, 30 and 30%.

Wrought or seamless iron or steel tubing over 10 in. in diam., changed from 10, 12½ and 15% to 10, 15 and 15%.

Coil chain and links 1¼ in. in diam., and over, changed from 5, 7½ and 10% to free, 5 and 5%.

Coil chain and links under 1⅛ in., changed from 5, 7½ and 10% to 15, 20 and 20%.

Malleable sprocket chain or link belting chain made free when used in agricultural implements, whereas it was formerly free for all purposes.

Rolled round wire rods in the coil of iron or steel, not over ⅜ in. in diam., changed from free to $2.25, $3.50 and $3.50 per ton, when imported to manufacture wire in the coil; for use in the manufacture of chain changed from free to $2.25, $3.50 and $3.50.

Chloride of lime and hypochlorite of lime, in packages of not less than 25 pds., transferred from the free list and made dutiable at 10c. and 15c. per cwt. When in packages of less than 25 pds., 17½, 25 and 25%, instead of free.

Cork slabs, boards, planks and tiles produced from cork waste or ground cork, changed from 15, 17½ and 20%, to 20, 30 and 30%.

Building stone, sawn on four sides, is made dutiable at 15c. per cwt., and when further manufactured at 45c., instead of 20%, as formerly.

Carbon electrodes of over 35 in. in circumference, changed from 3 to 20%.

Ferrosilicon made $4.50 a ton, instead of $2.50.

Ferro-manganese and spiegeleisen changed from $2.50 a ton to free.

Among the provisions for drawbacks are the following:—

Lapwelded tubing of iron or steel, not less than 4 in. in diam. and used in casing wells or for natural gas transmission, 50%.

Bituminous coal, drawback of 99% of duty extended to coke ovens, other than those owned by smelting works, when intended for smelting and melting ores.

Wire rods used for the manufacture of fencing wire, 9, 12 and 13 gauge, 99% of duty.

Charcoal used for smelting of ores, 99%.

Rolled hexagon iron or steel bars used in the manufacture of cold-drawn or cold-rolled iron or steel bars or turned and polished shafting, 99%.

THE STEEL HARDENING PROCESS.

By R. H. Cunningham, B.A.Sc.,
General Manager, Canadian Hoskins, Limited,
Walkerville, Ont.

ORIGINALLY the name "steel" was applied to various combinations of iron and carbon, there being also present, as impurities, small proportions of silicon and manganese. At the present time, however, the use of the name is extended to cover combinations of iron with tungsten, vanadium, nickel, chromium, molybdenum, titanium and some of the rarer elements. These latter combinations are quite generally known as the "alloy steels" to distinguish them from the "carbon steels," those in which the characteristic properties are dependent upon the presence in the steel of carbon alone. The alloy steels are divided into the "high speed" steels and the Mushet or "air-hardening" steels.

The specific properties that distinguish these different steels are due in part to their respective compositions, i.e., to the particular elements they may contain and the relative proportions in which these occur, and, in part, to their subsequent working and heat treatment.

Effect of Difference in Composition.—In general, any change in the composition of a steel results in some change in its properties. For example, the addition of a certain metallic element to a carbon steel causes, in the alloy steel thus formed, a change in position of the proper hardening temperature point. Tungsten or manganese added, tend to lower this point; boron and vanadium, to raise it. The amount of the change is practically proportional to the amount of the element added.

Further, adding a small proportion of carbon to iron produces steel, which has decidedly different properties than pure iron. Increasing the proportion of carbon in the steel thus formed, within certain limits, causes a variation in the degree in which these properties manifest themselves. For example, consider the property of tensile strength. In a 0.1 carbon steel (one in which there is present but 0.1% of carbon) the tensile strength is very nearly 25% greater than that of pure iron. Adding further carbon causes this to rise, at approximately the rate of a 2.5% increase in tensile strength for each 0.01% of carbon added.

Due alone to differences in proportion of carbon present, carbon steels are divided into three classes. The first of these embraces the "unsaturated" steels, those in which the carbon content is lower than 0.89%; the second, the "saturated" steels, in which the proportion of carbon is exactly 0.89%; and the third, the "supersaturated" steels, those in which the carbon content is higher than 0.89%.

Effect of Heat Treatment.—With a steel of a given composition, proper heat treatments may be applied which of themselves will alter in form or degree some of its specific properties, or practically eliminate one or more of them, or, perhaps, add certain new ones. Physical properties of size, shape and ductility are examples of the first. Of the second, heating a steel beyond its hardening temperature takes away its magnetism, making it "non-magnetic." And the third, the property of hardness—for practical purposes—may be added to a steel by the process of hardening. In connection with this it must be understood that strictly speaking, "hardness" is a relative term and that all steel has some hardness.

There are three general heat treatment operations so considered—forging, hardening and tempering. In all of these the object sought is to change in some manner the existing properties of the steel; in other words, to produce in it certain permanent conditions. Each of these operations, broadly speaking, consists of two parts, viz., raising and lowering the temperature of the piece. (In forging, of course, mechanical work is also done upon it.)

Obviously then, the controlling factor in all heat treatment is temperature. Whether the operation is forging, hardening or tempering, there is, for any certain steel and particular use thereof, a definite temperature point, at which to work the steel, that alone gives the best results. Insufficient temperatures, either through ignorance of what the correct point is, or through inability to tell when it exists, cause "burned" steel. This is a common failing, resulting in great loss. In degree, very slight variations, from the proper point, may do irreparable damage.

Due to temperature variation alone, steel may be had in any of three conditions: (1) in the "unhardened" or annealed state—when not heated to temperatures above 735° C. (1355° F.); (2) in the "hardened" state—by heating to temperatures between 735° C. (1355° F.) and 820° C. (1508° F.); (3) in a state softer than (2), though harder than (1), when heated to temperatures which exceed 820° C. (1508° F.).

The Hardening Process.—Hardening a carbon steel is the process of increasing its degree of hardness, this property being its power to resist penetration. It is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. In the different carbon steels this change for practical purposes is effective only in those in which the proportion of carbon is between 0.2% and 2.0%.

When heated, ordinary carbon steels begin to soften at about 200° C. (392° F.) and continue to soften throughout a range of 170° C. At the point 370° C. (698° F.) practically all of the hardness has disappeared. "Red hardness" in a steel, is a property which enables it to remain hard at red heat. In a high-speed steel this property is of the first importance, 550° C. (1022° F.) being a minimum temperature at which softening may begin. This is some 350° C. above the point at which softening commences in ordinary carbon steels.

The process of hardening a steel is best carried out in a closed furnace. Of the many sources of energy capable of producing the required heat, electricity offers the most attractive advantages. The electric resistance furnace, as now built in such a variety of sizes of either muffle or tube chamber types, has one fundamental point of superiority over all coal, coke, gas or oil-heated furnaces. *It is entirely free from all products of combustion*, the heat being produced by electrical resistance. This is important. It does away with the chief cause of oxidation of the heated steel. Further, the temperature of the electric furnace can be easily and accurately regulated to, and maintained uniform at, any desired point. When electric power is generated for other purposes, the increased cost of this form of energy for operating furnaces is not sufficient to orgue against it. Even when current is purchased, the superior quality of work performed by this kind of furnace, frequently more than offsets the slightly higher cost of operation.

In the actual heating of a piece of steel, it is essential to good hardening that small projections or cutting edges are not heated more rapidly than is the body of the piece, i.e., that all parts are heated at the same rate, and also that all parts are heated to the same temperature. These conditions are facilitated by slow heating, especially in case the treated piece is large. A uniform heat, as slow in temperature as will give the required hardness, produces the best product. Lack of uniformity in heating causes irregular grain, internal strains and may even produce surface cracks. Any temperature above the "critical point" of a steel tends to open its grain—to make it coarse and to diminish its strength, though such a temperature may not be sufficient to lessen appreciably its hardness.

Critical Temperatures.—The temperatures at which take place the previously mentioned internal changes of structure of a steel, are frequently spoken of as the "critical points." These are different in steels of different carbon contents. The higher the percentage of carbon present, the lower the temperature required to produce the internal change. In other words, the critical points of a "high" carbon steel are lower than those of a "low" carbon steel. In steel of the commonly used carbon contents there are two of these "critical temperatures," called the "decalescent point" and "recalescent point" respectively.

The decalescent point of any steel marks the correct hardening temperature of that particular steel. It occurs while the temperature of the steel is rising. The piece is ready to be removed from the source of heat directly after it has been heated uniformly to this temperature, for then the structural change, necessary to produce hardness, has been completed. Heating the piece slightly higher may be desirable for either or both of the two following reasons: (1) In case the piece has been heated too quickly, and not uniformly, this excess temperature will assure the structural change being complete throughout the piece; (2) any slight loss of heat which may take place in transferring the piece from the furnace to the quenching bath may thus be allowed for, leaving the piece at the proper temperature when quenched.

If a piece of steel, which has been heated above its decalescent point be allowed to cool slowly, it will pass through a structural change, reverse to that which takes place on a rising temperature. The point at which this takes place is the "recalescent point" and is lower than the rising critical temperature by some 30° to 100° C. (86° to 212° F.). The location of these points is made evident by the fact that while passing through them the temperature of the steel remains stationary for an appreciable length of time. It is well to observe that the lower of these points does not manifest itself unless the higher one has been first fully passed.

It is for the reason that these critical points are different for different steels, that they cannot be definitely known, for any particular steel, without an actual determination.

Heating a piece of steel to its correct hardening temperature thus produces a change in its structure, which makes possible an increase in its hardness, but this condition is only temporary unless the piece is "quenched."

Quenching.—This treatment consists in plunging the heated steel into a bath, cooling it quickly.

By this operation the structural change seems to be trapped and permanently set. Were it possible to make this cooling instantaneous and uniform throughout the piece, it would be perfectly and symmetrically hardened. This condition can not, however, be realized, as the rate of cooling is affected both by the size and shape of the treated piece; the bulkier the piece, the larger the amount of heat that must be transferred to the surface and there dissipated through the cooling bath; the smaller the exposed surface in comparison with the bulk, the longer will be the time required for cooling. Remembering that the cooling should be as quickly accomplished as possible, the bath should be amply large to dissipate the heat rapidly and uniformly. Too small a quenching bath will cause much loss, due to the resulting irregular and slow cooling. To insure uniformly quenched products the temperature of the bath should be kept constant so that successive pieces immersed in it will be acted upon by the same quenching temperature. Running water is a satisfactory means of producing this condition.

The composition of the quenching bath may vary for different purposes; water, oil or brine being used. Greater hardness is obtained from quenching, at the same temperature, in salt brine and less in oil than is obtained by quenching in water. This is due to a difference in heat-dissipating power possessed by these substances. Quenching thin and complicated pieces in salt brine is unsafe as there is danger of the piece cracking, due to the extreme suddenness of cooling thus produced.

In the actual round of shop work the steel to be hardened is generally of a variety of sizes, shapes and even compositions. To obtain uniformity both of heating and of cooling, as well as the correct limiting temperature, the peculiarities of each piece must be given consideration in accordance with the above outlined points. In other words, to harden all pieces in a manner best adapted to but one, would result in inferior quality and possible loss of all except this one. Each different piece must be treated individually in a way calculated to bring out the best results from it.

Theory.—The presence of these critical points in the heating and cooling of a piece of steel is a phenomenon. The most reasonable theory advanced to explain this is as follows:—

While heating, the steel uniformly takes on heat. Up to the decalescent point all of the energy of this heat is exerted in raising the temperature of the piece. At this point, the heat taken on by the steel is expended, not in raising the temperature of the piece but in work, which produces the internal changes here taking place between the carbon and the iron. Hence, while the heat added is being taken up in this manner, the temperature of the piece, having nothing to increase it, remains stationary or, due to surface radiation, may even fall slightly. After the change is complete the added heat is again expended in raising the temperature of the piece, which increases proportionally.

When the piece has been heated above the decalescent point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the decalescent point is reached, the temperature falls uniformly. Here the internal relation of the carbon and the iron is transformed to its original condition, the work required to do this being converted into heat. This heat, set free in the steel, supplies for the moment the equivalent of that being radiated from the surface. While this condition holds, the temperature of the piece ceases falling and remains stationary. Should the rate of evolution of heat from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling, but will obviously rise slightly at this point. In either event the condition exists only momentarily, for when the carbon and iron constituents have resumed their original relation, the evolution of internal heat ceases and the temperature of the piece falls steadily, due to surface radiation.

The Practical Problem.—From the foregoing sections it is evident, first, that there is a definite temperature at which to best harden any carbon steel, and second, that there results great loss, both of labor and material, unless the hardening is carried out at this temperature.

The actual shop problem thus presented is to determine readily and accurately the correct hardening temperature for any carbon steel that may be in use.

[A practical means of solution, even by one who is not an expert, will follow this article at an early date, comprising a description of apparatus and methods.—Editor.]

MUNICIPAL WORK IN SOUTH VANCOUVER.

Mr. S. B. Bennett, who has recently assumed the duties of board of works and waterworks engineer for the district of South Vancouver, sends in the following summary of street improvements carried out in that municipality up to December 31st, 1913.

South Vancouver has an area of over 9,000 acres or 14½ square miles, with a population of about 40,000.

Total mileage of streets in municipality	246.5
Mileage of streets cleared and rough graded	204.0
Mileage of street uncleared	42.5
Mileage of streets macadamized	35.4
Mileage of paved roadways	3.84
Mileage of planked roadways	12.00
Mileage of sidewalks laid	117.83
Mileage of street car lines, double track	4.57
Mileage of street car lines, single track	6.02
Mileage of single track, interurban railway	4.70
Mileage of double track, interurban railway	2.08
Number of wooden bridges built	7
Number of concrete catch basins	76
Number of wooden catch basins	76
Number of concrete manholes	11
Mileage of wooden box drains and culverts	13.14
Mileage of sewers laid	.15
Mileage of storm sewers laid	2.50
Mileage of concrete curb only laid	.24

Waterworks Department.

	1910.	1911.	1912.	1913.	Total.
Miles of water mains laid	76	69	39	15	199
Fire hydrants installed	132	169	216	66	583
Services installed	2,007	2,753	2,373	1,689	8,822

Like most other municipalities, South Vancouver has been suffering from the financial depression but is looking forward to considerable activity this season. Considerable paving work is proposed. The waterworks committee is also building a steel water tank of 750,000 gal. capacity. When completed it will be 75 ft. high and 45 ft. in diameter. The cost of the tank, painted and enamelled, will be $30,000.

To preserve steel from rust dissolve 1 part caoutchouc and 16 parts turpentine with a gentle heat, then add 8 parts boiled oil, and mix by bringing them to the heat of boiling water. Apply to the steel with a brush, the same as varnish. It can be removed again with a cloth soaked in turpentine.

REPORT ON THE MAITLAND RIVER AS A POWER PROJECT.

A REPORT on the power possibilities of the Maitland River, Ontario, is given in the sixth annual report of the Hydro-Electric Power Commission of Ontario. Since the preparation of the preceding report, continuous daily gauge readings were made at Benmiller, and these readings, with the aid of a rating curve of the stream, compiled from the regular monthly measurement of discharge, furnished the data for a further study of the hydrology of the river in its relation to the development of power.

The report contains duration curves plotted for the years 1911, 1912 and 1913, indicating that the amount of flow for economical development on this river ranges from 300 cu. ft. per second on the 212½ ordinate to 1,000 cu. ft. per second on the 152½ ordinate.

In last year's report the abnormal flow characteristics of the Maitland River were noted, and attention was drawn to the fact that any development of power must depend for continuous operation on the minimum flow of the stream in conjunction with such advantages as can be derived from local pondage.

During the summer of 1913, on a number of days the minimum flow of the stream was 75 cu. ft. per second. At the Black Hole site, with an operating head of 80 ft., this flow, without pondage, gives a minimum continuous power capacity of about 545 h.p. The local pondage above the Black Hole dam would be something over 700 acres. Assuming a maximum draw on this pond of 5 ft. (thus giving a minimum operating head of 75 ft.), a reservoir capacity of 3,500 acre-feet would be available.

An analysis of the mass curve of the Maitland River from 1911 to date, shows that 3,500 acre-feet of reservoir capacity will provide a continuous discharge of about 110 cu. ft. per sec. In extremely dry years it is probable this flow would not exceed 100 cu. ft. per sec.

From this the report ventures to state that any power development on the Maitland River at the Black Hole site could not be depended upon to deliver continuously more than 750 h.p.

The following table gives the amount of storage required for different rates of uniform draft up to 200 cu. ft. per sec., with the continuous available power for these amounts, if developed at the Black Hole:

Required Storage in Million cu. ft.	Storage in Acre feet	Uniform Flow in cu. ft. per sec.	Continuous Power Available
0	0	75	545 h.p.
80	1,835	100	725 h.p.
260	5,960	125	910 h.p.
520	11,920	150	1,090 h.p.
800	18,350	175	1,270 h.p.
1,100	25,230	200	1,450 h.p.

The table shows that for the development of 1,500 h.p. of continuous power at the Black Hole about 25,000 acre-feet of storage will be required. Owing to the fact that facilities for storage in the Maitland River watershed are lacking to an unusual degree, the purchase of land construction of the necessary works would entail an expenditure which, added to abnormal cost of development at the Black Hole, places the project, for the time being, outside of economic limits as a source of continuous power.

The rapid development in the quality of steel must be credited to a great extent to the automobile and the aëroplane. Wire for aëroplane stays or guys is made from 0.025 to 0.102 inch diameter, with a tensile strength of 350,000 pounds per square inch.

TORONTO WATERWORKS REPORT DISCUSSED.

THE Toronto City Council has before it two reports on extensions to the waterworks system of the city. They are that submitted by R. C. Harris, Commissioner of Works, in January last, and an earlier one, presented in 1912 by a board of experts appointed in 1911 by the city. Summaries containing the fundamental points of each were published in *The Canadian Engineer* for January 22nd, 1914, and May 30th, 1912, respectively.

The later report severely criticized the recommendations of the former, and it has been, in turn, subjected to criticism of a somewhat similar nature by the engineers of the former investigating board. On January 24th, Willis Chipman, C.E., its secretary, forwarded a memorandum in which it was demonstrated that at an intake located opposite Victoria Park, the site recommended by the Commissioner of Works, the pollution of the water supply would be eight times that at the intake at Scarboro, proposed by the board of experts, this statement being based on the assumption that an intake crib be located in the same depth of water and at the same distance from shore at each of these two points.

A second memorandum forwarded by Mr. Chipman to the Board of Control recently, deals further with the two proposals. Following are interesting abstracts from it:—

"It should be noted that we recommended that the Scarboro crib be located 2 miles from shore, and at a point where the depth of water is double that at the proposed intake crib at Victoria Park. There can be no reasonable doubt, therefore, that the pollution of the supply through the Harris intake off Victoria Park, would be at least ten times greater than at the proposed intake off Scarboro Heights.

"Our designs for an intake crib have been most unfairly criticized. We did not state in our report that the structure was to be built within the harbor and floated to place, as illustrated in the diagram annexed to the Harris report. Intake cribs of the proposed height have not been sunk for waterworks purposes owing to the fact that the water in the other great lakes in the vicinities of the large cities have not the depth of Lake Ontario at Toronto, but cribs of greater depths have been sunk at other places for bridge piers and abutments, of which full descriptions are available in engineering publications.

"We also, as a board, obtained offers from responsible and experienced contractors to construct an intake crib in this depth of water, whether built of concrete or steel, who were prepared to submit bonds as a guarantee that they would carry out the work to successful completion.

"We have been taken to task by Commissioner Harris for not having made a sufficient number of borings to determine the practicability of a tunnel at the depth proposed. In explanation I may state that it was not until the latter part of November, 1911, that the board finally concluded to recommend the Scarboro project, and as we were being urged by the council and the newspapers to complete our labors, and as it would have taken another full summer season to make the borings, we decided to submit our report, in which we expressed the opinion that shale of a similar character to that beneath Toronto harbor would be found beneath the lake off Scarboro, this opinion being based upon borings made by us at the Scarboro shore upon information received from the geological survey at Ottawa, and statements made by Prof. Coleman, of the University of Toronto, who has made a special study of the Scarboro formations. The borings recently made by Smith and Travers have confirmed our opinion.

"The leakage into the tunnel beneath the harbor during construction was only about 350 gal. per min., a trifling amount. All the evidence points to the fact that the shale off Scarboro is of precisely the same character as under the harbor, practically dry and without seams or faults.

"If, however, borings should demonstrate that we made an error in judgment, there is no reason why the Scarboro intake crib could not be located in the same depth of water and at the same distance from shore as that now advocated by Mr. Harris. The Scarboro intake would then be about 7 miles from the point of pollution instead of 2½ miles.

"Before concluding our report we consulted one of the foremost tunnel experts in America, who visited Toronto at the request of the chairman of the board, examined our designs and pronounced them practicable.

Reservoir Supply.

"We propose to pump water to an elevated reservoir, not for the fun of seeing it run down hill again, but to supply all of the city north of College Street, and the higher sections not now receiving a city supply. The College Street line, which now divides the intermediate service from the lower service, was to be maintained for the present, but we anticipated that this line might be lowered; that is, some street to the southward might be adopted in the future as the northern boundary of the low level district, this lower district to be served exclusively by the present John Street station.

"Assume two municipalities, one, say, 200 ft. higher than the other—there can be no reasons advanced why they cannot be supplied by two independent pumping stations. Connecting the two systems by one or more pipes provided with check valves and gate valves, permits either area to be supplied from the other in case of emergency, as was done recently in the city of Montreal when portions of the city were supplied by the Montreal Water and Power Company.

"When enlarged and improved, the old works may be depended upon for a minimum of 60,000,000 and a maximum of 90,000,000 gal. per day. The John Street system will then meet the demands of a population of something over 500,000, which will probably be reached within the next few years.

"The supply from Scarboro reservoir might, however, be drawn upon in case of a break-down in the John Street system.

"We did not recommend or propose that the entire water supply should be pumped to a height of 370 ft. We did not propose that the new reservoir should be operated in connection with the present city system, nor with the Rose Hill reservoir, excepting in case of emergency, and all of Mr. Harris' assumptions respecting the overflowing of the Rose Hill reservoir and the interference at the John Street pumping station, rendering the old plant useless, are simply nonsense.

"In regard to reservoirs, Commissioner Harris cites several large cities without reservoirs, but he fails to state that in each of these cities there is no ground of sufficient elevation upon which to construct a reservoir. It is hardly necessary to call attention to the fact that we did not recommend the city of Toronto to construct a mountain or hill upon which to erect a reservoir, but simply took advantage of what nature had provided.

"At Cleveland the capacity of the reservoir is over 100,000,000 gal., and dozens of cities might be mentioned where the reservoirs are of even greater capacity. If the city of Montreal had been provided with a reservoir containing 3 or 4 days' supply, the recent water famine might have been averted. At the rear of Mount Royal, a large reservoir for the Montreal Water and Power Co. is now in course of construction, and the fire underwriters and expert engineers have recommended additional storage reservoirs to lessen the possibility of water famine.

"We admit that there would be a loss of pressure due to friction. The longer the conduit and the smaller its diameter, the greater the friction, but, if I am not mistaken, the citizens of Toronto would prefer paying the trifling extra cost of pumping water through a few miles of large pipes, to the cost of the extra amount of chloride of lime necessary to disinfect a more polluted water supply, and the extra cost of filtration at the Victoria Park station.

"Furthermore, the extra cost of pumping through the mains, which would not exceed 10 or 12 pounds, would be offset by the extra cost of the pumping at Victoria Park. All of the water at this point will require to be pumped twice, first to the filters by low lift pumps and second by high lift pumps into the distribution system. No practical man will deny that pumping water twice will cost more than pumping it once to the combined height of two pumpages. The records at the John Street station and at the filtration plant, will, without a doubt, prove the above statement, but as no report of the city engineer or the public works department has been published since 1911, the public is in the dark respecting costs of operation and maintenance.

"In regard to the length of the proposed steel conduit from Scarboro westward, the distance is only four miles greater than with the Victoria Park scheme. With a new steel conduit of this length under an exceptionally light head, the possibility of breakage or interruption would be a minimum. When the population of the city of Toronto reaches 700,000 people, a second conduit will probably be required, but no one can foresee where this additional population will be distributed, and we did not, therefore, consider it advisable to include a duplicate conduit in our project. In an emergency, if the new conduit should for any reason be closed for repairs or inspection, the high level district could be supplied as it is at present by the high level pumping station, the water to be taken from the low level district and the Rose Hill reservoir.

"In regard to booster stations, the costs were not included in our report as we did not consider they would be required for a few years.

Pumping Machinery.

"In regard to pumping machinery, our recommendation was for an electric plant. The city had at that time contracted for a large block of electric power, electric pumps were being installed at the John Street station, and at the high level station, and as patriotic citizens we advocated electric power, on condition that two independent transmission lines should be constructed, also a reservoir of 130,000,000 gal. capacity.

Mr. Harris' statement respecting the pumpage of the entire water supply to a height of 370 ft. has been pointed out as incorrect. Of the 45,000,000 gal. per day now pumped at the John Street station, about 15,000,000 gal. per day is now re-pumped at the high level station, and the volume re-pumped is increasing rapidly each year. Mr. Harris' report only confirms that made by our commission.

"The maximum daily consumption in the low level district (south of College Street) is now given as about 50,000,000 gal., and in the high level districts, about 22,000,000 gal., or 72,000,000 gal. now pumped at John Street, of which 22,000,000 gal. are re-pumped at Poplar Plains station.

Pollution at Intake.

"Assuming two points near the north shore of Lake Ontario where the water is practically of the same depth and at the same distance from shore, the pollution due to the main sewer outlet near the Woodbine will vary inversely as the squares of the distances from the sewage outfall. This is axiomatic and can not be controverted.

"It must also be admitted that if the distance from shore be doubled and the depth of water also doubled, that the pollution will certainly be less than half. At Victoria Park intake, the supply under existing conditions would unquestionably be polluted at least four fold what it is at present, while at Scarboro the pollution would undoubtedly be less than one-half what it is at present, and probably less than one-fourth.

"The Harris report states that further treatment of the sewage of the city will be necessary if the water supply be taken from Victoria Park, also that the water supply should at all times be chlorinated. thus admitting the certainty of gross pollution."

ASBESTOS PRODUCTION IN QUEBEC.

The Province of Quebec contains the principal asbestos-producing areas of Canada. The present workable deposits are scattered through the great serpentine range which strikes through the townships of Broughton, Thetford, and Coleraine. The total length of the belt is 23 miles, with a width of 100 feet in the extreme easterly part, increasing to 6,000 feet in the Mock Lake area. The principal deposits are at Thetford, Black Lake, Danville, and East Broughton; the first two are the most important. The mineral occurs in a series of narrow and irregular veins, sometimes, though rarely, reaching a width of six inches. Large mills are now in operation in which the rock is broken and crushed and the fibrous asbestos is taken up from screens by suction fans, and blown into settling chambers. At present the annual production is over 100,000 tons, valued at upwards of $3,000,000. It includes a large variety of grades, from the long-fibred crude asbestos, valued at $300 a ton, down to the shortest mill fibre, valued at only $2 or $3 per ton, and "asbestic sand," used for wall plaster, and valued at from 75 cents to $1.50 per ton.

In a summary of the waterpower of the world the possible horsepower of France is estimated at 4,500,000, of which only 800,000 is utilized. About an equal amount of power is available in Italy, but only 30,000 horsepower is utilized. Falls of 10,000 horsepower are abundant in the Alps. The estimate for Switzerland is incomplete, but about 300,000 horsepower is in use. Germany has 700,000 horsepower available, with 100,000 applied. Norway has 900,000 horsepower available, with a large part already developed. In Sweden there is 763,000 horsepower available, but mostly at a considerable distance from any industrial centre. In Great Britain there is 70,000 horsepower already utilized, and an equal amount in Spain. The resources of Russia are estimated at 11,000,000 horsepower, of which only 85,000 has been developed. The United States is credited with 1,500,000 horsepower, while Japan has 1,000,000, of which 70,000 has been exploited; and in India 50,000 horsepower has already been developed.

TESTING OF CENTRIFUGAL PUMPS.

A CENTRIFUGAL or turbine pump is not a positive displacement pump and .there are no "rule of thumb" methods of arriving even approximately at its capacity. It may be, therefore, accepted that a well-equipped testing plant is one of the most important essentials for its successful manufacture.

From the manufacturer's standpoint the records of tests carefully carried out are of the utmost value. as they constitute the foundation upon which future propositions can be based, designs developed, improved and modified to suit particular requirements. From the purchaser's standpoint, on the other hand, is the absolute assurance that the hydraulic and efficiency requirements have been fulfilled and, secondly, that a trial run of several hours' duration will ensure continuous operation of the machine with no mechanical difficulties arising after leaving the works.

There are a number of testing methods in use with varying degrees of accuracy. They may be classified as follows: Weight or volume method; weir method; velocity meters. The last group includes Venturi meters, nozzles and the Pitot tube.

The instruments required, pressure and vacuum gauges to determine the total head, wattmeters to determine input to motor, or indicator to determine horsepower of steam engines, have long been standardized and are usually accepted without question by consulting engineers and representatives of purchasers on official tests; in any case their calibration is a simple matter and ready facilities are provided for this purpose. But the measurement of the quantity of water being handled presents many difficulties because the methods generally adopted, owing to their cheapness, such as weirs, nozzles, Pitot tubes and in fact all velocity meters are open to the very strong objection that their accuracy depends on constants determined by experiment which, as far as consulting engineer or official representative is concerned, may or may not be right. A means of direct measurement either by weight or volume is an absolute necessity.

In the testing plant of Canadian Allis-Chalmers, Limited, at Rockfield, near Montreal, no one single testing method is relied upon, but any one of the three above-mentioned testing methods can be used and the volume method can be used to check either the Venturi meters or the weir. It may be stated here that a testing plant established at the Mather & Platt works, in Manchester, England, served as a basis for the design of this unique equipment at Rockfield.

Figs. 1 and 2 represent views of portions of the testing plant. The overall dimensions of the tanks alone are 34 ft. 6 in. long, 18 ft. 3 in. wide and 9 ft. 4 in. deep, of such proportions as are well able to cope with the largest pumping units. All tanks have been placed underground so that factory space is not wasted and the flooring made in such a way that the tanks can be easily uncovered. The total area has been divided into three tanks; the suction tank, 18 ft. 3 in. long, 15 ft. wide, 9 ft. 4 in. deep; the calibrated delivery tank, 18 ft. long, 11 ft. wide, 7 ft. 4 in. deep, and the weir tank, which is 18 ft. long, 5 ft. 9 in. wide, 7 ft. 4 in. deep. All tank walls are made of waterproofed concrete and the bottoms carefully levelled. By raising the bottom levels of delivery and weir tanks above the suction tank, they drain by gravity through connecting valves into the suction tank. A small motor-driven centrifugal pump serves as drainage pump for all tanks. Suction pipes with foot valves and strainers of various sizes are situated in the suction tank, and little time is lost in making the suction pipe connections when pumps about to be tested are bolted to the cross rails, thus providing a firm setting-up.

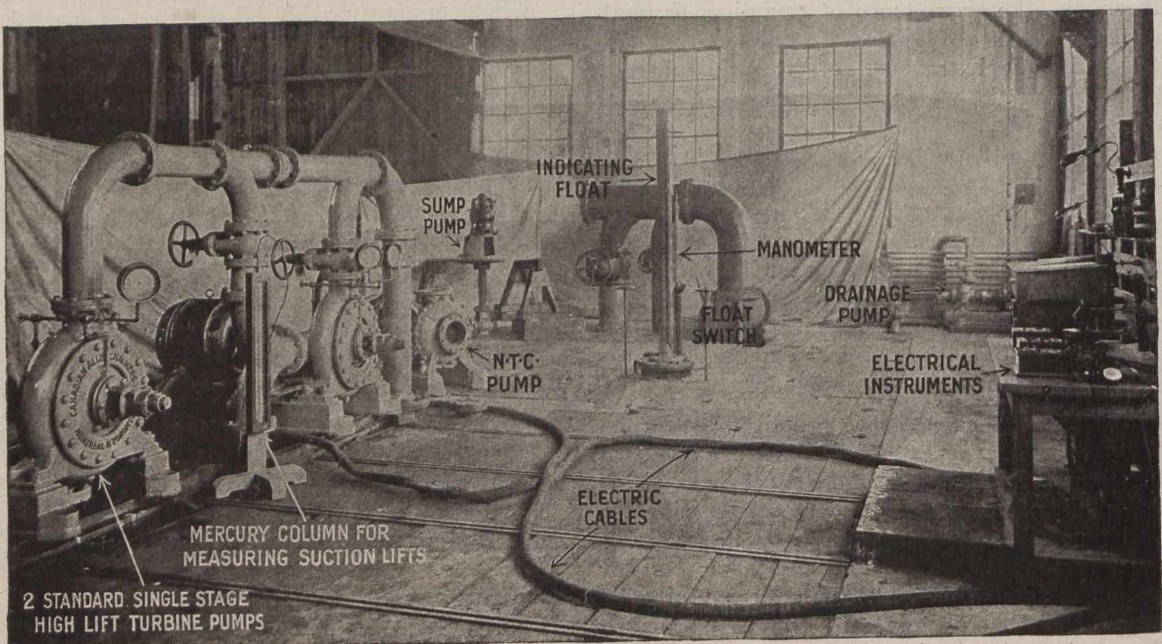


Fig. 1.

The discharge connections are formed by two elbows, which connect to a 6-inch and a 12-inch Venturi meter. Following the discharge pipes, they are carried to a common large pipe, which finally connects with a water switch. By removing a blank flange, a passage can be made from the delivery tank to the weir tank. On the wall dividing the delivery tank from the weir tank is located a manometer, as shown, which, by means of pipe connections to the Venturi meter tubes, registers the amount of water flowing through the tubes. Next to this instrument is mounted a float with indicator which indicates the height of water in either delivery or weir tanks by opening and closing valves.

Referring to the weir tank, it has a cast iron weir frame, which is set in the wall dividing the weir tank from the suction tank. Weirs of the V-notch shape, and rectangular weirs of 18, 22, 24, 35 and 48-inch widths can be inserted in this frame. A ladder with a platform has been provided to allow the test operator to descend and observe the levelling and careful setting of the weir crest to the zero mark of the float scale. Baffle plates in the weir tanks can be raised or lowered in wall frames to best advantage to check any disturbances of the water and to ensure a quiet flow near the weir.

A table with the necessary electrical instruments to measure the electrical input, and engineer's desk and a fitter's bench complete the equipment.

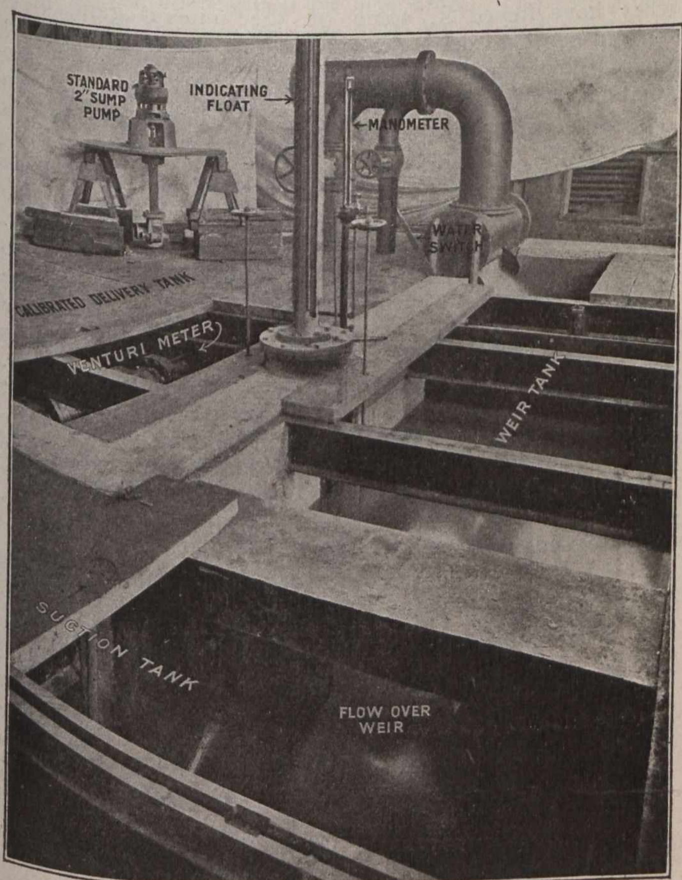


Fig. 2.

The method of test is as follows: All suction pipe connections are made with the above-mentioned pipes in the suction tank. The discharge connection is made with one of the two elbows, according to the size of pumps to be tested, and the water is discharged direct into the water switch. By operating the hand lever the water can be instantaneously switched either into the calibrated delivery tank, or into the weir flume. As the name indicates, the delivery tank, although of uniform section, has been carefully calibrated by weighing the water and noting the rise of level on the float scale. Assume the operator by means of the water switch has directed the flow into the weir flume. He observes the weir flume scale on the float and the manometer reading at the same time, thus checking the weir against the Venturi meter. Now the float is closed to the weir tank and opened to the delivery tank. The level of the water in the delivery tank having been observed and, with stopwatch in hand, the water switch lever is thrown over, allowing the water to fill up the delivery tank.

The operator allows the pump to discharge into the delivery tank for from, say, one minute in the case of 10,000 gal. per min. pumps to even half an hour if required for 500,000 gal. per min. pumps and noting the time, switches the discharge from the pump back into the weir flume whence it continues to circulate round. At his leisure and when the water in the delivery tank is quite still, the operator observes the new level and, subtracting it from the original level, arrives at an exact volumetric measurement of the water passing through the pump. Note here, also, that the water is still passing through the Venturi meters, thus checking them against the delivery tank. Thus the Venturi meter checks the weirs and the volumetric measurement checks the Venturi meter.

For any quantities over 10,000 gal. per min. the discharge is delivered direct into the delivery tank through bypass into the weir flume and over the largest weir which, having been checked up to 10,000 gal. per min., may reasonably be assumed to be exact for larger quantities.

It may also be mentioned here that steam inlet and exhaust pipe connections are available at the test plant and small or large steam turbine-driven pumps can be easily tested as motor or belt-driven units.

HYDROGRAPHIC SURVEYS IN ONTARIO.

THE stream measurement work developed in 1912 by the Ontario Hydro-Electric Power Commission was carried on continuously in 1913 with satisfactory results in the case of some rivers, and the reverse in others. The relation between gauge height and discharge was disturbed in nearly every case by ice conditions, as was to be expected. In the case of the rivers in the southwestern peninsula, such as the Grand, Maitland, Saugeen, Thames, Credit, and Nottawasaga, measurable velocities could in general only be obtained at wide shallow sections, where a high degree of accuracy in measurement could not be depended upon. The large number of mill-dams located in these streams also made it impossible to locate all gauges where they would not be affected by back-water at high stages of flow. This trouble has not yet manifested itself at the stations established on the Grand River during 1913, but it is to be expected during periods of high water.

In the case of the northern rivers, the above conditions were aggravated in many instances by the necessity of locating stations at accessible points. This usually meant the use of a bridge station, and in the case of the Sturgeon, Maganetawan, Wahnapitae, Spanish and Seguin Rivers, backwater trouble occurs intermittently owing to the operation of dams in connection with power development. The Mississaga station is seriously affected by wind levels on Lake Huron.

In the case of the Thames, Saugeen, South, Sturgeon and Credit rivers it has been found that by eliminating measurements where backwater effects are plainly evident, a fairly good station rating curve is obtainable. An effort will be made to re-locate the gauges at some of these stations so as to produce still better results.

RAILWAY TUNNELLING.

PART III.

By Leonard Goodday, C.E., M.E.

PREVIOUS articles of this series on the practical side of tunnel driving dealt with the method of procedure as followed generally in different countries. The sinking of shafts, setting out of tunnel, driving of headings, etc., were taken up in January 15th, 1914, issue of *The Canadian Engineer*. The description was continued as far as, and including in part, operations of mining and timbering, in March 19th issue, while in the following notes the discussion proceeds to the finishing of the brickwork.

From the stage at which the length under construction has been mined down to the top sill and this sill put into position the excavation must be got away quickly, as now begins the paying part of the work. Excavate down to the top of the bottom heading, placing the bars and poling farther apart. These bars may now be only a little longer than the length being mined and about 12 in. diam., one end of them being supported in the brickwork of the toothing which can be cut out for their reception, and the other end supported by temporary raking props, at a point a little back in the length from the front of the sill. About the level of the top of the bottom heading another sill is placed, the bottom of it being kept high enough to clear wagons, etc., passing through the heading. This sill is similar to the top one, but may be stronger and, of necessity, longer, because here the tunnel is nearly full width. It is placed in the same manner, letting each middle sill prop be exactly under one of those above, supporting the bars from the top sill. Two strong rakers must now be got in to support the top sill from formation, more particularly against face weight. They should be on very strong foot-blocks, and when in position, driven up tightly with driving wedges, inserted between the end of raker and the foot-block. The top end of these rakers should be formed into a jaw, to take in the bottom face angle of the sill, and should be provided with a good iron gland, just below the jaw to prevent splitting.

These top sill rakers should be got in as soon as it is possible, even before the middle sill is in, or, in any case, temporary rakers should be used. In getting out the remainder of the length, leave the sides in, and excavate the middle portion only, leaving side slopes like a cutting, and do not undermine the middle sill. Arriving at formation level, place two strong props on good foot-blocks under the middle sill, on either side of the bottom heading, and place 2 rakers to this sill, similar to but shorter than those for the top sill. The face weight is sometimes very heavy, tending to shove the sills into the length, especially when the tunnel is inverted, and in that case, besides these rakers, sill stretchers will be needed, stretching or strutting the sill ends from the last toothing. If this is not effective, "Judkin" rakers must be introduced. These are timbers abutting against one another at the centre of the sill face, and stretching it horizontally across the length to the toothing. The excavation of the slopes may now be worked, extending all to formation level across the tunnel, beginning at the top of the slope, and putting in a light bar here and there, sufficiently near to one another for them to secure the ends of any poling boards that may be required to support the ground. These bars should be supported by raking props at either end. Should the ground be good, no bars will be required below the middle sill. Do not undermine the middle sill, but leave a good footing of ground until the rest of the length is out, then take this out in bays, putting a prop under the sill from a foot-block on formation, one by one as the bays are removed.

The foundations of the side walls are usually carried down 2½ ft. below formation level and should be trenched to the net width of the lowest course of the brick footing. They must be level and solid. Any water accumulating in them can be got out by hand-pumping.

Each gang of miners should always have two faces to work, for if not, it will be idle while the bricklayers are lining. If these two faces be A and B, and the work just described as having been done in A face, while the mining of this length is going on, and before it is finished, the bricklayers should have commenced and keyed the arch of the length last got out in B face. Directly they have keyed it, some of the miners' gang in A should begin to drive the top heading for another length in B. They should be able to get the 5 bars drawn into that length before that in A is finished. There is then about room for the whole gang to get to work in this next length in B face.

By the time a few lengths are finished, it is likely that a good deal of water has been tapped, and that the method of emptying the sump by barrel is not sufficient. A steam pump is really the best and cheapest means to install. One of these occupies little space, and can be fixed in a manhole in the side wall of the tunnel, near the bottom of the shaft, and locked up. The force pipe is conducted up the shaft, and the suction into the sump, with a branch along the side wall to near the length that is being mined. To this latter can be attached a flexible hose. A stop-cock should be fitted to each branch of the suction, so that communication can be cut off from either pipe. The steam for the pump can be supplied from the winding engine's boiler.

Lining the Length.—Having the wall foundations out, everything is ready for setting the side wall frames.

The engineer should put a centre line point accurately in the middle sill, and mark off the face of the walls, and by driving a spike into the timber at any point above rail level properly distanced from the centre line. Set up the frame with its back edge against this spike, and plumb it. The projecting piece of timber marking rail level must be precisely levelled to rail level. Spike this frame securely, its place being at the leading end of the length, and close up to the sill. Put the frame up for the other wall in the same way. Four of these frames will be required for a first side length.

Bricks and mortar are now required in the length. It may be inconvenient to supply them from the open ends for all the faces, because of the number of these faces at work and the traffic in and out of the tunnel. When 8 or 10 lengths have been turned at any face, a turn-out should be put in off the main track, i.e., a siding where wagons can stand and allow others to pass them. For a tunnel of this length a mortar mill can be used in each of the entrance cuttings.

A gang for lining a length is made up of 4 bricklayers and 6 laborers—half the number being on each side and each party working on the same side of the tunnel for all lengths—so that their work will be similar throughout. The best one usually takes the leading end or toothing of the length on his side. The term "toothing" denotes leaving the bricks at the leading end projecting every alternate course, as the bond causes them to be laid, and they then form a bond for the next length. Some prefer every length to be finished up squarely. It has a neater appearance, and is quite as strong as bonding one length into another.

A length should be complete in itself, and as one length is lined a few days before the next is commenced, there is time for settlement. If the bricks in this first length are tooth, the next, when built to it, settles also, tears out of the toothing, and becomes broken. This has to be patched, is unsightly, and suggests weakness.

Again, the courses may not be started at the same level as the last, and to get the bricks into the last toothing a little squeezing takes place, the consequence being that the first three or four bricks in every course of the new length are found to be running up or down out of the general level. A block toothing is best where bricks are used for lining. Stone side walls are another matter.

English bond is best for side walls. The first course of all wall footings may be laid dry, and the footings should have half brick projection every two courses in height. In heavy ground, however, portions of these footings are carried up plumb to formation level, i.e., full width of bottom course.

On these solid "stick-ups" set the sills and props for supporting the centre ribs. Before the wall is at rail level the courses must be level (except in the case of a gradient). At rail level leave a projecting brick near the leading end as a guide and reference. Now stretch a line from the saw cut in the wall frame, marking the courses to the corresponding course of the last length. Continue this procedure following the courses marked on the frame until springing level, the top of the frame, is attained. Grout every course and flush every joint. As the brickwork proceeds, all cavities between the back work and the mined ground must be carefully filled and packed solid.

The walls should be built up without interruption until complete to springing level, after which the centres or ribs are set. The ribs for a 5-yard length are, as mentioned before, three in number, viz., two intermediate and one leading.

The leading rib must be so placed that the laggings provided (15 ft. x 7½ in. x 2½ in.) will reach and fit between the groove or projecting sweep in the rib under the last toothing and on the one now being put up. Fix the ribs together by spiking pieces of plank upon their under sides, and drive up the slack-blocks until the crowns of the ribs are all level, and about 1 in. over sight to allow for after settlement in the work. All the necessary laggings required must be in readiness on the scaffolds standing under the last length.

One lagging is placed on each side at the arch-springing. The bricklayers put on lagging by lagging as they require them as the brickwork progresses.

The laggings will not bear on the ribs in places, when the latter have been used several times; in such cases it is necessary that wedges be used under the laggings, to keep them up to proper line, and to allow of no sagging or springing.

When the underside of the lower bar is reached, 2 laborers may then do the packing and help getting these bars out, which is done with the aid of tackle. To get a bar out it is raised a little, so that another course of brickwork can be got in to secure the ends of the poling boards that will be released by the bar. In heavy ground nearly all of the boards round the arch must be left in behind the brickwork to keep the ground from "running." When the ends of the boards are secured, the bar can be lifted out of its place, and turned round until it can be got through a bay of the ribs, and back upon the scaffold under the last length. This is often hard work where many ribs are needed, and the nearer the crown the more crowded it becomes. For the arch, English bond for the brickwork is often insisted upon, while some prefer single-ring work, i.e., all bricks laid as stretchers with bonders of headers where possible, and which is good, securing better work and less mortar used. The more bricks and less mortar there are in such a piece of work, the better the work, providing there is enough mortar to properly bed the bricks. A ¼-in. joint on the soffit, if properly radiated from the centre, will be much thicker at the extrados of the brick, and must be so if the courses are to radiate. Care must be taken, so as not to overdo this, for if there is an excess, there will be a greater settlement afterwards, and in a wet tunnel the mortar gets washed out, reducing the safety of the arch.

Returning to lining the length, the arch is built up level with the top sill, when a bricking-in piece must be introduced. It has been shown that before the top sill could be got in the bars above it had to be back-propped ahead of it, as the brickwork cannot be built further forward than the sill, and as all bars must come out as drawn sooner or later. It follows that there must be a few feet of mined ground ahead of the toothing now being formed, poled with boards, but without support. When the bars are drawn out bricking-in pieces about 8 ft. 0 in. x 6 in. x 6 in., are placed behind the brickwork between each two bars, about 3 ft. of their length resting on the brickwork and the remaining portion projecting along the roof of the mined ground ahead. They are securely packed from the brickwork before the bar is taken out, and they will then hold up the poling boards and ground.

The seventh bars are the last taking out bars. Before getting up to this height, a temporary scaffold must be made above the main one.

When the bars are all out, bricking the arch continues under the drawing bars.

The last lagging which has been put on each side must be grooved on its top edge about 1 in. deep and the length of the lagging on which rest the block lagging, which are pieces of board 1 in. thick at the ends, 2 in. thick in the centre and about 3 ft. long, used for building the key. They are laid transversely to the other laggings.

At this stage the work is very arduous and comparatively slow progress is made. Generally speaking, 55 hours is an average time in which to line a 5-yard length. It can be done in about 42 hours, however, if a full gang is kept steadily on the work. This is, on the whole, rather uneconomical as when the brickwork approaches the key of the arch working space is badly curtailed. Better practice is to withdraw the gang of men on one side until the other side has finished up to the key or within about 1½ ft. of the crown. Then the other side is finished with greater ease and better workmanship.

The brickwork completed, the bars are drawn and operations continued on the next length.

After several hundred feet of tunnel is thus completed at any face, the centre drain should be built in. In size a drain 18 x 12 in. wide is generally sufficient. The bottom should be of 4-in. flag stone, and the sides of brick or flat bedded stone laid dry. A 6-in. flag stone bedded in mortar but with joints open forms a satisfactory cover. Its top should be at formation level, and the formation should rise from this flag towards the side walls of the tunnel, this rise to be about 6 in.

Bench marks should be plainly indicated opposite one another on the side walls, from which the height of the soffit at various points may be ascertained soon after the arch is turned. By renewing these measurements, any sinking or settling of brickwork can be noted.

REVISION OF UNITED STATES ROAD LAWS.

ROAD laws which have been on the statute books of various states of United States for more than one hundred years will probably be repealed as a result of the movement which has been inaugurated by the American Highway Association in conjunction with the American Bar Association. The committees appointed by the two associations have had prepared through the co-operation of the U.S. Office of Public Roads a complete literal compilation of the road laws of all the states, as well as the laws relating to indebtedness, the use of convict labor, and various other subjects which have a bearing upon the management of the public roads. An index chart for these various laws is now being prepared and as soon as it is completed the committees will determine upon the lines along which revision will be sought. The governors of the various states will then be asked to recommend to the legislators the appointment of special committees to confer with these committees with a view to adequate revision of existing road laws.

The first step in the revision of the state road laws will be to recommend that all obsolete, useless, or unnecessary road laws be repealed. The next step will be to simplify and arrange in logical order the existing necessary road laws. It has been found that in some of the states an accumulation of road laws running back over 100 years exists thus creating almost hopeless confusion. Certain basic features of good administration will be urged by the joint committees such as the payment of road taxes in cash; the elimination of a multitude of unnecessary road officials now characteristic of many of the states; the requirement of skilled supervision in the actual construction and maintenance of roads by providing qualification tests; the constant employment of highway engineers or superintendents; the adoption of the appointive rather than the elective method for such officials; the substitution of continuous maintenance for the present intermittent method; the proper utilization of convict labor where climatic and other conditions warrant its use on the public roads for the preparation of road materials; the general adoption of the principle of state aid and supervision; the proper safe-guarding and accounting of road funds.

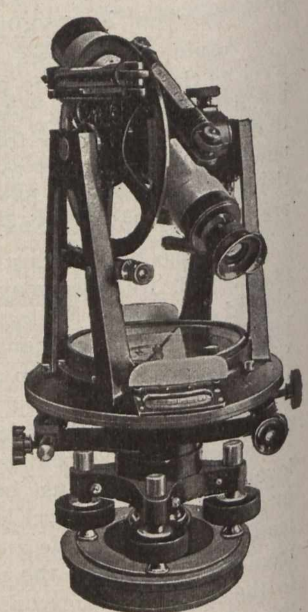
Wherever practicable, uniformity among the road laws of the various states will be urged by the committees as it is realized that the traffic is now controlled by economic conditions rather than by state lines and should not be hampered by conflicting laws of the various communities.

It is expected that a most interesting report will be made by the joint committees at the Fourth American Road Congress which will be held at Atlanta, Ga., November 9-14, 1914.

A NEW TRANSIT.

A new transit, called the "C. E. De Luxe," is being built by E. R. Watts and Son, Canada, Limited, of Ottawa. Among the interesting features appearing in the specification for this instrument, illustrated herewith, are the following:—

Horizontal Circle—Five-inch diam., reading to 30 seconds, graduated with two rows of figures, 0—360, both ways. One row of figures with the corresponding vernier is filled in with red, while the other row and vernier are filled with black.



Bubbles—The plate bubbles are enclosed in the compass, but are adjusted outside the compass by means of capstan headed screws.

Telescope—The telescope is made by Carl Zeiss, of Jena, and is fitted with their patent internal focusing arrangement, which gives absolutely accurate readings without the use of a constant.

Foot-Screws—The foot-screws are threaded on hard German silver, whilst the milled heads are made of hard rubber. The former admits of a fine thread and an easy motion. The hard rubber millings allow of a larger diameter head without increasing the weight, and are advantageous in extremely cold temperatures.

Tangent Screws—All tangent threads are cut in German silver. The upper plate, clamp and tangent screw milled heads are of a different shape to the lower clamp and tangent screw milled heads. This enables the observer to distinguish by touch which clamp and tangent he is using, whilst to further facilitate this point they are placed in such a position that even when wearing heavy mitts their distance from the plate denotes, without having to take the eye from the telescope, which clamp and tangent is being used.

A London engineer has recently compiled figures in an endeavor to throw light upon the vexed question of whether motor traffic is more injurious to road surfaces than is ordinary horse-drawn traffic. He takes as a basis of comparison the horse traffic periods of 1905-1906, and the motor traffic periods of 1911-12 which shows a decrease in annual cost per mile of roadway, for cleansing and scavenging, in the following six London districts: Battersea and Chelsea, $540 per mile; Fulham, a decrease of $5.30 per mile; Paddington, a decrease of $620 per mile; Wandsworth, a decrease of $470 per mile, and Westminster a decrease of $895 per mile. A particular case of saving in up-keep cost is given in the example of a macadam road between Hammersmith and Barnes, which went on pieces under motor traffic. The Barnes district council spent $47,000 in relaying this stretch with block paving, and a tabulation of expenses shows that not a single penny has been spent since then in repairs to the block paved road, although the motor traffic has increased at a very heavy rate. During the horse traffic period the cost of maintaining the macadam road was $5,750 in 1906, and $1,915 during the early part of 1907, in which year the roadway was relaid.

Coast to Coast

Guelph, Ont.—The financial statement of the water commissioners at Guelph for the month of March shows a balance of $3,418.96.

Fort George, B.C.—The last spike on the G.T.P. was driven on April 7th, at the east end of the bridge over the Nechaco at Fort Fraser river.

Toronto, Ont.—The net surplus for the Toronto Hydro-Electric system in 1913 amounted to $34,576, or approximately 3 per cent. on the total investment.

St. Thomas, Ont.—The St. Thomas board of works estimates its expenditure for the current year at $19,900, which is about the same as required last year.

Victoria, B.C.—The outcome of the consideration by the Victoria council of estimates for 1914 is that the aggregate amount to be raised has been placed at $2,460,000.

Brantford, Ont.—Civic estimates for this year at Brantford provide for a total expenditure of $539,465, as compared with $472,579 last year, showing an increase of $66,886.

Montreal, Que.—Latest advices from headquarters at Montreal state that the $1,000,000 station and office building of the C.P.R. at Vancouver will be ready for opening in June.

Regina, Sask.—A new generator at the new power house at Regina has been installed, and is working satisfactorily; while another generator, which will be powerful enough to carry the whole of the lighting system of the city of Regina, is reported to be on its way.

Winnipeg, Man.—The statement has been made by Morley Donaldson, vice-president and general manager of the Grand Trunk Pacific Railway company, that the last spike on this second transcontinental railroad in Canada will be driven and the last rail will be laid on April 9.

Fredericton, N.B.—The conclusion concerning the harbor at L'Etang, reached by Mr. A. D. Swan, M. Inst. C.E., M. Inst. M.E., M. Can. Soc. C.E., who has furnished a report to the Federal Department of Public Works on ports in Charlotte county, N.B., is that this port would not be suitable for the largest class of modern merchant vessels, but, if desired, it would make an excellent harbor for steamers of moderate size.

Hamilton, Ont.—The cost of Hydro-Electric street lighting at Hamilton has now been estimated at $88,125 for one year, as compared with $65,800 previously estimated. The increase is due to extra cost of corner lights, increased area to be lighted, and the Ontario commission's decree to increase the cost. When the Hydro's $88,125 system is running complete, there will be 9,100 lights, giving a total of 1,320,000 candle-power, evenly distributed.

Halifax, N.S.—On March 24, a bill was introduced in the Nova Scotia legislature to incorporate the Nova Scotia Tramways and Power Company, which is to have a capital of $5,000,000 with power to increase it to $10,000,000. It is also provided that the bill authorizes the company to purchase the Halifax Electric Tramway Company. Moreover, the Nova Scotia Light and Power Company agrees to transfer to the new company all its rights in certain power sites and lands at Gaspereaux.

Moncton, N.B.—The I.C.R. is now constructing 165 new bridges along the lines in the eastern provinces, while by October 30 new 35-ton passenger locomotives will be put into commission. A section of road from Pasaic Junction to Oxford, 70 miles long, will also be double-tracked by that time. Another project of the new I.C.R. head is that of utilizing the short line between Pictou and Oxford Junction for Sydney freighting. This will necessitate bridging across the West, Middle and East rivers of Pictou to overcome the Westville grade.

Yorkton, Sask.—Recently at Yorkton, what may prove to furnish an adequate water supply for the town has been discovered. A supply has been struck in a test well now being dug by the town, which promises to develop into a flow amply adequate for all requirements for years to come. The new test well is 6 feet in diameter, and at a depth of 35 feet the flow of water was struck. It is now proposed to sink a 15-foot well, 50 or 60 feet; and it is confidently predicted that this will produce a water supply sufficient for a city with five times the population of Yorkton.

Kamloops, B.C.—The vertical lift span in the C.N.R. company's new girder bridge, just completed across the North Thompson river, consists of a 93-foot deck plate girder, weighing about 236,000 pounds, which is balanced by counter weights attached to cables which pass over sheaves at the top of the towers. The span is raised and lowered by means of cables fastened at the top and bottom of the towers. These cables pass over drums at each corner of the span, which are actuated by a system of gears and shafts connected to a gasoline engine at the centre. Hand operation is also provided. The machinery is designed to lift the span 53 feet in 100 seconds, providing a clearance of 55 feet above high water.

Prince Rupert, B.C.—The construction work which has been accomplished by the G.T.P. Railway company along the banks of the Skeena river to its terminus at Prince Rupert is said to be one of the greatest of railway engineering achievements. For a 200-mile section of railway, millions of dollars were spent before a shovelful of earth was removed. But along the banks of the Skeena a route has been hewn free from sharp curvature or steep grades, despite the rugged contour of the river's course, and there is no danger of the turbulent river ever being able to disturb this roadbed. Very little tunnelling has been done, for nearly 4,000,000 cubic yards of rock were blown away on 186 miles of line between Prince Rupert and Hazelton to make a route through the Cascades.

Regina, Sask.—The new reservoir to be constructed at Regina is to be a replica, with trifling exceptions, of the 5,000,000-gallon reservoir at Tor Hill. An 18-inch supply main from Tor Hill reservoir is to be laid along Halifax street, while a 42-inch main between the reservoir and the power house will be constructed on Osler street. Arrangements are also being made to connect the new basin with the proposed 27-inch supply main when the latter is constructed in 1915 or 1916. The reservoir will hold a depth of 25 feet of water and will be constructed 20 feet above the surface of the ground. It will contain nearly 500 tons of steel; will be covered with a concrete top and above the concrete a 12-inch layer of soil. In this latter respect it differs from the Tor Hill reservoir, which has no earth covering. In order to hold the earth it is proposed to plant grass seed on the top.

Regina, Sask.—The Regina incinerator was put into full operation a few weeks ago. It has been erected at a cost of $65,000, has a capacity of 110 tons of garbage per day, and has two furnaces. There are two large boilers in the plant, fans for inducing draft and for drawing off the gases, which are used to heat the boilers and create steam, etc. The steam is forced through pipes in the main furnaces, and as the damp garbage is dropped down on the grates and steam pipes, it is dried out considerably and ignition induced. Once the fires are fairly hot, the fans keep the draft in such condition that the fire burns fiercely, and it is easy to keep a steam pressure of 60 to 100 pounds on the boilers, or enough to run the fans and a complete electric light plant of sufficient capacity to light all the buildings at the disposal works. At the present time it is only necessary to run one furnace at a time, in order to take care of all the city's garbage.

Vancouver, B.C.—The creosoted wharf to be constructed at the site of the proposed Marine and Fisheries building on the Soughees Reserve, for which the contract has just been let to Messrs. Parks, Tupper and Kirkpatrick, of Vancouver, will be 420 feet in length; and on the north side it will run inshore 224 feet. It will be 50 feet wide and will be 6 feet above high water mark. A considerable amount of dredging has been carried out during the past few months in order to give 20 feet of water at low tide; and the foreshore will be graded to a uniform level, giving a gradual slope toward the wharves. On the graded site it is proposed to build the new Marine and Fisheries Depot. The contract calls for the excavation of 27,000 cubic yards of material, composed mostly of clay. It is probable that the whole of the grading will be completed within six weeks after an actual start on the work. The wharf should be completed within four months, and before the expiration of that time it is probable that the contract for the Marine and Fisheries building will be awarded.

Edmonton, Alta.—The final plans recently filed for the route of the Canadian Northwestern railway, or the C.N.R extension into the Peace River district of Alberta, show that from Whitecourt, to which point at the confluence of the McLeod and Athabasca rivers the grade has been completed, the line will follow the valley of the Athabasca for about 50 miles on the south side, crossing the McLeod by a separate bridge. It will cross the Smoky river about 3 miles from the confluence of the Wapiti, and pass just south of the town of Grande Prairie, between Saskatoon and Bear Lakes. After crossing the Athabasca and leaving the valley for the north the route goes through township 62, range 18, townships 63, 64, and 65, range 19; township 66, ranges 20 and 21; township 67 and 68, range 22; townships 68 and 69, range 23; townships 69 and 70, range 24; township 70, ranges 25 and 26; township 71 and as far west as range 6, west of the 6th meridian; township 72, ranges 7 and 8; township 75, ranges 9 and 10; township 74, ranges 11, 12 and 13, to the Alberta-B.C. boundary.

Toronto, Ont.—Over a million dollars of the five million good roads grant by the Ontario government has already been expended in the north, according to the report which J. F. Whitson has submitted to the legislature, through W. H. Hearst, minister of lands, forests and mines. In this outlay, which reaches exactly $1,081,172.28, road construction of 764 miles has been completed during the past year. In all, 279 miles of bush roads were cut, the most of which are in the district of Temiskaming, in the vicinity of Cochrane, Porcupine, Iroquois Falls, from the Quebec boundary, 125 miles to Ground Hog; also a 50-mile strip from Haileybury to Englehart, Matheson, Charlton and Swastika. Mining roads were also extended into the Kirkland Lake Goldfields and Shining Tree. The estimated expenditures for 1914 amount to $950,000, of this Rainy River gets $85,000; Port Arthur, $60,000; Fort William, $90,000; the Soo-Sudbury road, $90,000. The largest individual grants go to the T. and S.N.O. and T.N.R. districts, these receiving $120,000 and $105,000, respectively.

Edmonton, Alta.—Route plans for 18 miles of the Central Canada Railway north of Edmonton have just been filed in the provincial department of railways for Alberta. These show that 60 steel and wooden bridges, ranging from 75 to 125 feet in length, will be required on the line, which will connect with the Edmonton, Dunvegan, and British Columbia railway at Round Lake, and will continue along the North Hart river to Peace River Crossing. It is also stated by the railway engineers that at least 50,000 yards of earth will have to be removed from every mile of line on the right-of-way along the North Hart river; and it is estimated that the construction cost of this stretch of line will be more than $50,000 a mile. The sliding banks along the tortuous windings of the North Hart river are fully 700 feet above the high water level. The grade drops that distance in the 18 miles of line before reaching Peace River Crossing, where the railway company will span the Peace River with a steel bridge costing $400,000. Thence the line will continue to Dunvegan along the north bank of the Upper Peace River.

PERSONALS.

C. B. CARTER, for two years municipal engineer of West Vancouver, has resigned.

A. J. DONEGAN has been appointed superintendent of the Algoma Eastern Railway, with headquarters at Sudbury, Ont.

E. I. SIFTON has been appointed general manager of the Hamilton Hydro-Electric System, and W. H. CHILDS will be his assistant.

C. M. ARNOLD, formerly city engineer of Lethbridge, has resigned his position with the Canadian Pacific Railway, as engineer of ditching operations in Alberta.

J. E. PENNYBACKER, who has been advisory expert for the Ontario Highway Commission, has resigned as secretary of the American Highway Association to accept the position of Chief of the Division of Road Economics in the Office of Public Roads, United States Department of Agriculture.

J. E. Pennybacker.

HERBERT DOUGLAS, lately of the mechanical department of the Canadian Pacific Railway Company, and formerly foreman of the erecting department of the Consolidated Mining Company at Trail, B.C., has received the provincial government appointment of assistant inspector of factories for British Columbia.

L. P. BURNS, A. SCULLY and J. T. LENNOX, president, secretary, and a director, respectively, of the Inland Construction Company, Limited, of Toronto, who recently secured the contract for the Swift Rapids section of the Severn river division of the Trent Canal, were in Lindsay last week following up their plans for undertaking the work. It is announced that Ragged Rapids will be made headquarters, and that a road will immediately be built from there to Swift Rapids.

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 90, a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the monthly meeting in Montreal of the Canadian Society of Civil Engineers on April 9th Mr. L. S. Bruner, of the Canada Cement Company, read a paper, entitled "Concrete Road Construction," and Mr. G. Henry, chief engineer of the Highways Department of Quebec, presented one on "Road Improvement in the Province of Quebec."

Mr. Bruner's was a most interesting address, illustrated by lantern slides showing types of roadway construction and illustrating the use of concrete to good advantage. Among others were views of the King Edward Highway, which, it is planned, will be officially opened during the Canadian and International Good Roads Congress in Montreal, May 18th to 23rd.

Mr. Henry's paper was read by Mr. R. A. Ross. It pointed out that in Quebec there were 45,000 miles of roads, including the mud tracks and trails of the colonists, the latter being little more than navigable and received very little traffic. Next to them were the by-roads, made of graded earth, which for a long time to come would need nothing but grading and draining. These were followed by the class of roads, which required artificial surfacing in order to meet traffic requirements, while the final class was the series of trunk roads or provincial highways connecting with big cities.

Mr. Henry stated that with the widespread system of roads in the province and the enormous amount of work to be done, the cost of improvement would mount so high that the present generation could hardly hope to see much improvement. The best that could be hoped would be for the improvement of the most-needed roads during the next few years. The general idea was that such work as was possible should be done on the ordinary roads, while the highways "de luxe" should either wait their turn or pay for their accommodation.

He warmly recommended the efforts of the Provincial Government to extend the work on highway improvements, especially advocating the straightening out of provincial roads so that a railroad crossing the same distance on either side should be at least 3,000 feet. A rather surprising feature of his address was the fact that the average annual period for such road work in this province was only 100 days, the rest being used up by winter and rainy days. The general conclusion was that the ancient system of statute labor and the "share system" should be dropped in favor of the municipally organized road building system.

Mr. H. H. Vaughn was chairman of the meeting.

"OIL SEEPAGES IN BRITISH COLUMBIA."

This was the subject of an address given recently by Mr. F. J. Crossland to the Vancouver Chamber of Mines. Owing to the desire of the British Government to secure an adequate and well-distributed supply of oil for naval use, the subject is one of great interest in the Province. The well-established oil fields of Mexico and California and the indications that are in evidence northward, have acted as a stimulus to oil investigations in British Columbia. Mr. Crossland stated that it was the intention of the Dominion Government to send a corps of experts to British Columbia this season to conduct exhaustive examinations of the carbonaceous deposits.

TORONTO SECTION A.I.E.E.

The fifth regular meeting of the Toronto Section of the American Institute of Electrical Engineers will be held in the Engineers' Club on Friday evening, April 17th, 1914, at 8.15 p.m. Mr. C. G. Spencer, Mechanical Engineer of the Toronto Power Company, will present a paper, entitled "Standby Steam Stations for Overhead Transmission Systems."

CANADIAN FORESTRY ASSOCIATION.

The officers for the current year of the Canadian Forestry Association are: President, William Power, M.P.; vice-president, F. C. Whitman; secretary, James Lawler, Journal Building, Ottawa.

COMING MEETINGS.

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

AMERICAN HIGHWAYS ASSOCIATION.—**Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.**

AMERICAN PEAT SOCIETY.—**Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.**

AMERICAN SOCIETY FOR TESTING MATERIALS.—**Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.**

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

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.**

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—**Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.**

The American Railway Engineering Association's annual convention was held at Chicago, Ill., March 17-20. The committee reports dealt with included those on rules and organization, signals and interlocking, yards and terminals roadway, wooden bridges and trestles, iron and steel structures, masonry, track, electricity, wood preservation, grading of lumber, water service, buildings, rail, ties, signs, fences and crossings, conservation of natural resources, economics of railway location, uniform general contract forms, records and accounts, and ballast.

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.

21565—March 27—Authorizing G.T.R. to construct siding into premises of Canadian Buffalo Forge Co., Limited, on Lot 18, city of Berlin, Ontario.

21566—April 1—Approving Montreal and Southern Cos. Ry., Co.'s Standard Freight Tariff C.R.C. No. 1; to become effective on April 13th, 1914; said tariff with copy of this Order to be published in at least two consecutive weekly issues of Canada Gazette.

21567—March 31—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal to take additional 25.8 ft., property of Joseph Bissonnette, parish of St. Joseph de Soulanges, Co. of Soulanges, Que., for its transmission line.

21568—April 1—Authorizing Lake Erie and Northern Ry. Co. to construct bridge across Lynn Pond and Lynn River, at Simcoe, Ont.

21569—March 31—Authorizing C.P.R. to construct bridge No. 19.86, on Farnham Subdivision, Eastern Division, across Richelieu Street, town of St. Johns, Que.

21570—March 30—Authorizing C.P.R. to construct spur for International Linseed Oil Co., at Moose Jaw, Sask.

21571—March 30—Authorizing C.N.R. to construct extension of spur, already constructed, to gravel pit, Lot 45, Tp. McIrvine, Rainy River District, Ont., and to cross Government Colonization Road and Rainy River Road in said Lot 45.

21572—March 31—Approving location C.P.R. station in Lot 17, Con. 7, Tp. Mara, Co. Ont., Ont., at Schepler, mileage 51.4, on Port McNicoll Subdivision, Ontario Division.

21573—March 28—Authorizing C.L.O. and W. Ry. (C.P.R.) to take, without consent of owner, certain lands for purpose of affording access to station grounds in town of Oshawa, Ontario.

21574—March 30—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional 28.9 ft. for transmission line, across Lot 142, parish St. Joseph de Soulanges, Co. Soulanges, Que., property of F. X. Menard.

21575—March 30—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional 25ft. for its transmission line, across Lots 309, 310, property of Francois Valade, and Lot 14, property of Mrs. J. A. Lerous, parish of St. Joseph de Soulanges, Co. Soulanges, Quebec.

21576—April 1—Granting leave to Midland Ry. Co., to lay pipes under industrial tracks of C.P.R., lying between Erin and Clifton Streets, city of Winnipeg, Man.

21577—March 31—Approving location and design of G.T.R. proposed new station at Edfrid, Ont.: Provided, whenever traffic on highways is blocked for more than five minutes, at any one time by reason of location hereby approved, Board shall be at liberty to re-locate said station.

21578—March 31—Directing that within 90 days from date of this Order G.T.R. install improved type of automatic bell at first public highway west of South Indian, Station, Ont.

21579—April 1—Relieving G.T.R. from providing further protection at crossing of 2nd highway east of Carlsbad Springs, Ont.

21580—April 2—Authorizing C.P.R. to reconstruct two bridges—namely, No. 24.0, Brockville Subdivision over Irish Creek, near Jaspar, Ont., and No. 2.9, Fredericton Subdivision, over Three Tree Creek, near Fredericton Jct., N.B.

21581—April 2—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional width of 25 ft. across Lots 126 and 123, property of Victor Juillette, and Lot 129, property of Hormisdas Legros, parish St. Ignace du Coteau du Lac.

21582—April 2—Approving location C.P.R. station at Spillimacheen, B.C., mileage 40.93 on Kootenay Central Railway.

21583—April 2—Ordering and Declaring that Bank of Montreal, New Westminster Branch, is authorized and required to pay to G.N.R. or its order sum of $1,222.50 deposited by Delta Shingle Co., Limited, to order of Board under Order No. 18508.

21584—April 3—Authorizing C.P.R. to construct spur for Fernie-Fort Steel Brewing Co., Limited, Fernie, B.C.

21585—April 2—Authorizing C.P.R. to use and operate bridges—namely, Red River Bridge, Winnipeg Terminals; No. 0.41, Fort William Terminals; 131.3, Brandon Subdivision, and 63.3, Lac du Bonnet Subdivision.

21586—April 2—Authorizing C.P.R. to construct spurs (1) for the Manley and Slater Automobile Co., Moose Jaw, Sask., (2) Canadian Standard Automobile and Tractor Co., Limited, Moose Jaw.

21587—April 3—Authorizing T.H. and B. Ry. to construct spurs in city of Hamilton, Ont., for Hamilton Bridge Works, Co., Limited.

21588—April 3—Approving C.N.Q.R. plan showing proposed arrangement of signals at crossing of C.P.R., at L'Epiphanie, Que.

21589—April 3—Authorizing Point aux Trembles Terminal Ry. to construct across Notre Dame Street, east on Island of Montreal, parish of Pointe aux Trembles, Que.

21590—April 3—Suspending C.P.R. Co. Tariff, C.R.C. No. E. 2765, and G.T.R. Tariff C.R.C. No. E. 2896, covering proposed new rules governing milling-in-transit of grain, pending investigation by Board.

21591—April 4—Amending Order No. 21558, March 26, 1914, by striking out the words, "National Steel Car Company, Limited," and substituting therefor the words, "Dominion Power and Transmission Company, Limited."

21592—April 3—Authorizing, upon certain conditions, the Pointe aux Trembles Terminal Ry. Co., to construct its lines and tracks across the lines and tracks of the C.N.Q. Ry., in the parish of Pointe aux Trembles, P.Q.

21593—April 2—Authorizing the G.T.R. to construct certain bridges on its line of railway.

21594—April 2—Requiring G.T.R. to flag all train movements over crossing of Bridge Street, Niagara Falls, Ont.

21595—April 2—Relieving, for the present, the G.T.R. from providing further protection at the crossing of Light Street, Woodstock, Ont.

21596—April 4—Authorizing the Can. Nor. Alta. Ry. to construct its line of railway across and divert the North and South Road Allowance, in Sec. 31, Twp. 54, Rge. 27, W. 4 M., Alta., at mileage 15.0.

21597—April 3—Ordering the C.N.O. and the C.L.O. and W. Rys. to widen out the approaches at Mary Street to 24 ft. and provide protection fences; to widen approaches at James Street to 24 ft., and to construct sidwalk on west side of crossing, in the city of Belleville, Ont.

21598—April 6—Amending Order No. 21457 by striking out the word "Ontario" under the heading "Province" in the operative part of the Order and substituting therefor the word "Quebec."

21599—April 1—Authorizing Cedar Rapids Manufacturing and Power Company to take lands O. Leroux, G. Methot, H. St Denis, and L. Brisbois in the Co. of Soulanges, Que.

21600—April 6—Authorizing the C.P.R. to construct a branch line for M. M. Cummings, Westboro, Ont.

21601—April 6—Authorizing C.P.R. to construct road diversion in Con. 16, Twp. 2, Rge. 15, W. P. M., Man., by grade crossing.

21602—April 6—Authorizing C.N.O.R. to cross Davenport Road, Toronto, by means of structure carrying highway over the railway.

21603—April 6—Authorizing C.N.O.R. to cross St. Clair and Prescott Avenues, Toronto, by means of structure carrying the highways over the railway.