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# THE CANADIAN ENGINEER

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JULY—DECEMBER 1912

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# The Canadian Engineer

An Engineering Weekly


## DESCRIPTION OF REINFORCED CONCRETE ARCH OVER CURRENT RIVER, CITY OF PORT ARTHUR, ONTARIO.

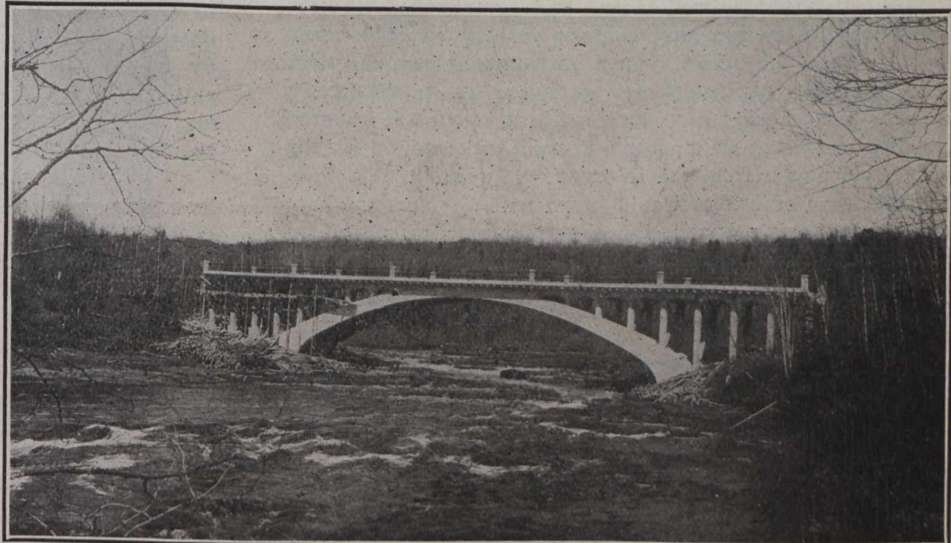
By L M. JONES, A.M. CAN. SOC. C.E., City Engineer.

The bridge to be described is situated on the line of the Black Bay Road, where it crosses Current River. This road is a government highway, and was constructed and used during the time of the construction of the Canadian Pacific Railway for hauling supplies.

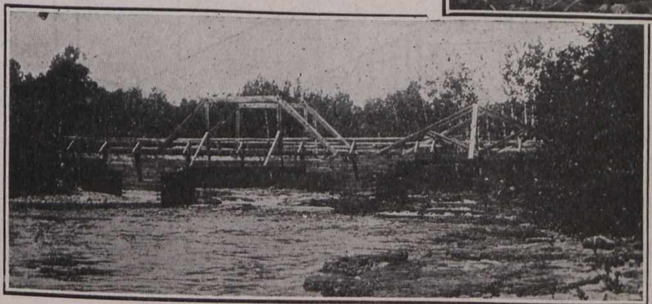
The waters of Current River have been developed by the city of Port Arthur for the generating of power which is being used in the operation of its various public utilities. In connection with the development of this river there have been a number of dams constructed for the purpose of storing water and the proper regulating of the flow of the river.

On the night of May 27th, 1908, the dam at the reservoir, known as Paquette, broke away, the water carrying everything in its path, and among the structures carried away was the bridge over the river at the Black Bay Road.

The rebuilding of this bridge was delayed for some time, and a temporary crossing to the northerly side of the river was constructed about a mile down the stream, which served the purpose until the Cumberland Street bridges, previously described, were completed.



View Showing the Completed Structure.



View of Old Bridge Carried Away by Flood.

As stated before, the Black Bay Road is a government road, and the city council of Port Arthur felt that a request should be made to the government for some financial aid in the rebuilding of the bridge, the type of bridge to be more permanent than the one which was destroyed by the flood. Consequently, plans were prepared which, together with a water color sketch of the proposed bridge and surroundings, were sent to the Honorable Minister of Public Works, with the result that the city received a grant of $5,000 towards the erection of the new bridge.

**General.**—The character of the river banks at the location of the bridge were admirably suited to an arch of long span, the banks being composed of solid rock, which, while being a little seamy and soft at the surface, proved to be good, solid trap rock a few feet down.

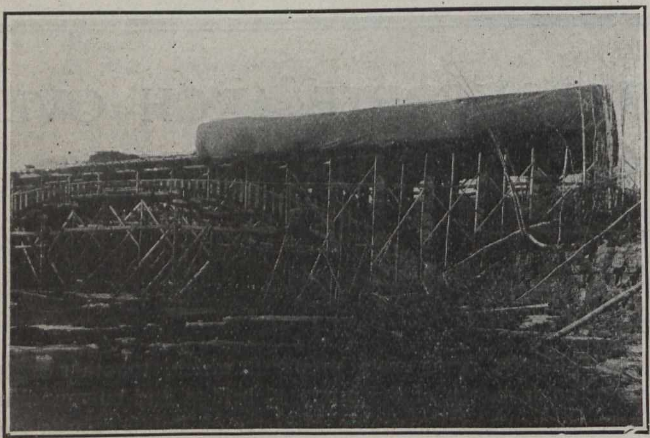
As will be seen from the sketches, the elevation of the old bridge was considerably lower than that adopted for the new one. Some opposition was met with in this connection, it being feared that the bridge was too high, but as this was a proposed route for future street car traffic, and the grades of the approaches being quite satisfactory for such traffic, the opposition was overcome, and now all are highly pleased with the results.

The type of bridge selected is a two-rib, reinforced concrete arch of one hundred and thirty foot clear span. The deck is supported upon reinforced concrete columns twenty inches square; the deck extending approximately thirty feet beyond the back of the abutment on each side of the river. This extension was designed beyond the back of the abutment so that the toe of the embankment would be well away from the action of the water. It also permits the use of a lighter structure, as there is no earth fill to add weight to the dead load.

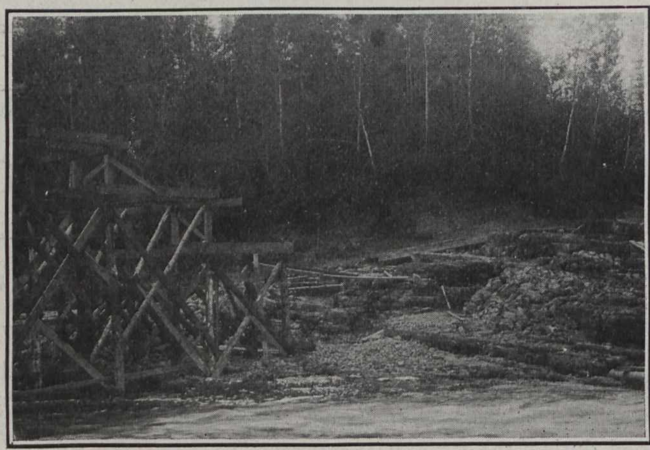
Built in this manner, there would be no need of rip rapping the slopes, and the necessity of wing-walls and retaining walls, which, at their best are unsightly, was obviated. This type of construction also adds to the graceful appearance of the structure, and its cost, as compared with the fill required to replace it, rip rapping, and wing-walls is not much greater. It might be well to add that about an eighth of a mile down stream from the bridge is an artificial lake, while upstream from the bridge, just a few hundred feet, the river turns practically ninety degrees northward, the farthest bank from the bridge being a tree-covered bluff about one hundred and fifty feet high, which forms a good back ground for the bridge, viewing it from the reservoir. It was felt, therefore, that this type of bridge would blend with the surroundings better than having spandrel walls, wing-walls, etc., for retaining the embankment.

The intrados and extrados were both designed as parabolic curves, the intrados being connected at the abutment to a curve of twelve-foot radius. The height from the springing line or arch to intrados is twenty feet, the distance between intrados and extrados at the crown being three feet six inches, and at the abutment six feet. Between each rib, at the base of the columns, struts and diagonal braces are constructed, also between columns near abutments. Between the ribs at the abutment a curtain wall was constructed connecting the ribs, which served as a strut and improved the appearance of the abutments from the river side.

The deck of the bridge is made of the beam and slab type, the slab being six inches in thickness. The deck was three inches higher at the centre of the bridge than at the ends, this being done to afford proper drainage of water to the outlets located at various points. The effect of this difference in height is not noticeable to the eye.



**View Showing Covering for Finishing Walks and Surfaces During Cold Weather.**

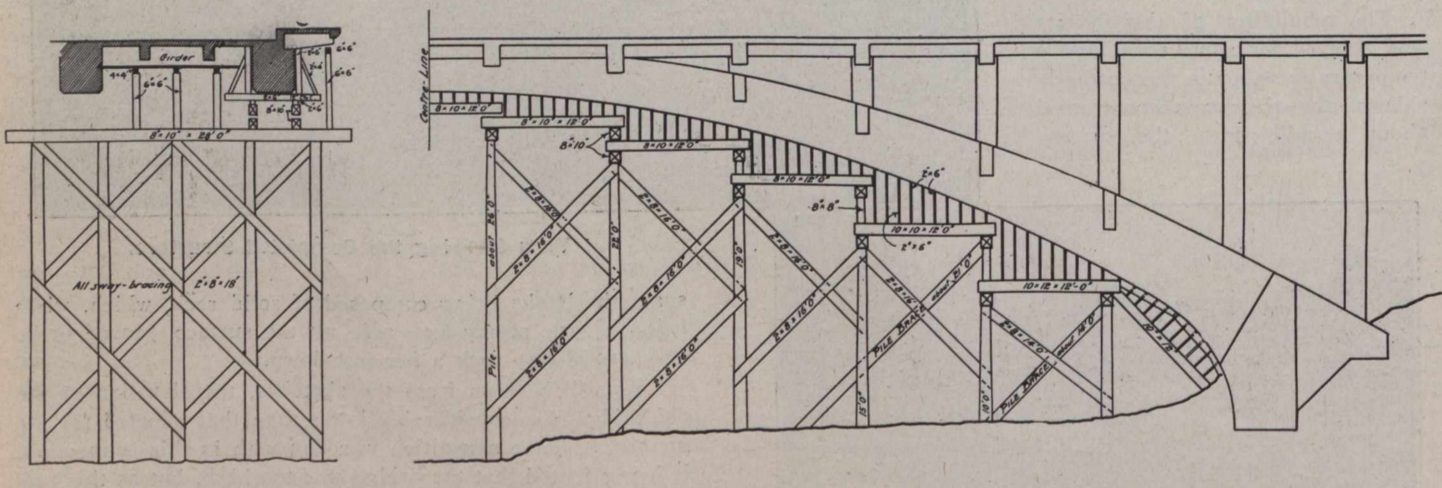


**View Showing Formation of Rock Foundations.**

The sidewalks, which are five feet wide, are supported by cantilever beams from the columns and ribs. It will be observed that in order to obtain sufficient concrete section for the cantilevers, without allowing beams to go below the extrados of the arch, the connection between slab and curb was designed with a fillet, built in monolith, at the intersection.

The width of the bridge between curbs is sixteen feet. This does not give sufficient room for car and vehicular traffic at the same time, but as neither traffic of this kind will be heavy for the present, the width will be fully adequate for the conditions. However, when the traffic has grown to such an extent that a wider bridge will be necessary, the intention is to take off one of the sidewalks and add other ribs, thus making the roadway double the present width. From outside to outside of sidewalks the width is 26 ft. 0 in.

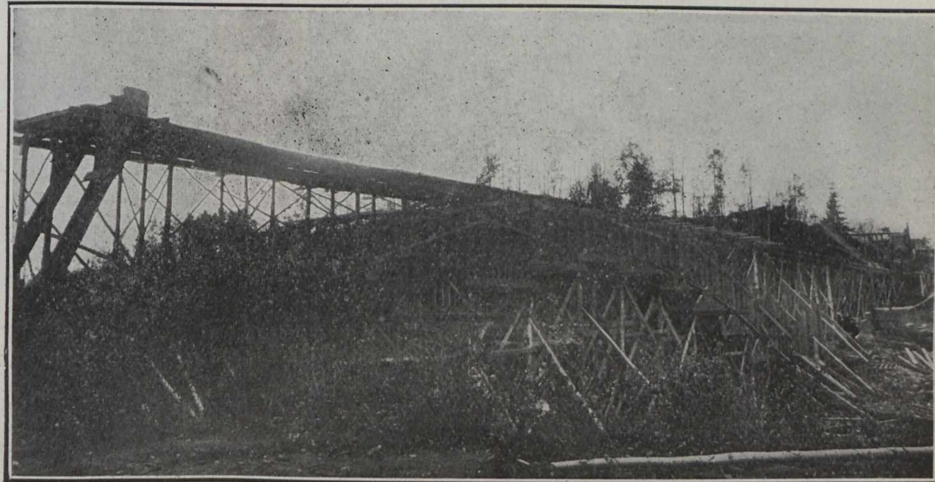
The railing consists of a two and one-half inch pipe, and over every fourth column a concrete pier is placed into which the pipe is inserted in a loose joint.



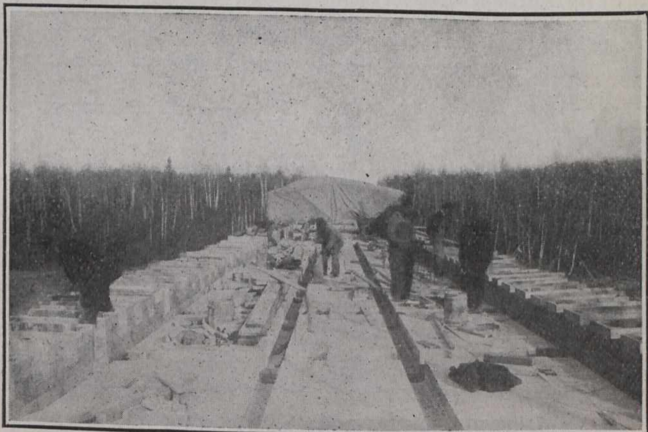

**Sketch Showing Details of Falsework.**

The difference in elevation of the river banks at the approximate ground level is about twenty-four feet. The natural approach to the bridge on the southerly end is very steep, so that it was necessary to make an excavation of considerable extent to secure a five per cent. grade descending to the bridge The material, however, was necessary to make the fill on the northerly end of the bridge. The roadway descends on a two per cent. grade from the bridge on this end.

Owing to delays in the passing of the necessary money by-laws, etc., the commencement of the work was put off until late in the season. The grant of $5,000 which the government had made towards the construction of the bridge was included in the estimates for 1911, so that when everything was considered it was thought best to build the bridge in the same year. The contract was let on August 25th, and work commenced three days later; the bridge proper was completed on November 10th.



**View Showing Arrangement of Plant and Runways.**



**View Showing Deck Forms Ready for Concrete.**

Upon enquiring, I understand that this arch, at the time of its completion, was the longest span of its type in Canada.

**Design.**—In the design of the bridge the calculations were based upon the following:

Ratio of modulus of elasticity of steel to that of concrete, 15.

Allowable working stress of steel in tension = 16,000 lbs. per square inch.

Allowable working stress for concrete:

(1) The extreme fibre, 750 pounds per sq. in.
(2) Direct compression, 600 pounds per sq. in.
(3) Shear, 50 pounds per sq. in.

The loads figured on were:

Live load, a thirty-ton street car, and an additional live load of 100 pounds per square foot, and a fill of gravel of approximately fourteen inches; impace figured at 50 per cent. of the live load.

**Cement.**—The cement used in the construction of the bridge was "Sun" brand Canadian Portland cement, tested to meet the requirements of the Canadian Society of Civil Engineers' specifications.

**Sand.**—The sand used was ordinary bank sand, coarse grained and sharp, containing a very small percentage of loam.

**Gravel.**—Gravel was used in place of crushed rock, owing to the difficulty of obtaining the latter. The gravel used was lake shore gravel, similar to that previously described, ranging in size from that of a pea to one which will pass through a one-inch ring.

**Concrete.**—The concrete was all machine-mixed in the proportions of the above material as follows:

Abutments next to rock, 1:2:4; in mass, 1:3:5; ribs and struts, 1:2:4; columns, beams and slabs, 1:1½:3.

A wet mixture was used, being well spaded and worked at faces of forms, so that when the forms were removed the surface finish had scarcely a scar upon it.

In the view will be seen the arrangement of the mixing plant. All the material was delivered on the bluff and the mixer was set below, so that the charging of same was made particularly easy. A long runway was constructed, as shown, and the concrete deposited in place by means of a chute.

**Reinforcing Steel.**—The steel used in the construction is the "Kahn" system of reinforcing, furnished by the Trussed Concrete Steel Company, of Walkerville, and was purchased direct by the city and delivered f.o.b., the site of works.

**View Showing Forms for Ribs Ready to Put Forms for Slides in Place.**

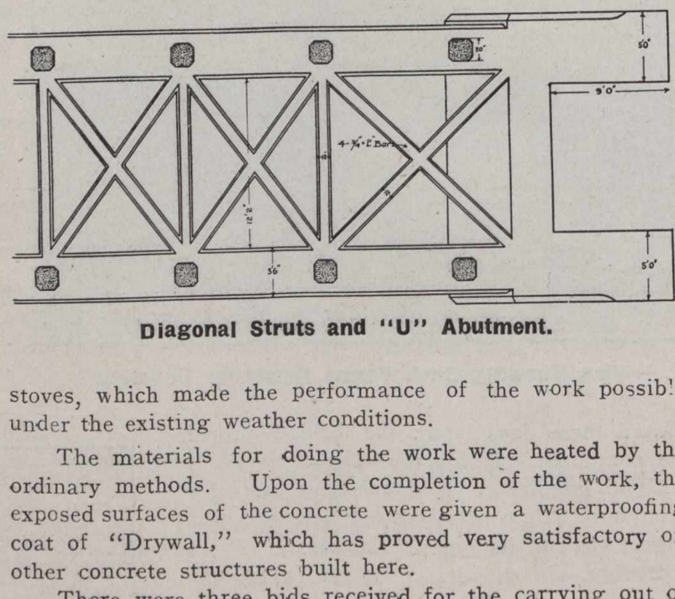
**Construction.**—After the necessary rock was removed for the foundations, the falsework for supporting the ribs was commenced. The sketch shows the manner of arrangement of supports and formwork. The upright posts were taken out of the woods a quarter of a mile from the site of the works, and served the purpose equally as well as squared timber. After the concrete in ribs was poured it was found gradually, as the work of pouring the ribs proceeded, the framework settled back to its original location.

The centres under the ribs were not removed for thirty-nine days after the pouring of the concrete. Observations

**Under Side of Ribs and Deck.**

**View Showing Formwork of Ribs and General Surroundings.**

taken before and after their removal revealed no settlement in the bridge whatever. The forms were taken off the ribs entirely at the same time, but owing to the lateness of the season and the cold weather the forms on the columns and deck were left on all winter. It will be interesting to note that most of the surfaced finishing of sidewalks, curbs, concrete posts, etc., was done under canvas, as shown in the view. This arrangement was heated with two or three



**Diagonal Struts and "U" Abutment.**

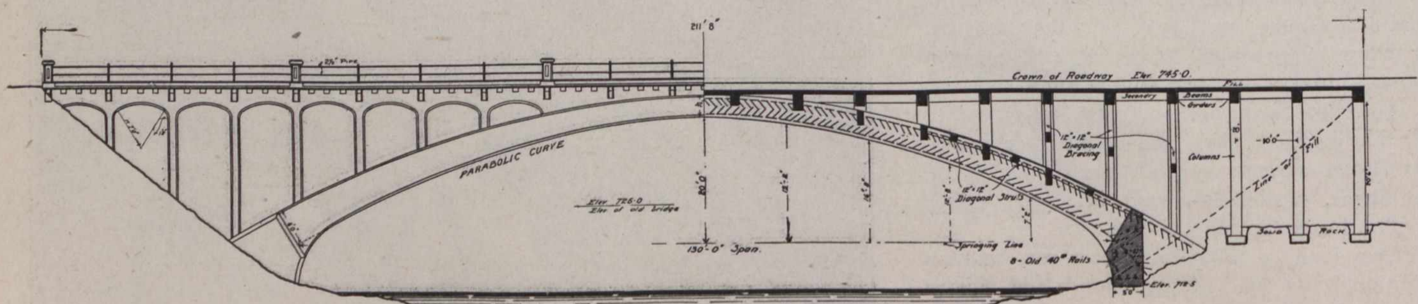
that the settlement in the forms at the crown of the ribs was two-hundredths of a foot. When the ribs and column footings were constructed the form work for the columns and deck were commenced, and no further concrete work was done until the forms were completed.

In the construction of the ribs the concrete in the abutments of each rib was brought up to the chamfer and there squared off at right angles to the thrust line. Then the construction of the balance of the ribs was commenced from the same end of the two ribs, also struts and diagonals being brought up at the same time for a distance of fifteen feet along the ribs, then the same amount of work was performed on the other end. When these two first sections were completed an uplift was noticed in the forms at the crown of about eighteen-hundredths of a foot. It was feared that this

stoves, which made the performance of the work possible under the existing weather conditions.

The materials for doing the work were heated by the ordinary methods. Upon the completion of the work, the exposed surfaces of the concrete were given a waterproofing coat of "Drywall," which has proved very satisfactory on other concrete structures built here.

There were three bids received for the carrying out of




HALF ELEVATION HALF-LONGITUDINAL SECTION

**Half Elevation and Half Longitudinal Section of Bridge.**

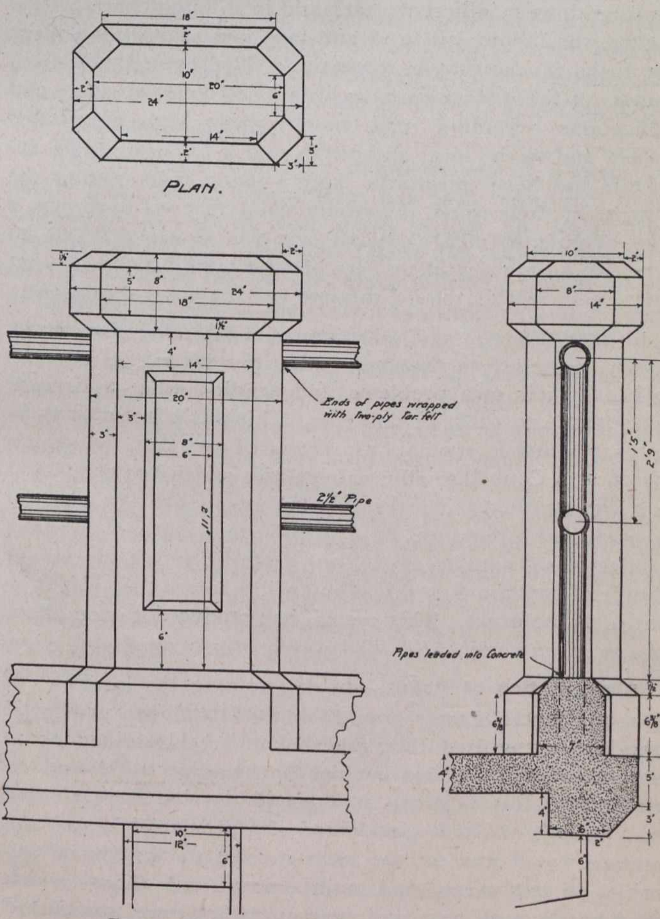
would increase, and if it became worse it was decided that the portion of the ribs at the crown would be built to counterbalance the weight at the haunches. However, this was not necessary, as no further movement occurred, and

the work; the successful tenderers being Messrs. Seaman and Penniman, of Fort William. This firm has a wide practice in this district, and deserve to be complimented upon the successful manner in which they carried out the construction. Also, for completing the work in the short time given them.

**Costs.**

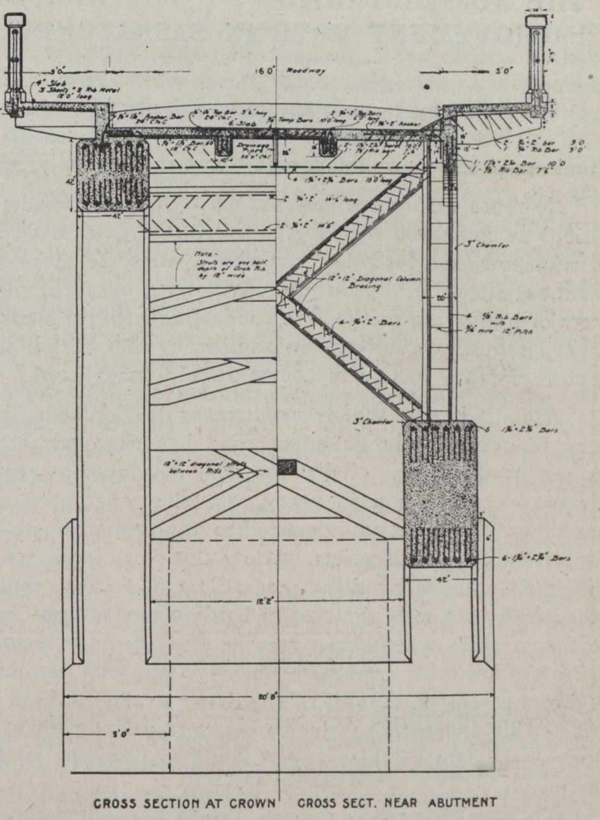
| | | |
|---|---|---|
| Lump sum price, as per tender | | $11,000.00 |
| Concrete in diagonal members, not included in original plan | 16.5 cu. yds. | |
| Changing thickness of floor from 4 in. to 6 in. | 23.0 cu. yds. | |
| Additional length of the columns | 10.4 cu. yds. | |
| | 49.9 cu. yds. | |
| 49.9 cu. yds. at $19 | | 948.10 |
| Additional concrete in the abutments, 48.0 cu. yds. at $11.50 | | 552.00 |
| | | $12,500.10 |
| Reinforced steel | | 2,220.00 |
| Freight and cartage on steel | | 235.37 |
| Engineering | | 147.04 |
| Advertising | | 225.30 |
| Sundries | | 56.72 |
| | | $15,484.53 |

The above does not include the embankment.




**Hand Rail Post Details.**

The design and supervision of construction of the bridge was carried out by the city engineer's department, Mr. E. Elliott Henderson, assistant city engineer, preparing plans of the design, with the assistance of Mr. N. V. Wrigley. Mr. Wrigley was also inspector on the construction, and for the successful carrying out of the work they deserve a great deal of the credit.




**Sections Through Bridge at Crown and Near Abutments.**

## THE NEW CANADIAN PACIFIC RAILWAY HOTEL IN VANCOUVER.

Contracts have been awarded for the erection of the new C.P.R. hotel in Vancouver. The work is complicated by the fact that the hotel will be erected on the site of the present building, the business of which will be carried on throughout the operations. The old building will be underpinned, and the excavations for the foundations, as well as the foundations themselves, will be completed before the actual work of demolition of the superstructure is commenced. As soon as the foundations are finished, the construction of the wing next to Opera House Lane will be rushed. This will be used in conjunction with the old building for hotel business, and as soon as the ground floor of the main wing is finished, it will be covered with a temporary roof and used. Then the old building will be torn down.

The main block will be of ten stories, and provision is made for extending the building to fifteen or sixteen stories, the matter now being the subject of negotiations with the civic authorities. The building is to be fitted up in the most sumptuous style. For instance, in the ladies' loggia on the Georgia Street side, prominent artists will be set to work to paint the walls in the Italian Renaissance style. The dining-room is planned to be the finest on the continent no less—and there will be a concert room having a seating capacity of 600, which may be used for a ballroom. On Granville Street there will be six first-class merchant shops, and a bar one hundred feet long. There will be 600 rooms in the building when it is of six stories, and 900 when it is completed to its full height of 16 stories. The main wing and power plant, for which the contract has now been awarded, will cost $1,500,000.

## THE ADMINISTRATION OF THE HIGHWAY IMPROVEMENT VOTE IN SASKATCHEWAN.

The following is an abstract of a bulletin issued by Mr. A. J. McPherson, the Chairman of the Board of Highway Commissioners of Saskatchewan.

No more distinctive features serves to mark modern conditions as compared with the past than the great development in transportation facilities. Immense sums are spent in railroad building and the highest skill employed in devising ways of improving methods in connection with railroads. The same applies to water transportation, so that within the last centry distance has been comparatively annihilated.

While it is true that transportation development has been very far-reaching in its effects and has changed the whole character of modern civilization, the development regarding highway construction in many countries where this change has taken place has not advanced to any proportionate extent, especially in rural districts. While the cost of transportation has been reduced by these modern methods to a very small amount per ton mile the cost of hauling agricultural products to the markets which have now become the towns along the railroad lines, still remains about 25 to 30 cents per ton mile. A direct saving in cost of this delivery to the markets can be effected by constructing good roads and under present conditions every cent of this saving would go into the pockets of the people.

It may be said that farmers would not gain anything by a quicker delivery to market and that they will make but a definite number of trips per day in any case and that they have to have the necessary horses for farm work so that they would not save anything by improving the roads. This is not the case, however, as farming in these days has become as systematic as any other line of business and successful farmers make every effort count the same as other successful men. Anything that will reduce the effort required to produce results such as the improvement of roads to market means an advantage in making a success of the business.

It is only a question of how much traffic exists or will be created on any road to determine the expenditure that would be warranted in improving it.

Land values adjoining are increased by the construction of good roads, land being of little intrinsic value unless the products therefrom can be transported to market in an economical manner. It is only necessary to examine the drop in land values as the distance from markets increases to realize that anything that will make them more accessible will increase the value of land. In many sections, at certain times of the year, the condition of the roads prohibits leaving the farm and the people on the farms through this lose interest in current events, become dissatisfied and are not in a position to carry on their business with an enthusiasm which is necessary to make a success of it. Bad roads react in this way so as to affect all departments of country life and improving the roads so that people can get about at all times readily indirectly raises the standard of living all along the line.

**General Policy.**—During the interval from 1905 to date the Department of Public Works has spent annually on the improvement and maintenance of roads and on the construction of bridges, amounts varying from $200,000 to $700,000 and much good work was done in opening up the country and giving ready access for the settlers to their natural markets.

Systems for the administration of these funds have been tried and a system gradually evolved which seems to be most consistent with conditions as they exist throughout the country.

In 1906 when it was decided to carry out an improvement in some certain locality one of the local residents who was known to have ability in that kind of work was appointed to organize the local labor and do the work. The result of this system was that the improvement of roads was always considered a secondary matter and the work was attended to or not, depending on whether the appointee found time to undertake it after attending to his own business and as a result, in many cases the work was not done or the money was spent at a season of the year when the most value could not be obtained for the amount expended.

In 1907 the system of administering the vote was changed with the idea of overcoming the defects observable during 1906. Instead of local men being appointed the best men that could be selected from the list of foremen employed in 1906 were appointed as road foremen to act during the full season and to go around from place to place where it was decided to make improvements, organize the local labor and see that the work was properly done. A great improvement was noticed under this system as the season advanced. These foremen rapidly became expert at laying out the work and directing how it should be done, wasted less in misdirected efforts and the quality and style of the work throughout the province became more uniform.

The same policy with slight modifications to meet changing conditions in different years and in different parts of the country was followed in 1908 and 1909 and regarding a large part of the expenditure on roads up to the present time. Conferences of these foremen have been held, many manuals and publications regarding road matters have been distributed to them and to the local authorities and a force of skilful inspectors has been constantly kept visiting them during the progress of their work, the result being that we have now a large number of men scattered over the province in all its parts who have an excellent idea of road building and of what is necessary in this regard to meet varying local conditions.

In 1910 this policy of education was extended more direcly than heretofore to the local authorities by asking them to work out their own problems and sending what assistance was possible to them in doing so. This was effected by making grants under regulations approved by the Lieutenant Governor in Council to all municipalities which had completed their organization under the Rural Municipality Act whereby the work had to conform to a certain standard and they had to collect certain information, thus ensuring a certain amount of study of conditions in the municipality before they would be entitled to the grant. This system has produced a good effect and has given satisfaction where properly worked out.

**Classification of Roads.**—In determining the location of the roads where grants would be warranted the provincial authorities recognized that roads should be classified as to their importance. Those having the heaviest traffic and on which traffic from a large area would develop were classed as main roads and were considered of a provincial nature and therefore would warrant the assistance of the provincial authorities in improving and maintaining, and those which served but a small area and sparse traffic were considered local and should therefore be attended to by the local authorities.

In a new country such as Saskatchewan and where development has taken place so rapidly many improvements are urgently required which are so large as to be beyond the means of the local authorities even when located on purely local roads. Nearly all bridges of any size, long grades across marshes and sloughs, side hill roads across ravines, etc., come in this class and the provincial authorities could not but recognize that if these much needed works were to receive attention that it must be from provincial funds. As a result practically all bridges of 20-ft. span and over and many culverts and small bridges have been constructed by the provincial government and in most cases the maintenance has also devolved on the provincial authorities.

**Capital and Current Expenditure.**—A large number of bridges deemed advisable to construct as steel bridges on concrete foundations or of reinforced concrete have been treated as permanent structures and paid for out of capital but all the road work and the majority of the bridge work has up to the present been met from the current revenue of the province. Many of these improvements are an undoubted permanent asset to the province and should be considered as capital and treated accordingly, while a great deal of work such as grading, minor improvements in filling holes, maintenance of bridges, etc., the result of which will disappear in a few years should properly be met from the current revenue.

It has been brought to the attention of the government from various sources that there is a necessity of a more rapid development regarding works which are of a more purely capital nature, and with this object in view provision has been made by legislation for meeting the cost of these improvements to the extent of $5,000,000 and it is the intention to proceed as fast as is considered advisable consistent with economy, efficiency and the resources available in the way of labor and equipment, with the prosecution of the work. This will be additional to the ordinary expenditures undertaken as in the past, but the latter will be made to cover works of a more purely maintenance character with the tendency constantly existent to spend the money in such a way as to produce permanent results.

The principle of making improvements of a permanent nature from capital expenditures has been recognized by the Legislature as regards local affairs in that The Rural Municipality Act and the Cities and Towns Act, which serve as the charters of these institutions, make provision for the issuing of debentures to cover the cost of improvements of a similar nature to be repaid within the life of the improvements.

The policy of enlisting the interest and co-operation of the local authorities in various ways and the distribution of the expenditure in accordance with principles as already outlined regarding works of a provincial nature, main roads, large bridges, etc., will be followed.

A larger sum will be available for the construction of permanent bridges and the usual vote will be supplemented by an amount sufficient to ensure that when advisable they will be constructed of steel, concrete and reinforced concrete instead of wooden structures which have a life of seven or eight years at most before they become of questionable strength.

**Road Laws and Administration.**—The laws relating to the construction and maintenance of public roads vary in different countries, each system being the outgrowth of many conditions peculiar to each country. Road building must vary to suit climate, physical conditions, density of population, character of traffic, etc.

When the construction of steam railways became common throughout civilization, attention was somewhat diverted from the building of common roads, but in recent years in all the most advanced countries the question of pubilc roads is receiving a great deal of attention and large sums are being expended theron.

A study of the laws and the methods of administration in the countries that are most noted for their progressive ideas on road building will show that some features are common to all, and it would almost seem that success need not be looked for unless those features receive attention.

A study of methods as adopted by progressive countries shows that it is hopeless to expect good road systems by depending on local municipal efforts. Roads are usually classified according to their importance and money is raised somewhat proportionate to the interest of the various authorities, state, provincial or local. Local authorities while having an interest in all the roads are not expected to meet the cost of constructing and maintaining important roads on which the traffic cannot be considered local and which therefore require proportionately heavier expenditure to keep in first class shape. A special effort and heavy expenditure is necessary to construct main roads and thereafter constant attention must be given to maintain them. In some cases men are constantly employed and devote their whole attention to the care and maintenance of main roads. In other cases the state or provincial authorities interest themselves in the construction while the maintenance is attended to by the local authorities. It has been shown to be folly to go to great expense in constructing good roads and then through neglect to allow them to get in bad repair. It is absolutely necessary that roads should receive almost constant attention after construction to keep them in first class shape, this being a case where "a stitch in time saves nine," without a doubt. The local authorities are in a better position to give this constant attention than the provincial authorities, being constantly on the ground, as it were, and they should recognize that this duty devolves on them.

Most countries where successful road systems have been built up maintain a central bureau for the collection and distribution of information, conducting experiments and generally acting in the advisory capacity regarding all phases of road work. Highway development in Saskatchewan has evolved naturally in accord with many of the principles outlined above and the present step being taken to provide for the construction of important improvements under capital account is entirely in accord with successful methods adopted elsewhere. These principles will be taken into consideration in the administration of any funds available for road improvement and methods worked out as seem best to suit the merits of the varying conditions throughout the province.

**Class of Roads to be Built.**—Up to the present there are very few places in the province where anything more than improvements to make the best possible earth road are undertaken and it is only where gravel is easily available that short stretches of gravelled road have been constructed. In some of the older towns their main streets are gravelled and are kept in very good condition, but as far as the country roads are concerned almost without exception they are simply earth roads.

There are many places throughout the province where the country has developed to a high degree and where in order to be consistent with conditions some better form of road than an earth road is wanted.

Settlement in other places has taken place rapidly, with the result that the necessary attention to the roads has not been possible and many obstructions exist and long stretches of almost or at times impassable roads prevent ready access to markets. The standard of road to be aimed at must necessarily, therefore, vary for different localities, but it is exceedingly advisable that as high a standard as possible should be set. In some localities gravel and broken stone roads should be constructed, while in others the removal or overcoming of obstructions and the construction of the best earth road possible is immediately advisable with the possibility of a better grade of construction in the near future kept constantly in vi w.

**Co-operation of Municipalities.**—In order to ensure that the necessary consideration be given the subject the Legislature has made provision in The Highway Improvement Act—a copy of which is appended—for the appointment of a Board of Highway Commissioners whose duty it will be to deal with the merits of the cases as they arise. It is very necessary to ensure success that the local authorities co-operate with the board in carrying out the work in accordance with the general policy above outlined. The classification of roads and the development of the system, the standard of construction and the attainment of that standard as the work proceeds, depends to a great extent on the consideration that will be given by them.

During 1910 and 1911 many of the rural municipalities have taken into consideration the roads throughout their districts that should be considered as main roads and as such entitled to have the expenditure of provincial funds in their construction and plans have been prepared showing the roads that have been decided on in this way. Municipalities will be asked to give further consideration to this matter with the object of building up complete systems of main roads through the extension of those already undertaken and the addition of connecting roads from municipality to municipality.

Municipalities should consult with adjoining municipalities as to the most advisable main roads to improve to become part of a road system that will serve the territory and the board will give every consideration to the findings of such deliberations when placed before them. Proper methods of carrying on the work will have to be evolved and such methods decided on as seem to best suit the circumstances and the local authorities can give valuable information in this regard.

What should be decided on is the most efficient and economical method and the one that will be most certain of producing desired results.

Of the latter sum a part will be used to construct permanent concrete and steel bridges, thus supplementing the vote made otherwise for this purpose during each of the last few years.

The foregoing will be sufficient to give an idea of the situation as it exists at present and an outline of the policy regarding improvements.

A short review of the matter under consideration may be set out as follows:

The government is pledged to spend $5,000,000, $1,500,000 of which it is proposed to spend in 1912.

This will be spent on improvements as follows:

1. Main roads to be decided after consultation with municipalities.

2. Main roads out of organized districts.

3. Large works such as bridges, heavy fills, side hill grades, etc., beyond the means of local authorities although not on the main roads.

The methods of carrying out the work may be classified as follows:—

1.—**Road Improvements.**—As grants to municipalities. By Highway Commission day labor. By contracts from municipalities. By contracts from the Highway Commission.

2. **Bridges.**—By contract. By Highway Commission day labor.

In addition to this the Highway Commission will investigate methods of improvement that may seem to offer a solution for peculiar difficulties and will distribute information to those interested that will tend to raise the standard of the work. It will be in a position to give advice wherever needed and will send an expert if required to any place in the province to assist in solving the problems of the local authorities.

It is confidently hoped by the foregoing methods and by enlisting the sympathy and co-operation of those interested in the work that the standard of highway work throughout the province will be raised to meet the necessities of the situation and that in a few years we can say that any person can go from any one place to any other place at all times throughout the year without the difficulty that will be encountered now and on a road that is suitable for the purpose.

## FLOOR AREA UNIT AS A BASIS FOR ESTIMATING WATER CONSUMPTION.*

By William W. Brush.†

In 1908 the writer was placed in charge of the general design of the delivery system to carry to the five boroughs of Greater New York the 500,000,000 gallons per day which would eventually be available from the Catskill watersheds, this work being carried on by the Board of Water Supply. Studies in connection with the design of this system required a determination of the existing consumption in each borough, and in sub-divisions of each borough, as well as an estimate of probable future growth in consumption.

It was found that the measurements of flow that had been made were not sufficient in extent to give a fair basis for estimating the present consumption in the various sections of the city, and that a per capita basis for consumption was practically useless for this purpose for the borough of Manhattan, due to the fact that large areas are wholly devoted to office buildings, manufacturing and other business purposes; and also due to the rapid changes going on in the elimination of buildings previously used for residences and the substitution of office buildings, lofts and factories.

While the water consumption of both large and small communities is generally expressed as the average amount supplied "per capita," this unit is used more on account of its convenience than for its usefulness as a basis for comparison of consumption in different towns and cities. In examinations made of the per capita consumption in different sections of large cities, variations of several hundred per cent. have been shown. The highest consumption is generally found in the highest class apartment houses, and the lowest consumption in the lowest class of tenements.

To carry out the work required to satisfy factory design the Catskill delivery system some unit of consumption was necessary that did not vary to the extent of the per capita unit and that could be applied to business as well as residential sections. An investigation of the available data on which to estimate future as well as present consumption showed that the area occupied by buildings would be the fundamental basis for future consumption, especially in the borough of Manhattan, and that, other things being equal, the amount of water used in any buildings would be dependent upon the ground area covered and the number of stories in height. It was, therefore, decided to study the use of the floor area unit as a basis for estimating consumption. The floor area was to be determined by multiplying the ground area of a building by the number of stories, allowing one additional story for basement or cellar. One thousand square feet of floor area was found to be a convenient unit and one that would give a resultant consumption averaging about three times that figured on a per capita basis.

To determine the present use of water per unit of floor area, typical buildings were selected in which the supply was measured by meters, and the resultant consumption determined. There were also available measurements of various districts in Manhattan, Brooklyn and the Bronx, which were made by use of the pitometer during waste investigations carried on in 1902-03. Table I. gives the results of these measurements, as well as those taken in 1911. A reduction in consumption in 1911 of about 15 per cent.

* Abstract of paper read before American Waterworks Association at thirty-second annual convention, Louisville, Ky., June 3-8, 1912.

† Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, New York City.

was effected by house to house inspection, while in 1902 no work had been done on water waste.

**Table I.—Water Consumption in Various Districts of New York.**

| No. of District. | Characteristics of Occupancy. | Consumption M. G. D. | Population Resident. | Consumption Per Capita. |
|---|---|---|---|---|
| | Gaugings, 1902-03. | | | |
| 1 | Large hotels, high-class residences | 1.87 | 8,396 | 223 |
| 2 | East side tenements | 1.44 | 38,906 | 37 |
| 3 | East side tenements | 5.40 | 90,000 | 60 |
| 6 | Residence and high-class apartments | 0.76 | 10,164 | 75 |
| 8 | Business, office buildings, waterfront, shipping | 9.45 | 11,000 | 860 |
| 9 | First-class apartments and hotels | 1.37 | 8,872 | 154 |
| 10* | East side tenements, some waterfront | 20.20 | 218,023 | 93* |
| 11 | Uptown residences and medium class apartments | 4.89 | 4,380 | 112 |
| 12 | Upper east side tenements, waterfront, power houses and breweries | 2.75 | 39,969 | 69 |
| | Gaugings, 1911. | | | |
| 1a | East side tenements, some waterfront (same as District No. 10) | 11.44 | 230,500 | 50 |
| 2a | All classes | 29.48 | 204,557 | 144 |
| 3a | High-class apartments and residences | 22.18 | 186,990 | 118 |
| 4a | High-class apartments, residences and tenements | 12.74 | 138,800 | 92 |
| 5a | East side tenements, and waterfront | 8.28 | 84,580 | 98 |
| 6a | High-class apartments, residences, tenements and waterfront | 14.82 | 173,000 | 86 |
| 7a | All classes | 13.38 | 169,100 | 79 |
| 8a | All classes | 13.66 | 209,393 | 65 |

* An error was later discovered in the measurement of flow in this district, which reduced the consumption as given by about 50 per cent.

With a variation in the per capita consumption of from 37 to 860 gallons daily, it was evident that it would be difficult to apply a per capita basis to different sections of the city to determine the consumption in such sections.

It was found upon examination that with the exception of those buildings where the consumption of water would be unusually high, such as hotels, laundries, ice plants, etc., the use of water per thousand square feet of floor area was from 150 to 300 gallons per day. This covered only those buildings used for business purposes, as under the rules of the Water Department, meters are not required in buildings used for residences. It was anticipated that apartments of the higher class would show a somewhat larger use of water per unit of floor area than would the tenement class, and that both would show a larger use than private residences.

The first computations made of consumption in districts which covered several blocks, included a high-class apartment house and hotel section in the vicinity of 80th Street, on the west side, and a low-class tenement section on the east side in the vicinity of 80th Street. The per capita consumption in these two districts was 154 gallons per day and 37 gallons per day, respectively, the high-class apartment district therefore showing a consumption, on per capita basis, of over 400 per cent. of that shown for the tenement house district. On the floor area basis, the figures for these two districts were 181 and 179 gallons per day per 1,000 sq. ft. respectively, or a variation of less than 2 per cent. between the two districts. While this close agreement in consumption for the two districts was a coincidence, it strikingly illustrates the uniformity obtained from the floor area basis as compared with the per capita basis in two residential districts where the character of population varied widely. As further studies showed the floor area basis to be a practical one, it was applied generally to the borough of Manhattan. The ground area was scaled from the atlas, and this area multiplied by the number of stories, the buildings being grouped as far as possible to reduce the labor. After the entire area of the borough of Manhattan had been determined the average consumption was computed and proved to be about 300 gallons per 1,000 sq. ft.

To determine the prospective use of water in the borough of Manhattan, the area available for building was determined, eliminating street and park areas, and the borough was divided into four groups, the average height of buildings and percentage of ground area to be built upon in each group being estimated. The future consumption per 1,000 sq. ft. of floor area was taken as 350 gallons for that section of the city below 59th Street, to provide a margin of safety in the estimates.

The experience of the past three years has shown that the floor area basis is useful also in the following work: (1) To determine what is the reasonable consumption in districts which are being surveyed by use of the pitometer, thus determining whether further investigations to detect leakage are advisable; (2) to determine consumption in individual blocks or groups of several blocks, where it is proposed to extend high service to cover districts previously supplied from low service; (3) to determine whether metered consumption indicated for large buildings is probably correct, where question has risen as to the presence of illegal connections; (4) to determine size of tap that should be granted for a new building.

The following illustrations of the use of the floor area basis in connection with gaugings of flow into districts and the use of water in buildings are of interest. In measuring the flow of water into one district in 1902-03, an error was made in the direction of flow through one of the large mains included in this district. The flow in this main, which was about 5,000,000 gallons daily, was taken as being into the district, whereas it should have been out of the district. The resultant error was, therefore, about 10,000,000 gallons daily, or about equal to the actual flow into the district. The resultant per capita consumption was 93 gallons, and was not considered to be abnormal. When the floor area unit was applied to this district it was found that the consumption per 1,000 sq. ft. was over 600 gallons per day, whereas no other district was found where the consumption had equaled 400 gallons, and few had exceeded 300 gallons. Investigation and subsequent measurements of flow in the district clearly showed the error, which was only discovered by applying the floor area unit.

The question of the presence of one or more illegal connections between the city's mains and the piping system of one of the large hotels was brought up. It was found that to measure the flow in the street mains and thus check the meters in the buildings would necessitate several taps, and the size of the mains was such that the rate of flow would be too small to give a reasonable degree of accuracy in the readings that might be obtained. To make the necessary taps and take readings would have cost several hundred dollars and would have interfered with traffic on two of the most congested streets in the city. A comparison of the use of water in this building on the floor area basis with that of several other buildings of like character showed that the building in question used more water than any of the other buildings. The evidence, therefore, was conclusive that the full amount of water supplied was passing through the meters.

The per capita basis for estimating consumption is the most practical one for general use, and will undoubtedly continue to be the standard unit. Experience with the floor area basis in New York city has shown, however, its usefulness in waterworks operation, and it is believed that other cities than New York will find occasions where the floor area basis can be utilized to advantage.

## TESTS OF CAR HEATERS.

An investigation has been made by the Cleveland Railway into the merits of various systems of heating trail cars for rush-hour service. The investigation was carried on under the supervision of T. Scullin, master mechanic of the Cleveland Railway, and J. H. Alexander, chief engineer for the City Street Railroad Commissioner of Cleveland. It was witnessed by Street Railroad Commissioner Witt and by representatives of the various car heater manufacturing companies whose apparatus was concerned in the test. An abstract of the report made as the result of this investigation follows:

"Three types of heaters were tested, namely, straight electric heaters, the forced ventilation electric heater and the forced ventilation coal heater.

"The tests were made upon three of the railway company's 900-type cars, having an over-all length of 52 ft., the front vestibule being inclosed and the rear vestibule open. Each type of heater was installed in a separate car. The tests were made with the cars end to end on a track in the shops of the railway company. Two side ventilator sashes in the front of the car and two in the rear were open during the entire test. The straight electric heater system manufactured by the Consolidated Car Heating Company was installed on car No. 909 and consisted of twenty-six heaters, installed underneath car seats, one main switch cabinet, one magnetic switch, one thermostat and one snap switch. The forced ventilation electric heater manufactured by the Peter Smith Heater Company was installed on car No. 911. It consisted of a compact electric heating unit in a sheet steel housing, equipped with a Sturtevant multivane blower, size C, direct-connected to a 220-volt, 8-amp series-wound, ball-bearing motor. The cold air taken from underneath the car is blown over the heating coils and distributed from a hot-air duct extending the length of the car body. This heater in service would be installed with an interrupter and thermostat to regulate the temperature of the car automatically. The forced ventilation coal heater installed on car No. 912 was also manufactured by the Peter Smith Heater Company and is similar to the heater described above, except that the heat is generated by the direct combustion of coal, the cold air being blown over the combustion chamber.

"The tests were started simultaneously at 10.46 a.m. on April 14, 1912, after the cars had been standing in an unheated building for about twenty-four hours.

"The temperature within the car was taken in all cases by three suspended thermometers, one in either end of the car body about 12 in. below the headlining and one in the centre of the car at about the height of the seat back. The latter temperature was considered to be representative of the temperature of the air in the portion of the car occupied by the passengers. The temperature indicated by the thermometers just under the ceiling was practically the same as that indicated by the thermometer in the centre, on the car equipped with the Consolidated heaters, and about 1 deg. to 2 deg. higher on the car equipped with the forced ventilation electric heater, while on the car equipped with the coal heater one temperature was slightly higher and one slightly lower than that in the centre of the car.

"The outside temperature considered in the test was that taken at about the height of the car windows. The temperature of the intake air to the forced ventilation heaters was about 2 deg. to 4 deg. lower than the temperature at the height of the car windows, while the temperature of the air about 3 ft. above the roof of the car was 2 deg. to 3 deg. higher. A five-hour continuous heat run was made on the three cars, an employee of the railway company being stationed in each car to take thermometer readings at a signal from the recorder. The first few readings were taken at intervals of two or three minutes, in order to obtain the curve of temperature rise of the car.

"The run on the car equipped with the coal heater was not successful, owing to the insufficient draft of the heater while in operation in the building, and another test was made subsequently on this car. In this test a fan was placed on the car roof, blowing the air over the top of the smoke-jack, which gave the draft desired.

"On this latter test more thermometers were available and they were distributed over the sides of the car to determine what effect the heat radiating from the side of the car when the car was not in motion would have upon the envelope of air close to the car body. These temperatures indicated that with the car in actual service there would be a greater radiation from the windows and a slightly greater radiation from the roof of the car.

"The tests run on the two electric heaters show that in order to maintain a temperature within the car 41.9 deg. Fahr. above the surrounding air it is necessary to expend about 10,900 watts, of 267 watts for each degree rise of temperature.

"The mean temperature of Cleveland for forty years for each of the winter months was obtained from the United States Weather Bureau, and the number of degrees of heating required to maintain a temperature of 55 deg. Fahr. inside the car was determined. It was also assumed that the current must be turned on the heaters a sufficient length of time to raise the temperature to 45 deg. Fahr. before the car goes into service, also that the car remains in service two hours in the morning and two hours in the evening."

In the comparison of costs of electric and coal heaters the contract under which the Cleveland Railway purchases energy was used for determining the cost of the electric heaters. The figures follow:—

**Estimated Cost of Power for Electric Heater for Trail Cars on Basis of One Car per Year.**

| | |
|---|---|
| Maximum demand at car from test (500 volts) .. | 11.00 kw |
| Maximum demand at d.c. bus substation (90% efficiency of distribution) .................. | 12.23 kw |
| Maximum demand at generator bus (89% efficiency of transmission and conversion) ... | 13.76 kw |

12.23 kw for 2¼ hours requires 8.16 kw of substation capacity, 50% overload allowed.

Investment in substation, 8.16 × $25 = $204.00.
($25 per kw of capacity installed.)

Fixed charges on substation equipment, $204 × 10% = $20.40.

(Includes 5% interest, 2.52% amortization, 1.36% taxes =9.88% or 10% used.)

| | |
|---|---|
| Investment in distributing system is $41.70 per kw of maximum demand. | |
| Investment in distributing system per car, $41.70 × 12.23 | $510.00 |
| Fixed charges per car per year, $510 × 10% | 51.00 |
| Maintenance of distributing system per kw of maximum demand per year | 2.00 |
| Maintenance of distributing system per car | 24.46 |
| Consolidated car heaters require 4661 kw-hr. at car or at generator bus, 4661 ÷ .80 = 5830 at $0.0038 | 22.15 |
| Substation operation and maintenance, 5190 × $0.0003 | 1.56 |
| Peter Smith forced draft heater required 4172 kw-hr. at car, or 4172 ÷ .80 = 5220 kw-hr. at generator bus, 5220 × $0.0038 | 19.80 |
| Substation operations and maintenance, 4640 × $0.0003 | 1.39 |

| Summary of Power Cost. | Consolidated Electric Heater. | Peter Smith Electric Heater. |
|---|---|---|
| Demand charge for power, 13.76 kw for 6 months | $82.50 | $82.50 |
| Energy charge | 22.15 | 19.80 |
| Substation operation and maintenance | 1.56 | 1.39 |
| Fixed charge on substation | 20.40 | 20.40 |
| Fixed charge on distributing system | 51.00 | 51.00 |
| Maintenance of distributing system | 24.46 | 24.46 |
| | $202.07 | $199.55 |

| Peter Smith Coal Heater: | |
|---|---|
| Fixed charge, .182 kw at $16.22 | $2.95 |
| Substation operation and maintenance, 148-kw-hr. at $0.0003 | .04 |
| Energy charge, 166 kw-hr. at $0.0038 | .63 |
| Total | $3.62 |

In building the fire in the coal heater, the following material was used: Kindling, 1.76 lb.; ash wood, 4.25 lb.; kerosene oil, 0.312 lb.; shavings, 0.004 lb.; coal, 35.29 lb.

In the general summary, each heater was charged with interest at 5 per cent. taxes at 1.36 per cent. and repairs and maintenance at 1 cent a day. Depreciation was charged at 7 per cent. in the case of electric heaters and 10 per cent. in the case of coal heater. The latter was also charged with the following special costs per year:

| | |
|---|---|
| Coal | $21.00 |
| Fuel and labor of kindling fire thirty times | 4.09 |
| Labor of attendance | 8.76 |
| Removing and reinstalling heater each season | 1.00 |
| Transportation and storage in summer | .50 |
| Value of space occupied by heater | 11.16 |

The final figures showed that the Peter Smith coal heater to be far more economical than either electric heater.

In regard to weight and space occupied and a general summary the report says:

"The weights of the various heaters installed complete are as follows: Consolidated, 457 lb. Peter Smith electric, 350 lb.; Peter Smith coal heater, 544 lb.

"The cost of power for hauling the equipment for this trailer service amounts to 2.18 cents per pound per year. The Consolidated electric heating equipment is carried throughout the year, while with the Peter Smith forced ventilation heating equipments the heating duct alone is carried throughout the year, the heater being removed and stored during the summer season.

"Either of the electric heaters installed in a car would be placed under the seats, while the coal heater during six months of the year occupies the space of one seat in the car; the value of this space is chargeable against this heater. In order to obtain this value it was assumed that the standing capacity of the car is one-half as valuable as the seating capacity. Thus in this car, seating sixty passengers and providing standing room for sixty more, the value of one seat space is one-ninetieth of the value of the car space. On a basis of 38 miles per day for a trailer 156 days per year, the mileage per heating season is 5920, which at 17 cents per car mile operating cost amounts to $1,006.40. Therefore $11.16 is the value of the space occupied by the coal heater during the winter season.

"Each of the three types of heaters has its individual advantages. The electric heaters afford the advantage of cleanliness, convenience and ready means of obtaining automatic regulation of the car temperature. The Peter Smith electric heater has the important additional advantage of providing a forced ventilation of about 12,000 cu. ft. of fresh warm air per hour. On the Peter Smith electric heater, however, no means were provided for automatically cutting off the current of the heating unit in case of failure of the blower motor, which would probably mean a burn-out of the heating unit. Both of the electric heaters have the disadvantage of being unable to heat the car properly in extreme weather. The curves show that in zero weather it would be impossible to maintain a temperature of more than 40 deg. Fahr. inside the car. With the coal heater a rise of over 48 deg. was obtained easily without any attempt at crowding the heater. The exceptionally high cost of power for heating the tripper cars electrically at rush-hour periods of the day for the climatic conditions existing in Cleveland renders the operation of electrical heaters extremely uneconomical if not prohibitive."

## METHODS OF REINFORCING A BRIDGE.

Reinforcing a bridge in such a way as to make the added material share not only in the live-load but also in the dead-load stresses was done on the Bengal-Nagpur Railway, India, according to the methods described by D. H. Remfry in a recent paper before the Institution of Civil Engineers. The bridge consisted of ten 200-ft. deck-truss spans, and two 100-ft. spans. Each span, during the reinforcing, was jacked up at six points, to take out most of the dead-load stress. The jacks were supported by falsework founded on 42-in. steel cylinders sunk in the sandy river bottom (and after using pulled and used again).

Special rivets were tried in the reinforcing, because some of the gussets furnished little room for driving additional rivets. The special rivets, of chrome-vanadium steel, had 45 per cent. greater shearing strength than mild steel, and, curiously enough, "tests seemed to indicate also that a greater bearing resistance could be relied upon in the plates when these special rivets were used, than with mild-steel rivets."

The success of the reinforcing is described in the statement: "Practically no permanent set was observable on the first passage of a train after strengthening." The deflections of the spans under live-load were 26 per cent. to 30 per cent. less than before reinforcing.

## WAVES IN LONG HYDRAULIC PIPES AND TUNNELS.

The subject of surges in pipe lines is an exceedingly interesting one to the hydraulic engineer. The following contribution by Robert H. Smith appeared in a recent issue of "The Engineer," London, and will be of interest to our readers, so that we have published it in full.

During last summer the Institution of Mechanical Engineers visited the great hydro-electric works of North Switzerland. The most interesting of these is that on the Löntsch River, the supply being from the Klönthalersee, a natural lake whose storage capacity has been increased to 50 million cubic metres by the building of a dam 21 m. high. From the lake the water flows through a tunnel cut in the rock of the face of the mountain side, a distance of 4.1 kiloms., with a cross section of 4¾ square metres and a gradient of 2.17 per 1000. At the end of the tunnel there is a sort of water tower, from which the water flows through three welded steel pipes 1¼ kilom. long and of diameter varying from 1.35 to 1.2 metre, down to the power-house at 325 m. lower level.

The variation of the water taken by the turbines causes corresponding change in the flow through the tunnel. Although the linear velocity of the water is never high, the immense weight of water flowing means a huge and quite irresistible momentum, so that not only must the valves be closed and opened with great care, but it is necessary also to provide what is in effect a gigantic relief valve at the lower end of the tunnel. The above-mentioned sort of water tower serves this purpose. Rising from the end of the tunnel is a sloping shaft cut through the rock and with a small waste-weir lip for overflow to the free air at 32 m. higher level than the tunnel end. At 3 m. above this tunnel end is cut horizontally a long gallery which acts as a small storage reservoir, into and out of which a large quantity of water can flow quickly. A second similar but larger gallery at 30 m. level above the tunnel end acts in the same way. During the deceleration of momentum in the tunnel when valves are closed, water flows up the sloping shaft and into the upper gallery, and during acceleration due to opening of the valves, the extra supply to the turbines is for many seconds partially effected by outflow from the lower gallery. The difference of water level between the Klönthalersee and the water in the sloping shaft is the head or driving force, which (1) overcomes frictional resistance to flow through the 4.1 kiloms. long tunnel, which resistance varies with the velocity, and (2) produces plus or minus acceleration of momentum in the water mass filling the tunnel. This head changes quickly during closing or opening of the valves owing to the filling or emptying of the galleries and sloping shaft. The result is the setting up of oscillations or waves, which continue for some time after the disturbing operation of the valves has been finished, but which are gradually damped down by the frictional resistances.

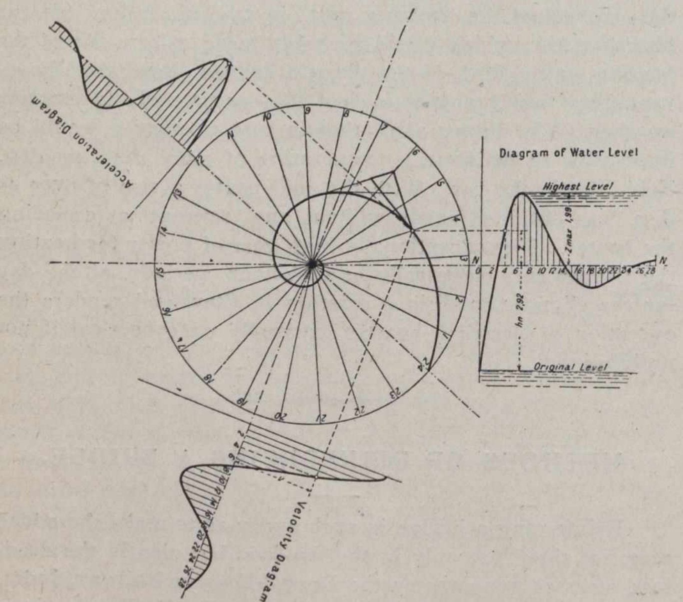



**Fig. 1.—Diagram Illustrating Case 1.**

Normally the lower of the two relief galleries is full, the water is level in the sloping shaft being above it. On the opening of a valve the level in the shaft sinks rapidly and the driving head increases rapidly until the level of the lower gallery is reached, when it remains practically constant for some time until this gallery is emptied—if the change in the supply goes so far as wholly to empty it. On the other hand, when valves are closed, the level being normal above the lower gallery, the level in the sloping shaft rises quickly and a quick decrease of driving head occurs until the water reaches the level of the upper gallery, when it practically remains constant, the overflow lip of the waste weir placing a limit upon this decrease of head.

All hydraulic engineers are familiar with the dangerous effects due to the acceleration and deceleration of large masses of water in long pipes. For great works like those of the Löntsch Valley it is, therefore, of great importance to arrive at a knowledge as accurate as circumstances will permit, of what occurs under conditions such as those described. Dr. Franz Prásil is the best known Swiss expert in hydraulic calculations. His excellent paper on "The Efficiency and Governing of Modern Turbines," read at the summer meeting of the Institution of Mechanical Engineers at Zürich, will be in the recollection of our readers. In Nos. 21, 23, 24 and 25 of the fifty-second volume of the Schweizer Bauzeitung, he has given a full and learned investigation of this "Water Tower Problem" of the waves or swinging motion of water in long pipes and tunnels.

It would be impossible in a single article to follow the mathematical course of Dr. Prásil's calculations, and only a small number of your readers would care to examine them so far as to judge for themselves of their correctness. It will be interesting, however, to give a brief account of their general results and of the degree of approximation to physical fact to which they pretend. Dr. Prásil starts his paper from the beginning of all things, and his first pages are devoted to arriving at the general equation for damped vibrations. We can leave this first part without further mention, because this equation is well known to electrical engineers in its relation to damped electrical oscillations. Applying it to the problem of water waves in pipes damped down by friction, and changing the letters used by Dr. Prásil to those in more familiar use by British engineers, this equation may be reduced to the following, which is its simplest general form:—

**With Nomenclature.**

| | |
|---|---|
| Length of tunnel | = $l$ |
| Cross-section of tunnel | = $a$ |
| Horizontal cross-section, or water surface in water tower | = A |
| Height of water level in water tower above water level in supply reservoir | = $h$ |
| Volumetric discharge of water through valves beyond water tower | = $q$ |
| Frictional and viscous coefficient of resistance to flow through tunnel | = $f$ |
| Time reckoned from beginning of disturbance due to closing or opening of valves | = $t$ |
| Acceleration of gravity | = $g$ |

For any steady positive flow through the tunnel the head $h$ is negative; but the wave may, and does, carry water up into the tower so as to make $h$ positive in spite of $q$, the flow through the discharge valves, remaining positive, and while also the flow forwards through the tunnel remains positive. While $h$ is positive, however, and also while it is negative up to a certain limit, deceleration takes place in the tunnel flow. During the steady flow before the disturbance commences the value of $h$ is called $h_n$ and the discharge flow $q_n$ the suffix $n$ indicating the word "normal."

The frictional resistance to the flow through the tunnel is assumed to be approximately proportional to the first power of the linear velocity, and the total head lost in the whole length of the tunnel in overcoming this resistance is taken $= f \times$ velocity. Of course, $f$ depends upon the dimensions and the smoothness of the surface of the tunnel. For high velocities the actual resistance is more nearly proportional to the square of the velocity; but the above assumption greatly simplifies the calculation and makes only little difference in the practical result of it, while the difference is on the safe side, inasmuch as the true physical law damps down the oscillation more vigorously and more quickly than does this approximation.

It must also be mentioned that the problem is worked out on the assumption that the water surface area A remains the same at different levels in the water tower.

The fundamental general equation is:—

$$l\,A\,\frac{d^2h}{dt^2} + g\,f\,A\,\frac{dh}{dt} + g\,a\,h + g\,f\,q + l\frac{dq}{dt} = 0$$

The sum of the first and last terms of this equation represent the acceleration of momentum of the mass of water in the tunnel. The sum of the second and fourth terms represents the frictional resistance. The middle term represents the driving head. Or, more definitely, these terms divided by $g\,a$ represent the quantities just mentioned. The first three terms are placed here consecutively in mathematical order for the variable head $h$; the last two in order

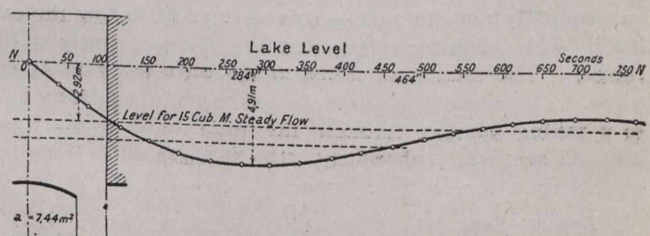



Fig. 2.

for the variable $q$. These two, $h$ and $q$, are the only two quantities involved which vary; and they vary independently of each other.

Except when the valves are wholly closed, or $q = 0$, it is not possible practically to keep $q$ quite constant; but the first two special cases are worked out on the assumption that $q$ does remain constant, when also the last term $l\frac{dq}{dt} = 0$. This greatly simplifies the solution and gives a very good preliminary notion of the sort of results to be expected in all cases of more complex conditions.

Before stating the results for special cases there must here be noticed what appears to the present writer to be the most serious deviation from actual physical fact embodied in Dr. Prásil's solution. This is the assumption that the whole mass of water in the whole length of the tunnel moves at each instant of time with exactly the same velocity. In a short length of pipe like that between the buckets of a reciprocating pump and its delivery air vessel, this is a very close approximation to physical fact. But in a large tunnel a couple of miles long the error is very much greater. It is so because of the air dissolved in the water. If the water contained no air it could be treated mathematically as a practically inelastic and incompressible mass; the changes of pressure would be transmitted practically instantaneously through the total length, and every part would suffer the same acceleration or deceleration at each instant of time. But under the actual changes of pressure the contained air contracts and dilates; and, in consequence of this, the changes of pressure are transmitted along the length as waves at a velocity very far from approaching "infinity" in comparison with the time period of a complete oscillation of the water velocity; and the result is that the successive periodic water velocities do not arise all along the tunnel at the same instant, but the appearance of each is retarded by an appreciable time at each place in proportion to its distance from the end where the disturbing influence has its origin. Moreover, in a long tunnel there are unavoidably many roof pockets where air gathers, and the quantity of air in each such pocket increases whenever the pressure increases, as every one knows how air is thrust out of ordinary undistilled water on any considerable pressure being applied to it. These air pockets constitute so many highly elastic cushions which must modify in no negligible degree the mathematical results based upon complete incompressibility.

Another approximation made by Dr. Prásil is to neglect the accelerations of momentum of the water in the water tower itself. It is probable that in all actual cases this is a perfectly permissible approximation having no appreciable effect upon the practical result.

**Special Case I.**—Dr. Prásil first solves the problem for the case of quite sudden partial closure of the discharge valves. Before the closure the water level in the water tower is $h_n$ and the discharge flow $q_n$. The discharge is suddenly reduced to $q$, and remains at this amount during the following waves and until steady flow has been again established by frictional damping.

If $2\pi T$ ($= 6.28\,T$) be the total period of the resulting wave—that is, the time interval between successive maximum water levels in the water tower—Dr. Prázil finds that this time is given by the equation

$$T = 2\,l\,\sqrt{\frac{A}{g\,(4\,a\,l - g\,f^2\,A)}}.$$

It is to be noted that this time increases with the length of tunnel; that it increases with the ratio $A/a$ of the section of the water tower to that of the tunnel; and that it is also increased by greater frictional roughness of the tunnel walls. It is to be particularly noticed that it is independent both of the previous and final flows $q_n$ and $q$ and also of $h_n$, the head previous to the closure.

After the waves produced by the sudden change of discharge have been completely damped out by the frictional resistance, the steady permanent new head of water from reservoir level to level in water tower is diminished.

$$\text{from} - h_n \text{ to} - \frac{q}{q_n}\,.\,h_n$$

The progress of the wave as expressed by the rise and fall of water level in the water tower is given by the equation

$$h = -\frac{q}{q_n}h_n + \left(1 - \frac{q}{q^n}\right) h_n \frac{a}{f\,A}T\,\frac{\sin\left(\frac{t}{T} - \beta\right)}{e^{\frac{cf}{2l}t}}$$

The second term here measures the wave motion and shows that this oscillates round the level $-\frac{q}{q_n}h_n$ to which the water in the tower quiets down. The amplitude of this wave motion is proportional to $\left(1 - \frac{q}{q_n}\right)h_n$ the difference between the original and the final head. It is also proportional to T; but as T involves $f$ $a$ and A it is better to consider the whole factor $\frac{a}{fA}$ T, which equals

$$\frac{2al}{f\sqrt{gA(4al - gfA)}}$$

This increases with $\frac{a}{A}$ the ratio of tunnel to tower section, increases with $l$ the length of tunnel, and decreases as $f$ the frictional roughness of the tunnel increases. There is a purely theoretical limit to this last decrease at dimension ratios which never occur in problems when it is useful to make these calculations. At the same limit the increase of the wave time-period with the length of tunnel would change to a decrease.

The amplitude of the wave is continuously damped down with the advance of the time $t$ from its initiation. This gradual diminutions is measured by the division by the

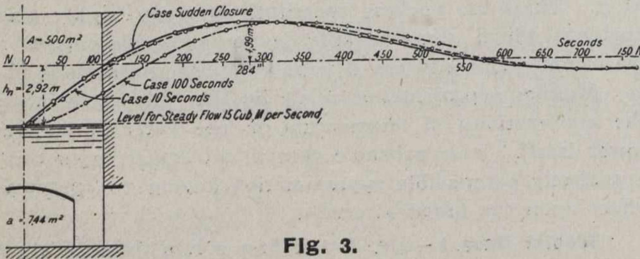



**Fig. 3.**

factor $e^{\frac{g}{2l}t}$ where $e$ is the base of natural logarithms. Dr. Prásil expresses this graphically in a diagram as the polar ordinate to a logarithmic spiral. The rate of increase of the radius of the spiral is proportional to the roughness $f$ and inversely so to the tunnel length $l$.

The angle $\beta$ in $\sin\left(\frac{t}{T} - \beta\right)$ expresses the phase of the wave motion at which it starts under the somewhat artificial assumption of instantaneous change of discharge from $q_n$ to $q$. The physical meaning of $\beta$ is that at time $\beta$ T the water in the tower reaches, and passes above, the level to which it finally settles when the wave is completely damped out.

To calculate $\beta$ the equation is

$$\sin\beta = \frac{4lgfT}{4l^2 + g^2f^2T^2} = \frac{f}{2al}\sqrt{gA(4al - gf^2A)},$$

and this calculation is necessary in order to find the maximum height to which the water will rise in the tower.

This maximum water level is reached at the time given by

$$\sin\left(\beta + \frac{t}{T}\right) = \sqrt{1 - \frac{gf^2A}{4al}} = \sqrt{\frac{al}{Ag}} \cdot \frac{\sin\beta}{f}$$

By inserting this value of the sine and the value of $t$ found from it in the equation for $h$ we find this maximum level. The second maximum is found by adding to this time $2\pi$ T; while the first minimum is found by adding to it $\pi$ T.

The following numerical example is given by Dr. Prásil:

$l$ = 2.76 kilometres; $a$ = 7.44 square metres.

A = 500 square metres;

$q_n$ = 15 cub. m. per second; $h_n$ = 2.92: $q$ = 0

Normal velocity of water in tunnel = $\frac{15}{7.44}$ = 2.02 m. per second.

Results:—Whole period of wave = $2\pi \times 147$ sec. = 15 min. 9 secs.

$\beta$ = 41 deg. 24 min.

Time of first maximum height of wave = 6 min. 24 secs.
Height of first maximum above lake level = 1.99 m.
Depth of first minimum below lake level = 0.61 m.
Final level in water tower = level in lake.

In Fig. 1 are seen the various diagrams used to assist in and illustrate the solution of this special example.

In this example the original kinetic energy of the mass of water filling the tunnel is 4271 metre-tons. The weight of water lifted into the water tower during the rise of level to the first maximum is 2455 tons. In coming to the final level this weight does work equal to 2455 × 29.2 = 7169 metre-tons. The sum of these two quantities of energy is spent partly in lifting 2455 tons through the height 2.455 m. or 6027 metre-tons, and partly in overcoming frictional resistance to the amount of 5413 metre-tons.

**Special Case II.**—The second special case worked out by Dr. Prásil is that of sudden opening of the discharge valves after being wholly closed. In this case $q_n$ = O and $h_n$ = O. It is obvious that in consequence of inertia the flow through the tunnel will start into being gradually, and also that the discharge through the valves will increase gradually from zero. But as a first approximation Dr. Prásil works out the mathematical ploblem on the assumption that the valve discharge increases instantaneously to $q$ and remains constant at this amount until the disturbance wave has been damped out.

The result is shown in Fig. 2. It is the precise reverse of that in special case I., it being made so by taking the final steady flow $q$ equal to the flow corresponding to the 2.92 permanent head of water, namely, 15 cubic metres per second.

The level in the water tower sinks to the minimum level under that of the reservoirs of 4.91 m. = 2.92 + 1.99. It Galley Four—Waves In Long Hydraulic Popes And Towers subsequently rises to 2.92 — 0.61 = 2.31 m. below the same level. The following oscillations are of successively smaller range. The total time period of the wave is again 15 min. 9 sec. The angle $\beta$ is again 41 deg. 24 min., corresponding to a falling passage through the final level at the time 1 min. 44 sec., the subsequent rise through the same level occurring at time 9 min. 19 sec.

**Special Case III.**—The third case taken is that of gradual closing of the valves so as to decrease the discharge at a uniform time rate from $q_n$ to O in time $t_c$. Here

$$q = q_n\left(1 - \frac{t}{t_c}\right) \text{and } \frac{dq}{dt} = -\frac{q_n}{t_c}$$

The solution for the water level in the tower is in this case

$$\frac{h}{h}t_c = \frac{T}{f}\sqrt{\frac{al}{Ag}}\,\frac{\left(\sin\frac{}{T} - \beta\right)}{e^{\frac{lcf}{2l}t}} + t - t_c + al - gf^2 \text{ A}$$

This is evidently an exactly similar solution to that given in Cases 1 and 2, except for the addition of a straight line term, namely $t$. Adapting the appropriate constants the same graphic construction applies, substituting an oblique straight line as the base from which to measure. Thus, if the distances along the horizontal axis in the diagram be the time $t$ and the vertical ordinates be to a curve drawn in the same manner as in Cases 1 and 2, then the height between this curve and a straight line drawn through the origin downwards at 45 deg. will give the values of $\frac{h}{h_n}t_c$. The values of T and of $\beta$ are here the same as those already given.

After the valves have completely closed the wave continues, but under changed conditions, the change being expressed mathematically by the omission from the equation of the above-mentioned straight line part, with also a change in the values of $\beta$ and of the factor of the sine term. These new values depend upon the point in the above diagram, which makes the time $t = t_c$ The value of h for this point can be found algrebraically from the above equation by inserting in it the value $t = t_c$.

Fig. 4 gives Dr. Prásil's diagram for the solution with the same data as taken in the illustrations of Cases 1 and 2 and for the uniform complete closure of the discharge occupying 200 sec.

He calculates the results also for complete closure in 10 sec. and in 100 sec. These three results along with Case 1 for instantaneous closure or closure in O second, form a series which well illustrate the effect of more or less rapid stoppage of the flow through the discharge valves. The more important of the practical results are brought together in the following table:—

**Table of Results of Stoppage of Discharge in 0, 10, 100 and 200 Seconds.**

Full flow 15 cubic metres per second.

Length of tunnel, 2.76 kilom. Section of ditto, 7.44 sq. metres.

Head from lake to water tower for full flow, 2.92 m.

Time period if wave, 15 min. 9 sec.

| | | | | |
|---|---|---|---|---|
| Full closure of valves, in sec. | 0 | 10 | 100 | 200 |
| Head at instant of full closure, m. .................... | 2.92 | 2.77 | 1.48 | 0.32 |
| Head at lowest dip of wave, m. .................... | 0.61 | 0.60 | 0.53 | 0.44 |
| Negative head at top of wave, m. .................... | 1.99 | 1.99 | 1.95 | 1.82 |
| Factor of sin $\left(\frac{t}{T} - \beta\right)$ in formula for $h$ at top of wave, m. ............... | 4.417 | 4.358 | 3.825 | 3.188 |
| $\beta$ deg. min. ................ | 41 24 | 39 30 | 22 44 | 5 46 |

The level of the water at the top of the wave being the most important quantity, it is seen that this varies very little; it begins to decrease perceptibly only with periods of closure longer than 1½ min. In Fig. 4 the three curves for 0, 10, 100 sec. are plotted together and to the scale of the diagram the differences between them are barely measurable. Dr. Prásil therefore concludes that for practical purposes the much simpler calculation based upon the assumption of instantaneous closure, either complete or partial, is sufficiently accurate, especially as it deviates from exact physical truth in the direction of safety in the provision to be made in designing the water tower.

Dr. Prásil then proceeds to investigate the results of sudden opening almost immediately followed by sudden closure, a condition arising in the supply of electric energy to tramways of limited extent and not very frequent service so that the load curve is very peaked, and also the effects of an overflow or waste weir at the top of the water tower such as we see in the Löntsch Valley. The necessary limits of this article prevent us following him further in these analyses. He also gives a careful examination of the difference resulting from using the formula $f v^2$ instead of $f v$ for frictional resistance to water flow.

His general conclusions are as follows:—

1. If in place of a water tower the relief opening is into a reservoir of water area A, and if $A/a$ be greater than about $100\,l$ in kilometres then no periodic wave motion will occur on opening and closing the discharge valves, the frictional damping effect preventing this; but in ordinary practice where $A/a$ is much less than this such waves will arise.

2. The maximum height of the wave is reduced very little by gradual closing of the valves below what is calculated for sudden closing.

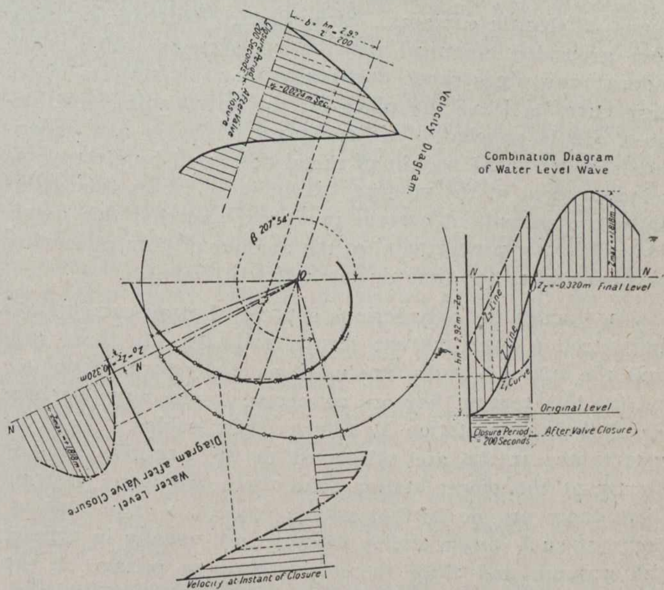



**Fig. 4.—Diagram Illustrating Case III.**

3. The approximate height of the wave can be calculated by help of a work balance account.

4. The maximum dip of the wave due to opening is nearly the same as the height calculated for closing the valves.

5. The theory of damped vibrations gives approximately correct results when applied to this problem.

6. In a service in which periodic variations of discharge take place the phenomenon of resonance may arise under certain conditions.

7. The maximum height of wave may be limited by the use of an overflow weir arranged at top level of the water tower.

## GAS RATES IN MONTREAL.

The town of Montreal West, being the extreme western end of Westmount, which in turn is the west end of Montreal, has adopted a twenty-year contract with the Montreal Light, Heat and Power Co., for the supply of gas for lighting and heating and industrial purposes. The terms are $25 per light per annum for lighting the roads, streets, lanes and other public places, the posts to be supplied by the town and the lamps and apparatus by the company.

The rates for private lighting will be as follows per 1,000 cubic feet:

For the first five years, $1.25.
For the second five years, $1.15.
For the third five years, $1.05.
For the fourth five years, $1.00.

These quotations are net; and the company also reserves the right to charge an extra 10 cents per 1,000 cubic feet to persons who do not promptly pay their accounts. It is also provided that if the town of Montreal West is hereafter annexed to the city of Montreal, the terms given to the customers in the city shall be extended to the citizens of Montreal West, after the second term mentioned above.

It may be of interest to add that recently the company made a rate of 95 cents per 1,000 cubic feet to the citizens of the city of Montreal.

## ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.*

By Albert F. Ganz, M.E.†

Electrolysis is defined as chemical decomposition by means of electric currents. Stray electric currents escaping from grounded electrical distribution systems which reach underground pipes cause destruction from electrolysis where these currents leave the pipes for the surrounding soil, because soil is an electrolytic conductor. Theory and experience show that the weight of metal destroyed by electrolysis is independent of the voltage, except in so far as this determines the amount of current produced, and that this corrosion is directly proportional to the amount of current leaving the pipe and to the time during which it leaves.

In practice the only serious sources of stray currents are single trolley direct-current electric railways. In these railways the running tracks are used as the return conductor, and for this reason they are connected to the negative bus-bar of the power station by return feeder cables. In most systems the tracks are connected to the negative bus-bar directly at the power station, and there are many systems where there are no further return feeders. The running tracks of such single trolley railways are usually in contact with ground, and since there is a drop in voltage in the rails, current leaks from the rails to flow through ground, the amount of stray current depending upon the drop in voltage in the rails and upon the resistance of the path through ground. Since electric current can only flow in a closed circuit, all current which leaks from rails and flows to ground and on underground pipes must again leave these pipes where negative return feeder cables are connected to the rails, in order to flow back to the negative terminal of the generator and so complete the electric circuit. Where these stray currents leave these underground pipes to flow to the surrounding soil electrolytic corrosion is produced, resulting in a destruction of 20 lb. of iron in one year for every ampere of current. It has been disputed whether the amount of destruction produced is always equal to the theoretical amount; a number of laboratory experiments made recently by the author under practical conditions with current densities as low as those found in practice on underground piping seem to indicate that the actual amount of destruction is always at least equal to the theoretical amount, and is often even greater than the theoretical amount.

Since stray currents flowing through ground and through underground piping are caused by potential differences between the pipes and rails set up by the drop in voltage in the rails, the simplest way to determine the probable existence of stray current on underground piping it to measure the potential differences between pipes and rails. Such measurements made throughout a system constitute the usual potential survey. These potential differences are, however, not a measure of the current flow between pipes and rails, as this is determined also by the resistance of the path through the intervening ground, and this resistance cannot be practically measured. Since the actual electrolytic danger of a pipe is determined by the amount of current flowing on the pipe, it is necessary to make current measurements at many points throughout a piping system. The existance and direction of current flow on a pipe can be determined from drop measurements between service connections, but the magnitude of the current flowing cannot be determined from such drop measurements. To determine the actual amount of current flowing a length of pipe is exposed and the drop in potential along a known length of continuous pipe is measured, and this drop is divided by an assumed resistance for the included length of pipe.

Since the positive potential of a pipe referred to rails, plus the negative potential of the pipe referred to rails, plus the drop in the pipe, is equal to the drop in the rails, the potential and current surveys enable one also to form an estimate of the drop in rails, and thus to form an idea as to the condition of the railway return circuit.

After drop and current measurements have been made at a sufficient number of points, they are conveniently plotted on a mains map, and a study of this map will indicate where current is leaving the pipes. Such points will always be found in the regions where the pipes are positive to the rails. Other points remote from the positive region will in most cases also be found where current leaves the pipes to flow to other pipes or to other underground metallic structures, or to flow to ground in cases where the negative bus-bar is grounded through low resistance ground connections. The author has found large stray currents leaving water pipes in districts where these pipes were from ten to twenty-five volts negative in potential to the trolley rails, and more than five miles away from the railway power station. At points where the current survey indicates current leaving excavations should be made and the pipe examined for evidences of electrolytic corrosion.

Besides the danger from electrolytic destruction of the pipes, stray currents where they flow on underground piping systems frequently enter buildings through service connections and produce a serious fire hazard. For example, current may flow into a building through a water service pipe, then flow from the house water piping to the house gas piping, and then out from the building through the gas service pipe. Such contacts between service pipes or between the service pipe and the lead sheathing of a telephone or a power cable frequently occur through metal ceilings, or where the pipes rest against each other. Since dangerous heating may be produced where the current flows through such contacts or where vibration may momentarily separate the contact and produce an arc, nearby inflammable material is in danger of being set on fire. The author has, in fact, found many cases where currents up to 30 amperes were flowing into and out of buildings through service pipes or lead cable sheaths. Evidences of arcing having occurred between such contacts in buildings have also been found. There is no doubt that many fires have started in this way, but it is always difficult to prove the cause of a fire because of the destruction resulting from the fire.

There is only one complete remedy for electrolysis, and that is the use of a completely insulated return circuit. Such railways may be provided with double overhead trolley wires, as used in Washington, D.C., Cincinnati and Havanna; or with an insulated outgoing and return current in underground conduits, as used on the surface lines on Manhattan Island; or with separate insulated third and fourth rails for the outgoing and return current, as is used on the Metropolitan District Railway in London. With these systems the running tracks are not used as a part of the electric circuit, and as both positive and negative sides of the circuit are insulated no stray currents are produced.

Where a road operates on a private right-of-way, the rails can often be practically insulated from ground and the escape of current from the tracks prevented. For surface roads this can sometimes be practically accomplished by placing the rails on wooden ties above ground and using broken stone for ballast and keeping the rails out of contact with ground. In the case of railway lines operating on ele-

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†Professor of Electrical Engineering, Stevens Institute of Technology.

vated structures the rails can be fastened to wooden ties and kept out of contact with the structure. In one large elevated railway system this is done, and the running tracks, supplemented by large bare copper cables fastened to the wooden ties, are used for the return circuit. In this way the return circuit is quite thoroughly insulated from the elevated structure and from ground, thus preventing stray currents from this system.

A number of remedial measures intended to reduce stray currents from electric railways using the grounded rails for a return conductor have been tried. These methods may be divided into two classes, the first class aiming to remove the current harmlessly from pipes by metallic connections or bonds between the pipes and the railway return circuit, and the second aiming to minimize stray current through ground.

Since stray currents cause damage only where they leave pipes to flow to the surrounding soil, attempts are frequently made to prevent destruction from electrolysis by connecting or bonding the pipes or other structures by means of metallic conductors to the rails or to the negative return circuit, so as to remove the electric current by metallic conduction and thus prevent corrosion from electrolysis. This method can protect lead cable sheaths because they form continuous electrical conductors, but is not generally applicable to underground piping systems, because the latter do not form continuous electrical conductors, but are more or less discontinuous networks. While lead calked joints usually have a relatively low resistance, it frequently happens that they develop such high resistances as to make them practically insulating joints, due undoubtedly to the formation of oxide coatings. Cement joints and cement pipes have such a high resistance compared with iron pipes that they are practically insulating. Bonding of pipes to rails or to the negative return circuit can only afford local protection to the extent that the piping conducted forms a continuous metallic conductor, and this latter is an unknown and uncertain quantity in a piping network.

In the practical working out of a bonding or drainage system two opposing tendencies develop: first, there is a reduction in the difference of potential between pipes and rails in the positive areas, and consequent reduction of damage in those areas; and second, there is an increase of current flow on the pipes throughout the entire system, thus increasing the danger of trouble at high resistance joints or other places where two piping systems, or separate portions of the same system, are electrically discontinuous. As a rule, in the early stages of this system and especially in small networks when there are comparatively few bond connections and the resistances of the paths over the pipes are therefore relatively high, the effect is apt to be beneficial, reducing the danger in positive areas more than it increases the danger elsewhere. As the system grows and the load increases, more and heavier bonds become necessaary. The current on the pipes may finally become so great that the trouble from current shunting around joints or between separate systems will increase more rapidly than the danger in the positive areas is reduced, and any further increase in the bonding becomes an actual source of danger to the system. Since bonding transfers the trouble from the region where it was most evident to a new locality where it may require several years to manifest itself, the false impression is created that the trouble has been removed. It is due largely to this obscure and slow manner in which trouble develops that has caused this method to become quite widely used.

A number of cases have been reported where a main bonded to the negative return circuit at the power station was completely destroyed by electrolysis a block or two away because of a high resistance joint in the main, forcing current to shunt around the joint and leave the main a short distance away from the power station. In one of these cases one entire block of main had to be replaced. In another case the water main on one side of the street was bonded to the negative return circuit at the power station, and a main on the opposite side of the same street, although connected through cross-piping to the bonded main, was completely destroyed because high resistance joints had developed in the connecting pipes.

In addition, bonding pipes as a means of protection always renders the bonded structures a part of the negative return circuit, and therefore a source of danger to other underground structures which are not bonded. It has, in fact, been frequently found that where gas or water service pipes cross bonded cable sheaths, currents are induced to flow from the service pipes to the cable sheaths, and produce gradual destruction of the service pipes. In the case of one city 19 service pipes were destroyed in the course of one year directly where these pipes cross telephone ducts containing cables whose sheaths are bonded to the railway return circuit. One engineer who has studied this problem very carefully and entirely impartially has very aptly likened bonding to the drug habit, producing temporary relief at the expense of permanent and perhaps irreparable injury to the victim, which injury is, however, too rarely attributed to the true cause.

Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bonding, to ground connections from the negative bus-bar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact which is not generally appreciated, that where large stray currents exist, these can always be reduced to a small fraction of their present value by removing all ground connections of the negative bus-bar and installing insulated return feeders proportioned for equal drop from radially-disposed points in the track system located at some distance from the power station. By this method the rails are drained of current and any desired part of the voltage drop can be removed from the rails and transferred to insulated conductors from which currents cannot leak. In Europe such radial insulated return feeders for bringing current back from the rails to the power station are made necessary by regulations limiting the allowable drop in voltage in the rails, and in most cases such installations of insulated return feeders have substantially removed serious trouble from electrolysis.

This system of minimizing stray currents by means of radially-disposed insulated return feeders has also been installed in a number of American cities, and the method is gradually being recognized as by far the best for minimizing stray currents. This system, in fact, removes the root of the trouble by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is therefore correct in principle. The railroad companies frequently object to this system, claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities to-day. The fact is that in many electric railways there is practically no installation of negative feeders and the railway companies are often not willing to install even a moderate amount of return feeder copper.

A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Of course, where the negative bus-bar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This, however, is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit. The railway company can divide the annual charge of interest on copper invested and operating expense in any ratio within wide limits without affecting the amount of stray current produced from the system.

The pipe-owning companies suffer constant expense on account of stray railway currents in the form of repairs and depreciation of their underground structures, and in the form of liability for accidents, and this can be reduced with certainty to any desired extent, short of complete elimination, by the assumption on the part of the railway company of expense in the form of interest and power charges for its return circuit. The railway companies should in all fairness assume this expense and responsibility. If the railway companies would apply as much engineering knowledge and money to their negative circuits as they do to their positive circuits there would be but little trouble from electrolysis. The pipe-owning companies should co-operate with the railway companies by affording them access to their pipes for making necessary measurements, etc. After a railway company has installed a reasonable and fair return circuit it sometimes happens that it is desirable to eliminate any remaining current on pipes by the use of properly located insulating joints. Under these circumstances the pipe-owning companies should be willing to co-operate with the railway company in the installation of such joints.

In the decree recently filed in the celebrated Peoria case the railway company is enjoined and restrained from injuring the property of the water company by electric current escaping from the rails or structures of the railway company. No particular method for preventing escape of current is prescribed in the decree, because the court in its decision has already stated that a court does not have the power to prescribe by injunction any specific system, and that this power resides only with legislative bodies. In its decision the court, however, lays great stress upon the insulated radial return feeder system, which is spoken of as a quadrilateral system. The decree also requires the water company to co-operate with the railway company to the extent of giving the railway company access to its piping system for the purpose of measuring flow of current upon its system, and of determining whether injury from electrolysis is being continued, in order that the railway company may determine whether it is complying with the terms of the decree.

It is evident from this decree that the expense of providing a proper return circuit for the railway system so as to minimize escape of current falls entirely upon the railway company, as it should in all fairness. One section of the decree states that within six months after the expiration of one year after the date of the decree the railway company may apply for a hearing on the question whether it should be permitted to make an experimental use of the drainage system, in order to ascertain whether such drainage or limited use thereof can be practically applied to the piping system. It appears from the decision and the decree that the railway company must within one year improve its return circuit so as to prevent as much as possible the escape of stray electric currents from its system. If, after this has been done, it is found that stray currents still exist on the piping system, then the railway company may apply to the court for a hearing to determine whether the water company should be directed to permit the railway company to try a drainage system as an experiment to remove the remaining current harmlessly.

A drainage system such as contemplated as a possible final measure by the Peoria decree, when properly controlled so that only small currents are drained from the pipes, does not have the objectionable and dangerous features of promiscuous bonding where large currents are made to flow on the pipes, as often found in American cities, and may even be a safe final method where the soil conditions are favorable and where the underground structures are all continuous electrical conductors. It nevertheless seems to the author very unfair that any pipe-owning company should be compelled by a court order to permit an electric railway company to use its pipes as a return conductor for its railway system, even to the slightest extent. If the court does not have the power to compel the railway company to adopt any specific method for eliminating the danger from electrolysis, then it certainly should not impose any specific method upon the pipe-owning companies. The latter may, for example, prefer to remove any small remaining stray currents by means of properly located insulating joints.

It is the author's firm conviction that such remedial measures as pipe drainage or insulating pipe joints should be used, if at all, only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures. This view appears to be entirely in accord with the Peoria decision, and is certainly in accord with the best engineering practice.

## BRITISH COLUMBIA'S LUMBER INDUSTRY.

In the lumber industry trade is somewhat brisk, and conditions are healthy. Local demand is better, and orders are increasing in quantity from east of the mountains. For several months past, the output of logs in the coast camps has been almost fifty per cent. higher than for the same periods of last year, in May, for instance, the cut being 65,000,000, as against 45,000,000 a year ago. Yet there is no great surplus on hand. Prices are firm but loggers are looking forward to an advance. The coast mills are all busy, though in the interior activity is hardly average. Manufacturers there decided last winter not to cut extensively this year, preferring to wait until such times that so much lumber was not imported from the United States. Only about two-thirds of the mills are operating, though if the privy council upholds the decision of Mr. Justice Cassels, that lumber sawn twice must pay duty. There will be a distinct diminution in the importations from the western states. On the other hand, many of the mills east of the mountains are preparing to operate double shifts.

Activity is best shown by the new mills. The Empire Lumber Company, which will develop limits at Cowichan Lake, Vancouver Island, has a capital of $7,500,000, New York people being mostly interested, and are getting ready for business. The capital of the Canadian United Lumber Company is $4,000,000, and the operations planned are on a more extensive scale, this company has taken over three mills in the Kamloops district, and will erect two more in the same section, one at Coquitlam and two on Vancouver Island. Mr. Robert Marr has started a new mill near Princeton. The South Vancouver Lumber Company has a new establishment just east of Eburne, on the Fraser.

# The Canadian Engineer

**ESTABLISHED 1893.**

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., MANAGING EDITOR — A. E. JENNINGS, ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

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

**NOTICE TO ADVERTISERS.**

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

**NOTICE TO SUBSCRIBERS**

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## CONTENTS OF THIS ISSUE.



## "THE CANADIAN ENGINEER" IN MONTREAL.

In pursuance of the policy of *The Canadian Engineer* to strengthen still further its position in all parts of Canada, a larger and more convenient Montreal office of this journal has been opened at Rooms 617 and 628, Transportation Building, in that city. The importance of Montreal in the engineering and contracting life of Canada cannot be overestimated. Our realization of that fact prompts the present provision of greater service by this journal to Montreal interests. Mr. T. C. Allum, well known throughout the city, will continue as editorial representative, and will, as heretofore, keep our readers in the closest touch with all important developments. A file of *The Canadian Engineer* has been provided for the use of citizens and visitors, who are also invited to make every reasonable use of this branch office.

Special arrangements have also been made for the convenience of those who desire to consult plans and specifications of projected work throughout Canada. The new telephone number is Main 8436.

## THE INTERNATIONAL ROADS CONGRESS OF 1913.

We noted in a recent issue that the third International Roads Congress would be held in London, England, in June, 1913. The first was held in Paris, 1908, and the second in Brussels, 1910, and in the future the Congresses will be held triennially. The object of the Congress is to collect, discuss and circulate all the latest scientific knowledge with regard to the construction and maintenance of highways. Mr. W. Rees Jeffreys, the secretary of the Road Board of Great Britain, a Government body which is responsible for the building and maintenance of roads in conjunction with local authority, is now in Canada as the representative of the International Roads Congress to arouse interest in next year's meeting. His aim is to secure as large and as representative an attendance from Canada as possible. Already over thirty governments have intimated to the British Minister of Foreign Affairs their intention of taking part officially in the Congress. In an address to the Ontario Motor League directorate Mr. Jeffreys laid emphasis on the waste of money resulting from slipshod methods of road construction, and we agree with him, for the present deplorable state of many of our roads throughout Canada are due primarily to the lack of judgment in putting down the right class of road for the traffic conditions. A great impetus would be given to interurban motor traffic if roads which could be used by heavy carrying trucks were built. It would in a measure solve the present railway traffic congestion.

There is little question but that a good deal of education must be given and public interest aroused before conditions can be improved here. The sentiment of the Provincial Government of Ontario towards the good roads question is shown by their recent action in refusing to meet the vote of the city of Toronto with a grant of $30,000 towards putting down a class of pavement more fitted for the traffic conditions on the roads leading into Toronto. It is to be regretted that an opportunity like the above should have been turned down by the provincial authorities. It shows very clearly that meetings like the International Roads Congress are most useful in spreading a knowledge of the resulting benefits from proper road facilities. We are pleased to note that the Dominion Government has appointed the Hon. Frank Cochrane as their representative to the Roads Congress for 1913. We sincerely hope that this action will be followed by the several provincial authorities throughout the Dominion, and we believe that results would justify the appointment of delegates from the different county road boards and the cities and towns throughout the country.

## CONSULTING ENGINEERS WANTED.

We note in the daily press the following advertisement: "Applications from consulting engineers will be received by the Advisory Industrial Committee of the Toronto Board of Education to instal the power, mechanical equipment, heating, ventilating, illuminating, plumbing, and other appliances in connection with the new Technical School of Toronto. Applications to be addressed to the Secretary-treasurer, Board of Education, City Hall, and to be sent not later than July 2nd, 1912."

The mental capacity of the Toronto Board of Education is exhibited very well by the above. They are accustomed to call for tenders for the material used in the construction of the buildings, so naturally they call for tenders for the engineering knowledge necessary to design and equip the new Technical School. All that is needed to complete the above advertisement is the statement: "The lowest tenderer not necessarily accepted." It would be natural to expect that should one of the Board desire expert medical services he would insert an advertisement, stating the nature of the trouble, and asking for applicants for the position of medical consultant. Or if a lawyer were needed for certain legal advice, naturally the Board, or its individual members, would turn to the publicity of the daily press, and, by soliciting competition between members of the profession, secure the needed advice and the lowest possible market figure for the same.

No doubt applications will be received in answer to the above; and the Board, exercising their accustomed business acumen, will choose the tenderer whose price looks reasonable to them. The city, however, will eventually pay, and pay well, for such methods. The consulting engineers in Canada who take on the class of work outlined in the advertisement are not very large in number, and, by enquiry, in a very short time the Board could have secured reliable information regarding the securing of a competent man. As long, however, as they proceed in the way they have done, the city can expect to pay the difference between expert engineering advice secured in a proper manner and plumber's experience obtained on the "lowest tender" principle, and the difference will be found on examination to be considerable.

## THE NEW COMMISSIONER OF THE DOMINION RAILWAY BOARD.

Official announcement has been made that the Government has appointed Henry L. Drayton, K.C., of Toronto, as chief commissioner of the Dominion Railway Board, to fill the vacancy created by the death of the late Judge Mabee. This appointment will receive the unanimous approval of those interested in a capable and efficient Railway Board. It is well known that the efficiency of the Board depends almost altogether on the personality of its chairman. Mr. Drayton, as corporation counsel for Toronto, has succeeded in no mean way in his fight for a square deal for the city with the different corporations, and it is for his ability as a public service lawyer there that he has been chosen for the chief commissionership. The Dominion Government has made no mistake in choosing Mr. Drayton, for we feel sure his judicial fairness, his executive ability, and his strong personality will make him no mean successor to the late Judge Mabee.

## A BRIDGE FOR VANCOUVER ISLAND.

A British Columbia delegation has just waited on the Dominion Government to urge Federal aid for the proposed construction of a bridge to connect Vancouver Island with the mainland at Seymour Narrows on Butte Inlet. The Department of Public Works in the near future will undertake a survey of the situation to determine the feasibility and probable cost of the undertaking. It is understood that a previous survey was made about forty years ago by Sir Sanford Fleming, who at that time estimated the cost of bridging the Narrows at $18,000,000. The delegation informed the Government that they believed with modern methods of construction the bridge could now be built for about $15,000,000. They urged the Government to undertake the work in order that Vancouver Island might have railway connection with Eastern Canada. It was further pointed out that no single transcontinental line could undertake a work of such magnitude alone, and that, therefore, the Federal Government should build one bridge available for all three transcontinental lines, charging a rental to each road on a mileage basis.

There is little question that, should the Government feel justified in committing itself to the project, it would mean a tremendous impetus to the development of Vancouver Island. The immense and now comparatively undeveloped resources there would immediately become capable of development. The engineering features of such a bridge from the point of view of design and construction would be of great interest if the Government decide to finance the work.

## EDITORIAL COMMENT.

In last week's issue we published an article, entitled "Longest Reinforced Concrete Arch Bridge in the World." Unfortunately we omitted placing the author's name in the text. Mr. V. Elmont, of Westmount, Que., very kindly compiled the article for us, and we are glad to make this correction here.

* * * *

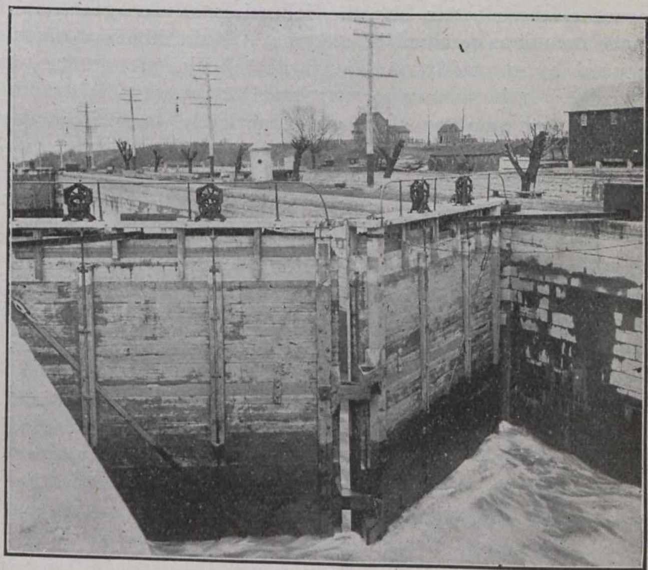
We note considerable criticism in the daily press concerning the expenditure of the highway improvement vote in Saskatchewan. Statements are being made to the effect that the appropriation is being used for political purposes. No doubt much of this talk is of a pre-election nature. At the same time it is to be hoped that the Government will deal fairly with this money, for they have a magnificent opportunity to illustrate the benefit to be derived in the building of bridges and good roads for the opening up of the country.

* * * *

Toronto is at last awaking to the necessity for placing overhead electric wires underground. The Board of Control has arranged a conference with Premier Borden pending an application to the Dominion Railway Board, to compel all Dominion companies having overhead wires in the down-town section placed underground. We doubt very much whether any other city in Canada is in as bad condition from overhead wires as Toronto, and it is high time that definite action was taken for the removal of these wires. Montreal has done a great deal during the past two years to improve conditions there, and the extraordinary growth of Toronto justifies immediate action.

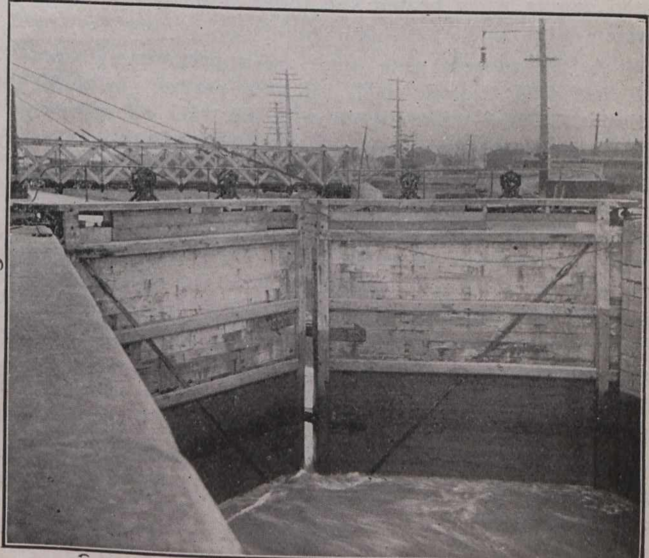
## A SAFETY DEVICE FOR PROTECTING LOCK GATES.

The problem of protecting canal lock gates from possible injury from vessels is most important. A device which has been used very successfully on the Welland Canal is the Gowan safety device. It might be explained that miter gates in a lock consist of two leaves or wings, one hinged on either lock wall, which, when closed, rest against a sill



**Front View of Gates, Showing Gowan Safety Device.**

on the bottom of the lock and against each other along the miter joint. When the pressure of water is against these leaves their safety depends on the miter joint being held intact. In case of a vessel coming up-stream and striking one of these leaves, as shown in the sketch, it forces this leaf back a short distance; and with the ordinary miter joint, the moment this leaf is forced back the support for the opposite leaf which rested against it is removed and the pressure of water upsets it. The pressure of water now



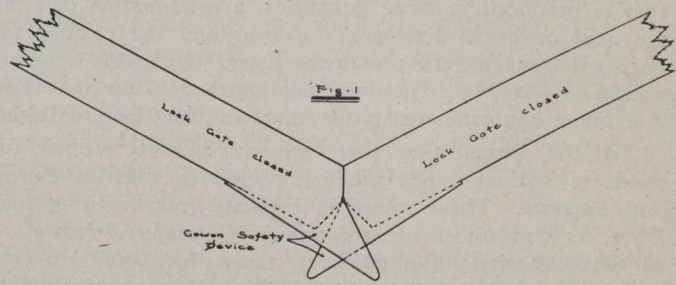
**Rear View of Gates, Showing Gowan Safety Device.**

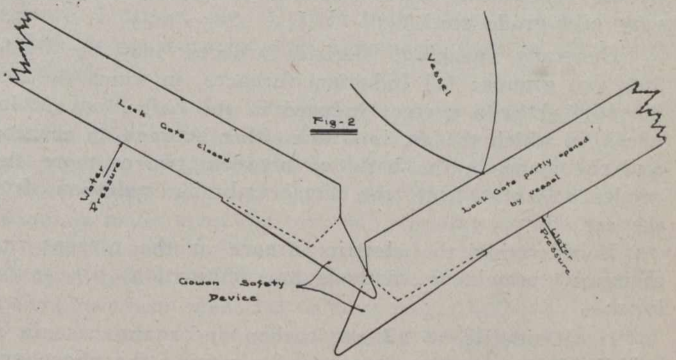
forces the first leaf (and the vessel) down stream, and it also upsets.

The Gowan safety device, as applied to the existing gates on the Welland Canal, consists of four very strong cast steel fingers, two on each leaf, one towards the top of the leaf and the other towards the bottom. These fingers project a couple of feet beyond the miter, and, as will be seen from the sketch and photograph, one leaf can be pushed back very nearly the full length of the finger, but still give support to the opposite leaf.

Vessels rarely hit the lock gates with any great speed, and it is anticipated that this device will prevent a large majority of accidents which would otherwise occur.

The fingers are placed on the leaves, as shown, those on one leaf fitting in between those on the opposite leaf. This will prevent one leaf from jumping off its pivot when the other one is struck, as usually happens, the upward water pressure on the bottom of the gate being sufficient to lift it.




We are indebted to Mr. J. L. Weller, engineer-in-charge of the Welland Canal, for the above information, and for the use of the sketch and photographs. It might be added that it was through Mr. Weller's efforts that the safety device has been installed there.

## ELECTRICITY vs. STEAM FOR WATER PUMPING.

Some interesting figures are shown by a comparison of the cost of pumping water by electricity and steam in the city of Woodstock, Ont. A short time ago the pumping facilities were changed so as to employ the power furnished by the hydro-electric commission.

In January, 1911, there was pumped by steam 46,494,000 gallons of water with the use of 145 tons of coal at a cost of $3.15 per ton. In January, 1912, there was pumped 40,400,000 gallons. The coal used in this month was 18 tons for heating purposes only. In February, 1911, the amount of water pumped was 43,484,000 gallons with 136 tons of coal, as against 38,000,000 gallons in February this year. In March the record shows 48,524,000 gallons last year with 151 tons of coal, and 40,000,000 gallons for March this year. The water is pumped against a head of about 100 pounds pressure.

The actual figures for the electrical operation have not as yet been computed, but it is estimated that the cost will be reduced by about $2,000.00 per year.

Woodstock pays $29.16 per horse-power, including a charge of $3.16 for stepping down expense.

## THE ELECTRIC FURNACE AS A MEANS OF PRODUCING IMPROVED STEEL.*

**By W. R. Walker.†**

In the manufacture of steel by either the Bessemer or open-hearth process, it is very difficult to remove the last traces of oxygen. In the basic Bessemer process the over-blown metal, which is an extreme case of oxidation, contains only 0.06 per cent. oxygen. Oxygen in combination with carbon (carbon monoxide), silicon, iron, aluminum and manganese, and also the combinations of silicates with these oxides, are very deleterious in steel.

My investigations lead me to believe that in the manufacture of steel for the so-called heavy products and steel that is produced in large quantities, a combination of either the acid or basic Bessemer converter and the electric furnace will take a very prominent place. With this combination it is possible to produce steel extremely low in oxygen and other impurities at a cost that will not be prohibitive.

At the present time there are over seventy electric furnaces of various types producing electric steel in Europe and America. These range in capacity from 1 to 15 tons. There is now under construction in Germany a furnace of 25 tons capacity. A number of these furnaces are competing successfully with crucibles in the manufacture of very high-grade steel

Generally speaking, electric furnaces may be divided into two groups: (1) Induction furnaces, in which the heat is supplied by a current induced in the bath; (2) arc furnaces, in which the arc is struck either between an electrode and the metal in the bath, or between two or more electrodes so as to heat the metal only by radiation from the arc.

In operating the electric furnace at the present time the most prominent methods or combinations are as follows:—

(1) Oxidation of silicon, carbon and manganese in an acid-lined Bessemer converter and removing the phosphorus in the basic-lined electric furnace with an oxidizing slag and then recarburizing, and with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(2) Removal of silicon, carbon, manganese and phosphorous in a basic-lined Bessemer converter, and further removing phosphorus (if desired) in the basic-lined electric furnace with an oxidizing slag, and then with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(3) Removal of silicon, carbon, manganese and phosphorus in the basic open-hearth furnace and then recarburizing, and in the basic-lined electric furnace with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(4) Melting of cold scrap of inferior quality in a basic-lined electric furnace; removing phosphorus with an oxidizing slag and then recarburizing, and with the aid of manganese and carbon and with a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(5) Melting high-grade materials in the electric furnace and dead melting as in the crucible process.

The phosphorus is removed in the basic electric furnace in the same manner as in the basic open-hearth furnace—that is, by the use of lime and oxide of iron—and the resulting slag containing the phosphorus is removed and a new slag formed consisting of burnt lime and fluor spar; when the slag is melted, coke dust is added, which, coming in contact with the lime in the slag and the electric arc, produces carbide of calcium. The free carbon, and possibly the carbide of calcium in the slag, with the aid of carbon and manganese in the bath, eliminate the oxygen from the steel.

As compared with the Bessemer and basic open-hearth process, the electric has the following advantages: (1) The more complete removal of oxygen; (2) the absence of oxides caused by the additions, such as silicon, manganese, etc.; (3) the production of electric-steel ingots of eight tons in weight and smaller that are practically free from segregation; (4) reduction of sulphur to 0.005 per cent., if desired; (5) reduction of phosphorus to 0.005 per cent., as in the basic open-hearth process, but with the complete removal of oxygen.

As evidence of the reducing properties of the slag in the basic electric furnace, it has been found that if oxide of manganese and oxide of iron are thrown on the molten slag, the oxides are reduced to the metallic state and the reduced metal goes into the bath. Blown metal from the acid Bessemer converter, containing only 0.10 per cent. to 0.20 per cent. manganese, has been completely deoxidized in the electric furnace without addition of manganese or aluminum, the usual amount of silicon being added in the steel ladle. Rails made from this steel are now in service. The composition of one heat of this steel is as follows:—

| | Per cent. |
|---|---|
| Carbon | 0.55 |
| Manganese | 0.13 |
| Sulphur | 0.017 |
| Silicon | 0.19 |
| Phosphorus | 0.022 |

These rails are comparatively soft, but are showing superior wearing qualities compared with the Bessemer rails in the same track and under the same service conditions.

Electric-steel ingots crack much less in rolling than either Bessemer or basic open-hearth steel. Cold electric-steel ingots, when heated and rolled into rails, roll extremely well.

At the present time there are approximately 5,600 tons of standard electric-steel rails in service in the United States. These rails have been in the track about two years. During the past winter some of these rails have been subjected to very low temperatures—in some cases as low as —52° F., and are being exposed to all possible conditions of severe service. It is too early to state much about the wearing qualities of these rails, but from present indications it would appear that rails made by the basic electric process can be made somewhat softer than by either the Bessemer or basic open-hearth process and still show highly satisfactory wearing qualities. Up to the present time we have not heard of any basic electric rails in use in this country being broken in service.

For experimental purposes I have had made a small tonnage of electric-steel rails, which have varied in analysis as follows:—

| | Per cent. |
|---|---|
| Carbon | 0.50 to 0.75 |
| Manganese | 0.13 to 0.80 |
| Silicon | 0.10 to 0.40 |
| Phosphorus | 0.02 to 0.06 |

On account of the wide variation in the chemical composition of this steel, it would be difficult, without going

*Abstract of paper delivered to American Iron and Steel Institute.

†Assistant to the President, United States Steel Corporation, 71 Broadway, New York City.

into considerable detail, to discuss the physical properties of these rails. It might be stated, however, that electric steel of a given tensile strength has a slightly greater amount of elongation than basic open-hearth steel, and that electric steel is somewhat denser than basic open-hearth or Bessemer steel.

With the electric furnace it is possible to produce steel which, when magnified one thousand diameters, shows no oxides or slag enclosures.

As high-grade electric steel can be produced at a lower cost than crucible steel, there has been a gradual increase in the production of electric steel for certain purposes where crucible steel was formerly employed, and where it has been demonstrated electric steel can be successfully used. This increased production has not been so marked where the object has been the improvement of steel entering into products manufactured in large quantities where the expense involved for experimental work is very great, and where of necessity it takes several years to demonstrate if rails and other products made by the electric process are superior to those made by either the Bessemer or open-hearth process. From present indications it would seem probable that there will be a decided increase in the production of electric steel for these products in the near future.

### DISCUSSION.*

Three years ago the 15-ton, basic-lined Heroult furnace erected at the South Chicago works of the Illinois Steel Co. made its first heat. It was then the largest electric furnace in existence, and as yet none of greater capacity has been put into actual operation, although there are a few 20 to 25-ton furnaces under construction in Europe.

Our purpose was to demonstrate whether it was feasible to successfully operate a large electric furnace and make electric steel in large tonnages. At the time the South Chicago furnace was started the electric furnaces used in the manufacture of steel here and abroad were small, running from a ton or less to five tons in capacity. The aim abroad was largely to find a process cheaper than the crucible. Our aim was to command a superior steel, and, if possible, at a cost that would permit of its use in such products as rails.

Our mechanical, metallurgical and other problems proved many, and our experience soon demonstrated that the conditions surrounding the successful operation of a large electric furnace were in many respects entirely different from those involved in the use of smaller units. For example, the demands of a 15-ton electric furnace proved to be far in advance of the art of manufacturing electrodes. Our necessities represented a requirement that the electrode manufacturers of America and Europe had not been called upon to meet, and it took much time and money before there was finally secured the 20-in. round amorphous carbon electrode now being used.

While in the application of the electric furnace to the metallurgy of steel there is usually embodied the preliminary removal of impurities by oxidation, the thermal and chemical conditions that obtain are unusually favorable to the final purification of the metal. Although it has proved perfectly feasible to make steel of superior quality from even low-grade cold material, the usual practice at South Chicago is to refine in the electric furnace full-blown metal from the Bessemer converter.

While the electric furnace at South Chicago has probably operated on a greater variety of products than any other furnace in the world, especial attention has been given to the production of electric steel for rails. The results have been most promising.

The steel, in teeming, lies much more quietly than is ordinarily the case with open-hearth or Bessemer. The ingots when split show a very solid metal, with a remarkable freedom from blowholes. The pipe, unless filled, is as deep as with openhearth or bessemer steel. Segregation is at a minimum, and the steel is exceptionally homogeneous. Chemically speaking, almost any result within reasonable limits can be obtained. Physically, the metal is more dense than either openhearth or bessemer. In its ultimate strength and elongation for the same carbon, there is but little difference between electric and openhearth steel in the higher carbons. In the lower carbons, electric steel has a tendency to a higher tensile strength and a possibly somewhat lower elongation.

Many etched sections of rails indicate that the steel from the electric furnace is peculiarly uniform in structure, and it appears to be exceptionally free from oxide and slag inclosures as partially determined by microscopic examination. In fact, such superiority as electric steel may have, probably largely lies in its relative freedom from oxygen.

How much there may be in the theory advanced by some that the characteristics of electric steel are partially due to the influence of the peculiar thermal conditions upon its molecular structure, I cannot say. Certain indications, however, point to there being more in this hypothesis than is generally recognized.

We have, thus far, received no report of any breakage from the 5,600 tons of standard rails that we have shipped. Some of these rails have been in track for two and a half years or more. Some of the first rails that we produced were intentionally made upon the soft side, running as low as 0.55 per cent. in carbon. Our later electric rails, of which the laboratory results would indicate a relatively better wearing quality, have been made ten or more points higher in carbon.

On account of the comparatively short time that the electric rail has been in service, any statement in respect to its comparative quality is open to question. Of course, the final verdict on the merits of any steel must be in that metallurgical court of last resort—result in service. But whatever may be the verdict, American steel practice and the public must be the gainers from the extensive work that has been done in the endeavor to produce, through the electric furnace, a rail of superior quality.

* By T. W. Robinson, Vice-President Illinois Steel Co., South Chicago, Ill.

## OUTLOOK FOR RAILROAD EARNINGS.

**By H. M. P. Eckardt.**

The gross revenues of the Canadian Pacific Railway for March, 1912, were $10,389,000, as compared with $8,648,000 in March, 1911, and $7,667,000 in March, 1910. The increase in 1912 over 1911 therefore amounts to $1,741,000, or over 20 per cent., and the March, 1912, figures represent an increase of 35½ per cent. over March, 1910. Canadian Northern's traffic for March, 1912, was $1,572,700, representing an increase of $302,100, or about 20 per cent., over 1911, and an increase of $638,700, or about 68½ per cent., over 1910. Taking these two Western roads together, their gross earnings in the month just ended amounted to $11,961,000, which figure represents a gain of $2,043,000, or 20 per cent. over 1911, and a gain of 39 per cent. over 1910.

As the Grand Trunk earnings for March exceeded $4,000,000, the gross traffic receipts of the three systems amounted to about $16,000,000. These receipts are all passed through the bank accounts of the companies. So their average daily deposit with the banks in March would approximate $700,000, taking no account of interest on their investments and other income distinct from the freight and passenger receipts. With especial reference to the Western roads it is difficult to see how they can do other than continue to report satisfactory increases during the remainder of the calendar year. In an interview in The Monetary Times on August 6th, the Winnipeg manager of the Canadian Bank of Commerce says, "Everything points to the coming year as being the best we have ever had. * * * Speaking of prosperity, we need only consider the thousands of immigrants who are to enter Canada from both the Old Country and from across the border to realize that it would hardly be possible for anything but a successful year to follow."

There is no doubt that this remark applies with especial force to the business of the railways operating in Western Canada. It might almost be said that the immigration movement alone promises to ensure an eminently successful year for the railways.

Thus, taking the movement from the British Isles, it is well known that the Canadian Pacific and Canadian Northern steamships will derive a large revenue from the ship loads of European immigrants which they discharge at Halifax, St. John, and Montreal. There is not only the passage money across the ocean, but the passage money for the long land journey from the seaports to the Western points. In the case of the movement of American farmers the direct and immediate benefit experienced by our railways is more pronounced. For these settlers bring with them horses, cattle, implements, and effects by the train load. So with a promised movement of 400,000 or 500,000 new settlers into Canada in 1912, it would appear that prosperity for the railways was reasonably assured.

One may get some idea as to how these newcomers benefit the transportation companies by supposing that all of them settled in new towns or cities by themselves. An immigration movement of 400,000 would suffice to create 40 new cities of 10,000 population, or one immense city the size of Montreal. when one considers what an immense amount of freight has to be moved annually in order to supply Montreal's needs it becomes clear that the 1912 newcomers will minister most importantly to the prosperity of the railways.

A good farmer with a sufficient working capital will, with his family, create far more traffic for the railways than will the average family settling in a city. The farmer and his family create more traffic as consumers as well as producers. But, fortunately, one does not have to look solely to the immigration movement for indications of prosperity. Another thing which should help the Dominion is the revival of industry and trade in the United States. Depression has been more or less in evidence across the boundary line for a considerable time; and now there are signs of decided improvement. When the United States are prosperous Canada always derives considerable benefit.

Another auspicious development is the ending of Britain's labor troubles. It will be a little while before the real significance of this event is appreciated. But there is no doubt that the labor leaders saw distinctly that persistence in the attempt to paralyze the trade of the country was fast creating a hostile public opinion. This with the almost complete exhaustion of many labor unions' funds seems to point to the coming of a number of years devoid of important labor troubles. At any rate, British finance is now rising hopefully and confidently from the depression in which it has been involved. And one might presume that sound Canadian enterprises would receive a better welcome in London.

Our borrowings in London also minister importantly to increase the traffic of the Canadian railways. For the borrowings invariably spell increased imports of merchandise of one kind or another. In discussing the railway prospects there is the Western wheat crop of 1912 to consider. Last year 10,000,000 acres were seeded to wheat in the three prairie provinces. Whether this area is increased or not depends largely on the climatic conditions prevailing in the spring months. Fall plowing was interfered with late in 1911 by unfavorable weather; and the farmers are said to have entered the spring season handicapped on that account.

On the other hand there are this year 20,000 more farmers at work in these provinces. Some of them are farming on a big scale. Whatever may be the fortunes of the crop it will probably create much traffic for the railways—before and after it is harvested. Finally, the transportation of construction materials required for new mileage now under way promises to bulk importantly in the accounts of the railways. These and other considerations doubtless have played their part in creating and strengthening the optimism with which the securities of the representative railways are now viewed.

## THE PUBLIC HIGHWAYS ACT OF SASKATCHEWAN.

The following is an abstract of the Public Highways Act of Saskatchewan, passed on March 15th, 1912.

There shall be expended annually under the provisions of this Act such sums as may be determined upon from time to time by the Lieutenant-Governor-in-Council, but not exceeding in the aggregate the amount voted by the Legislative Assembly for the purpose.

For the purpose of carrying out the provisions of this Act there shall be a board to be styled "the board of highway commissioners" consisting of three members to be appointed by the Lieutenant-Governor-in-Council, one of whom shall be appointed as chairman; the said commissioners shall receive such remuneration and perform such duties in addition to the duties assigned to them by this Act as may be determined by the Lieutenant-Governor-in-Council.

There shall be associated with the board for advisory purposes a committee consisting of two members to be appointed annually, one by the executive of the provincial organization representing rural municipalities and the other by the executive of the provincial organization representing urban municipalities. The members of this committee shall receive for attendance at meetings at which they are requested to be present by the chairman of the board such per diem allowance and travelling expenses as may be fixed by the Lieutenant-Governor-in-Council.

It shall be the duty of the board and it shall have power:

To lay out, plan and determine upon a system of public highways for the province which system may from time to time be altered or modified as the board may determine;

To determine upon the most feasible and economic methods for constructing, improving and maintaining public highways;

To furnish the officers of municipalities with information respecting the construction, improvement and maintenance of public highways:

To appoint such engineers, inspectors and officers as are necessary for the proper carrying out of the duties of the board and the provisions of this Act. All such appointees shall receive such remuneration as shall be determined by the Lieutenant-Governor-in-Council;

To inquire into and to report from time to time to the minister upon such matters as he may direct;

To report annually to the minister upon all work done and moneys expended under their direction as provided by this Act.

Subject to the approval of the minister the board may expend such sums of money as it may deem advisable upon the construction or improvement of any public highway and may also enter into any contract or agreement with any person, company or municipality for the construction or improvement of any such highway; the minister shall before approving of any such expenditure, contract or agreement, require the board to furnish him with such plans, specifications, estimates and other information as he may deem necessary respecting the proposed work.

For the purpose of the better carrying out of the provisions of this section the Lieutenant-Governor-in-Council may from time to time make such general regulations as may be deemed advisable regarding the expenditures to be made by the board on public highways.

All the provisions of The Public Works Act concerning the entering upon and the expropriation of lands required for public works shall apply to any works carried on or proposed to be carried on by or under the direction of the board and for the purposes of the said entry and expropriation the board shall have all the powers conferred upon the minister by the said Act.

The minister shall submit annually to the Legislative Assembly within the first fifteen days of the session thereof a report containing a statement of the work done and the money expended under the provisions of this Act.

The Lieutenant-Governor-in-Council shall have power to make any provision not inconsistent with this Act which may be required for the better carrying out of its provisions.

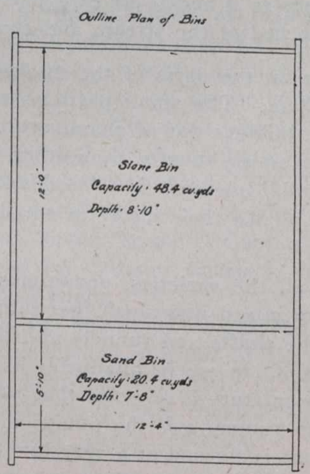
## A WELL-PLANNED CONCRETE PLANT.

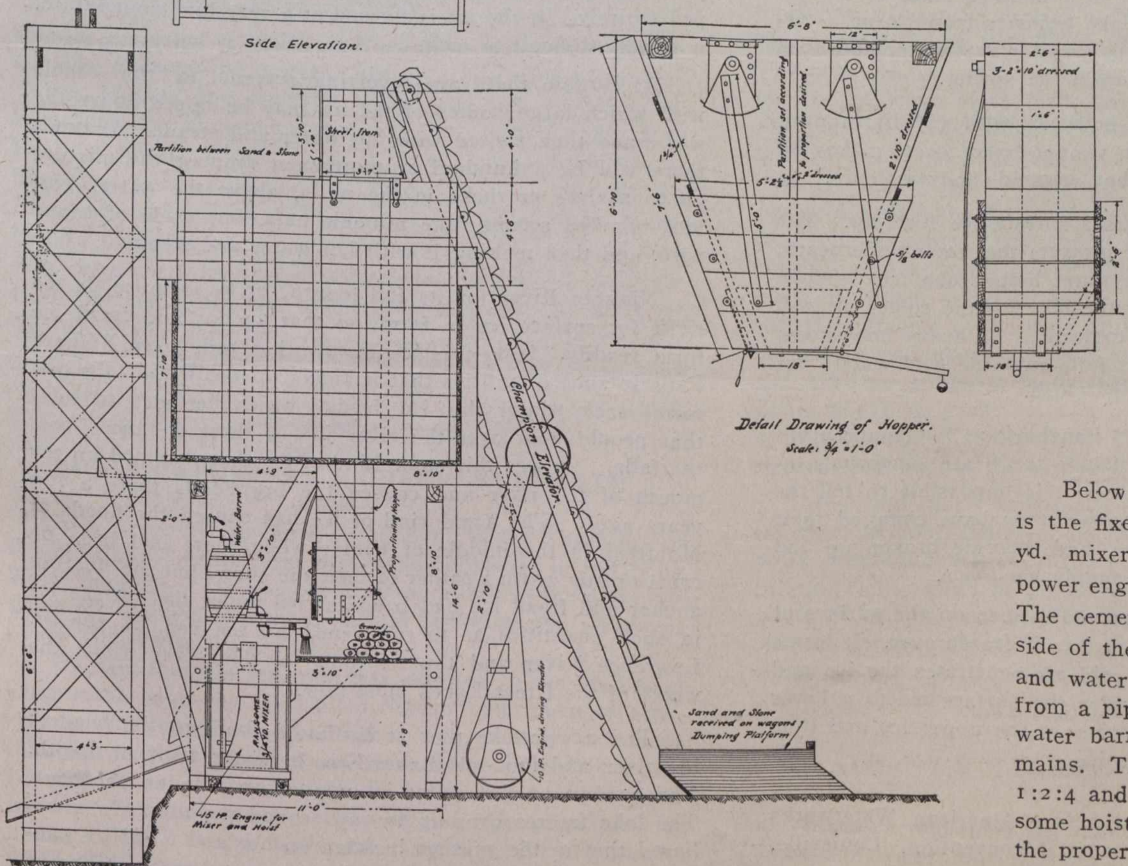
A plant lay-out which would be very suitable for buildings where about 10,000 cubic yards of concrete are to be placed is that which was employed in building the American Can Company's new reinforced concrete factory, located on Beach and Palmer Streets, Philadelphia. This building is five stories high with basement, and has over-all dimensions of 346 by 100 feet. The ¾-yard Ransome mixer has turned out 9,200 yards of concrete for this work, at times mixing 290 yards in a trifle less than eleven hours or 25 per cent. over normal rating. The plant has been so satisfactory that it has been taken down and is being used in constructing the new West Philadelphia High School, where about 8,000 yards of concrete will be mixed.

One of the features of this plant outside of its economy is the fact that it has been made so simple that it can be taken down and easily erected on another job. The tower is of wood and 100 feet high.

An inspection of the accompanying illustration will make perfectly clear the course the materials follow. The sand and stone, the latter mostly ¾-in., are dumped from wagons on to the platform and raised by a bucket elevator, driven by a 10-horse-power engine, to the sand and stone bins at the top. The stone bin has a capacity of about 48 yards, while the sand bin holds about 20 yards. From this point the aggregate fall by gravity into a proportioning hopper being admitted through gates. The hopper is provided with a partition that can be set according to proportion desired.

Below the proportioning hopper is the fixed batch hopper of the ¾-yd. mixer operated by a 15-horse-power engine that runs the hoist also. The cement is piled in bags alongside of the top of the mixer's hopper and water is turned into the latter from a pipe leading from a marked water barrel connected to the city mains. The concrete is proportioned 1:2:4 and is discharged into a Ransome hoist bucket that is unloaded at the proper point. The contractors on this job are Cramp & Co., of Philadelphia, with F. V. Warren in charge.




A Well-Planned Concrete Plant.

## ICE TROUBLES AT BUFFALO.*

By Henry L. Lyon.†

The city of Buffalo takes its water supply from Niagara River and Lake Erie and pumps it direct into the city mains. The source of supply is unlimited, it is only a question of being able to get it to the consumers on time. The reservoir holds 116,000,000 gal., but is not at a sufficient elevation to supply more than half the city and would not supply that part satisfactorily for more than a few hours. The daily average consumption of the city is 135,000,000 gal. and at times it runs up to 200,000,000 gal. The reservoir on the low service and the water tower on the high service act as balance wheels in regulating pressure.

The old intake pier is situated about the middle of Niagara River and 1,000 ft. from the pumping station, which is situated on the bank of the river. The intake is built in the narrowest part of the river about 1 mile from the foot of Lake Erie. The current is from 7 to 15 miles per hour. The pier is connected to the suction canals, or wells, in the station by two tunnels under the river. One is 6 ft. in diameter, the other 6 x 12 ft. in cross section. The ports to admit the water are about 4 ft. above the bottom of the river and on both sides of the pier. The river at this point is 16 ft. deep, the bottom being a smooth limestone rock, with scattered boulders. On the sides of the pier are ice shields of steel (see Engineering Record, April 1, 1899) extending to 2 ft. above the bottom of the river, so that the water must come under the shields from the bottom of the river, not the surface; on the sides of the shields are gates that can be opened and closed so it is possible to take the surface water if ice closes the lower levels.

When ice is running down the river the current turns it over and over and churns it up, forcing large quantities to the lower levels so that the river is a floating mass of ice for its whole depth. When the lake becomes frozen over a certain phase of the ice trouble is over for the winter and does not reappear until the break-up in the spring.

The location of the pier, however, with a swift running river for a mile above so it cannot freeze over, makes an ideal situation for frazil, anchor, ground, and slush ice.

The swift current prevents a surface ice forming. The frozen ice surface in the lake protects the water underneath, as the cold air will penetrate water better than ice. When the water flows from under the lake ice the colder air will cause frazil and anchor ice to form. A heavy snowstorm will not melt readily when it falls into the cold water, but becomes waterlogged and forms slush.

The terms "surface ice," "anchor ice," "ground ice," "frazil ice," "pebble ice," "slush ice," are somewhat indefinite. In a great many cases it is impossible to tell the several kinds of ice apart after they have changed their original position or formation and become broken up and mixed. They then become simply slush ice.

Surface ice is the form generally seen on the surface of lakes and ponds, when their surface is frozen over. It forms first on the surface, as the cold air penetrates the ice and reduces the water directly under the surface ice to a lower degree, it turns into ice, attaches to the upper ice and thus increases the thickness of the ice.

Anchor, or ground ice, will only form in a running stream on a clear, cold night, the air temperature being very near or below zero. It never forms under surface ice or in cloudy weather. It forms near the bottom of the river and attaches itself to rocks or other hard substances, preferably a dark substance. It loosens itself from the substance to which it is attached when the sun rises or the weather moderates. It is very buoyant and if stones or other things are imbedded in it will raise them and float them down stream. It has been known to raise and float abandoned anchors so they could be recovered by the owner or pirates. Small boats should look out for such conditions, because at times anchor ice rises in large masses and has been known to overturn such boats.

Frazil ice is only formed in swift running streams, where surface ice cannot form and then only in very cold weather. It forms best on a dark, windy day, or a clear, cold, windy night, when the wind is blowing against the currents. It consists of fine crystals sometimes very hard, and floats readily. When it, as well as anchor ice, is forced under surface ice and attaches to it and to its own particles, it will often fill up the whole bed of the stream and cause floods.

Anchor ice forms on the ports of the intake pier, so as to completely close them. The small particles seem to rise out of the water, like bubbles out of champagne, and attach to the sides of the openings, then to each other in lightning rapidity, until the whole opening is closed and cannot be broken by pike-poles. We then resort to small charges of dynamite.

Runs of ice of all the varieties, sometimes separately, more often all of them mixed into slush, get into the intake, pass down through the shafts and tunnels and then into the suction canals, or wells, in such quantities as to clog the pumps. At times the mixture is so solid that water will not pass through it to the pumps, and the pumps must be stopped entirely. If the ice is formed at a very low temperature, it is very difficult to melt.

At Buffalo there are revolving screens in the canals with which large bodies of the ice may be raised above the water and then melted with hot water and steam. At times there will be a hundred or more men dipping the mixture on to shelves or racks in the wells, above the water, with long-handled scoops, like minnow nets, but made of heavy wire, and then melting it with hot water and steam.

Niagara River for its full length, 35 to 40 miles, is too swift for surface ice to form, so that anchor and frazil ice form readily. It is this ice mostly that runs over Niagara Falls in such quantities that it banks up below the falls and forms each winter the ice bridge which becomes so solid that people walk over the river just a short distance from the falls. It was this same kind of ice that dammed up the mouth of the river and caused the big floods there a few years ago. The same kind of ice has caused the floods at Montreal in the middle of winter when there had been no rains or any warm weather to melt the snow, but the floating anchor and frazil ice had been carried under the surface ice in such quantities as to completely fill the bed of the St. Lawrence River and thus formed a dam over which the whole of the Great Lakes must flow.

The new intake pier at Buffalo is built at the head of the river and foot of Lake Erie in water 24 ft. in depth. The current at this point is only about 2 miles per hour. The lake freezes over up to and around the pier. It is believed that in the present location anchor and frazil ice cannot form; the surface ice will form only 15 in. in thickness and ice troubles are probably a thing of the past.

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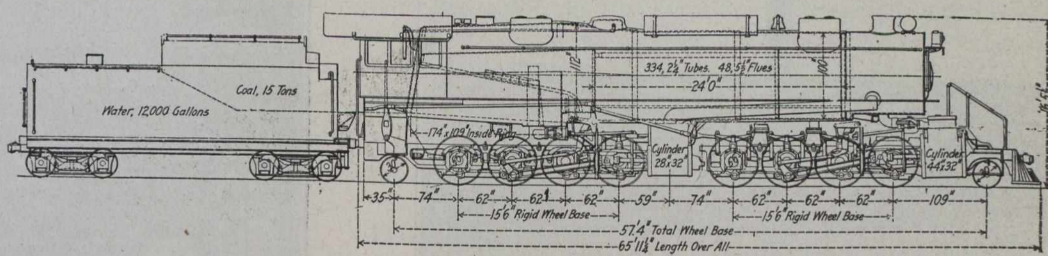
* Abstract of paper read before American Waterworks Association at thirty-second annual convention, Louisville, Ky., June 3-8, 1912.

† Deputy Water Commissioner, Buffalo, N.Y.

## A NEW LOCOMOTIVE.

The American Locomotive Company is just completing for the Virginian Railway four Mallet compound locomotives that far outclass in weight and power even the largest of the most recently constructed big locomotives. The engine will weigh, in working order, 540,000, with 479,200 lbs. on drivers. The combined weight of the engine and tender will be 752,000 lbs. The total length of the engine over all is 65 feet 11¼ inches, and total length of wheel base, 57 feet 4 inches. These engines will have a tractive power of 115,000 lbs. or 60 per cent. more than the pioneer of this type built in America for the Baltimore and Ohio Railroad. By the American Locomotive Company's system of compounding, the tractive power at slow speeds can be further increased to 138,000 pounds by working the engine simple.




With two of these Mallets as helpers and a Mallet of 92,000 lbs. tractive power as a road engine, it is expected to take a train of 4,230 tons over a 14 mile, 2.07% grade. This grade is the ruling point on the entire line as all the tonnage passes over it. The road engine will then take the train unaided through to the terminal of the division.

Vanadium steel was used in the frames, crossheads, driving tires, all springs, main driving axles, main crank pins, centre of piston heads. Cast iron containing vanadium was used for cylinder castings, valve chamber bushings, piston bull rings.

Apart from the enormous weight and power of the locomotives, the dimensions of some of the principal parts are impressive as showing the extent to which all limits were exceeded in their design and construction. The following dimensions warrant special attention:

| | |
|---|---|
| Outside diameter of boiler at front end | 100" |
| Outside diameter of largest ring | 112" |
| Tubes, number and diameter | 344; 2¼" |
| Flues, number and diameter | 48; 5½" |
| Heating surface, total | 6760 sq. ft. |
| Superheating surface | 1310 sq. ft. |
| Fire box ring | 184½" x 119" |
| Length of boiler | 50' 1⅛" |
| Low pressure cylinders, diameter and stroke | 44" x 32" |
| High pressure cylinders, diameter and stroke | 28" x 32" |
| Tender, water capacity | 12,000 gal. |
| Tender, coal capacity | 15 tons |

## PURIFICATION BY COPPER SULPHATE.

In a paper before the Institution of Water Engineers of Great Britain, on the "Use of Copper Sulphate in Purifying Water Supplies," Mr. George Embrey described the measures taken for destroying plant-growth in the Witcombe reservoirs of the Gloucester Waterworks.

He said that his attention was directed to the reports of experiments made by the United States Department of Agriculture with copper sulphate, and in 1904 and 1905 numerous investigations were made to determine the amount which could be used for the destruction of the lower forms of plant life without destroying the fish or rendering the water toxic to human beings. It was found that quantities of 1 to 1,000,000 fulfilled these conditions, but quantities of 1 to 3,000,000 were sufficient to destroy the Algæ which were believed to cause the trouble. In 1908 permission was given by the Sanitary Committee to carry out an experiment at Witcombe reservoirs, which were at the time choked with "Chara Vulgaris." This plant was propagated by means of spores contained in an Archegonium, and fertilized by Antheridia from an Antheridium; the bursting of the Archegonium set free myriads of minute greenish cells, which, with the countless Anthrozoids, gave the water a distinct color and a fishy odor. In consequence of this odor it had been suggested that the particular Chara was a new species named Chara Fœtida, but the author did not find that the plant differed in any material respect from the well-known Chara Vulgaris, except in regard to the odor. This, however, was removed by washing the plants, and an examination of the washing water revealed the presence of numerous Spongilla Fluviatalis, which gave out a distinctly fishy odor. A portion of these was used to inoculate a nutrient agar medium, which, on incubation, yielded Proteus Vulgaris, an organism well known to evolve a fishy odor. The author therefore believed that this was the cause of the odor.

The author's method of applying the copper sulphate differed from that usually adopted, which was to place the crystals in a canvas bag trailed at the stern of a moving boat. The defect of this method was that the copper sulphate solution was very much diluted before it reached the bottom of the reservoir. This, however, was overcome by scattering the fine crystals over the surface of the water, as in sowing seed, the crystals falling rapidly to the bottom before dissolving. The sulphate was used in the form of a fine powder containing 98 per cent. of the salt, the present price of which was 28s. per cwt. The three reservoirs had capacities, when filled, of 60,000,000 gallons (No. 1) and 30,000,000 gallons each (Nos. 2 and 3), and for these 4 cwt. of sulphate was used, giving approximately a proportion of 1 to 3,000,000. Each reservoir was allowed to stand at least three days, and if convenient, a week, at the end of which period not a trace of sulphate of copper could be found in the water. The water should be treated in the early spring (about February), when the bottom was usually covered with diatoms only; in March and April the confervæ made their appearance, and later the Chara began to grow. It had been found that if the treatment was applied in the early stages the diatoms were destroyed, and neither the confervæ nor the Chara appeared.

After four year's experience the author could confidently say that the odor and color so frequently met with in reservoirs containing water collected from the Upper Lias and Inferior Oolite could be perfectly removed by the use of sulphate of copper, and that no danger need be feared if the operation were performed with care and under proper supervision.

## ALBANY'S TYPHOID DEATH RATE.

Albany's typhoid death rate in 1911, as reported by the Bureau of Water, was 15.8 per 100,000 population. The city is supplied with Hudson River water purified by sedimentation, double filtration and hypochlorite.

## NEW GARBAGE INCINERATION PLANT.

The extensive plant shown in the accompanying illustrations is a garbage and refuse destructor erected in the city of St. Petersburg, Russia, by Messrs. Heenan & Froude, Ltd.,

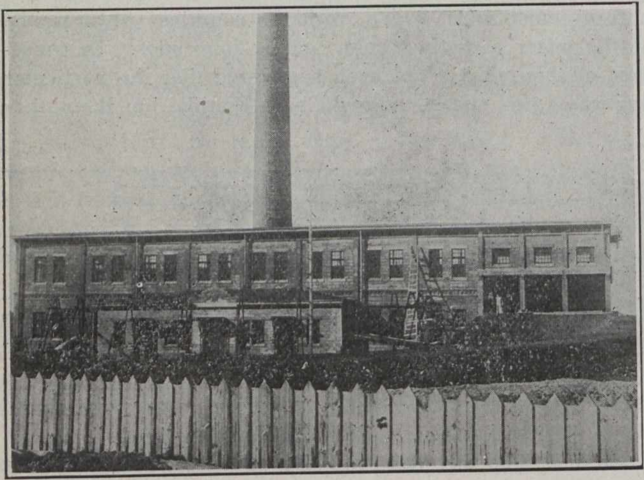


**Fig. 1.—General View of Heenan & Froude Garbage Incineration Plant for St. Petersburg, Russia.**

of Manchester, the parent company of Heenan & Froude of Canada, Limited, who are erecting somewhat similar plants for the same purpose in Ottawa, Moose Jaw, Calgary and Edmonton. The plant is designed to consume 150 tons per day

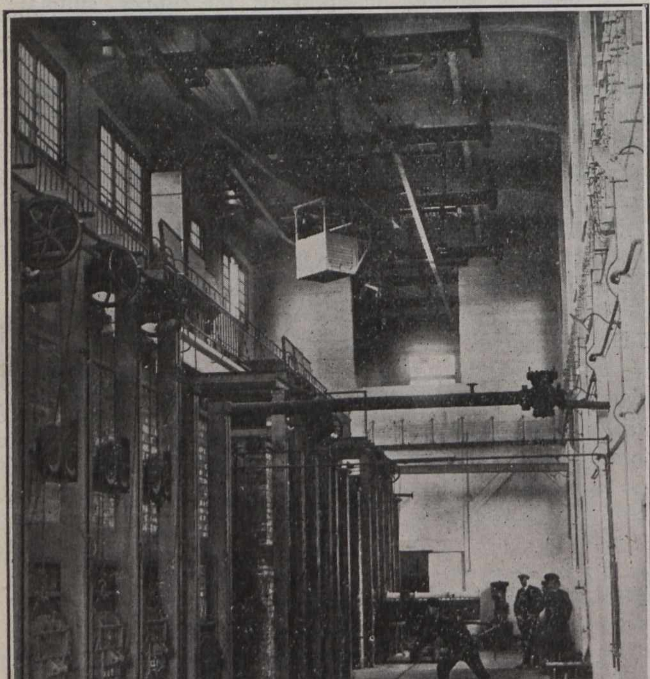


**Fig. 2.—View of Clinkering Floor Showing Method of Withdrawing Clinker.**

of the general city refuse. An outside view of the plant is shown in illustration No. 1.

The incinerator itself is of the new trough grate mechanical clinkering type. Illustration No. 2 shows the front of the furnace with a clinker truck opposite one of the grates in the rear of the room. A man is engaged turning a winch on this truck, which withdraws the whole of the clinker from the cell in one operation. As the illustration shows, this is easily performed by one man instead of requiring the laborious efforts of two or three as in the old style of clinkering.

The material to be consumed is charged into the furnace by means of a container opening into the top of the cell. These containers are shown in illustration No. 3. They are filled with material, the upper door is closed, and a door open-

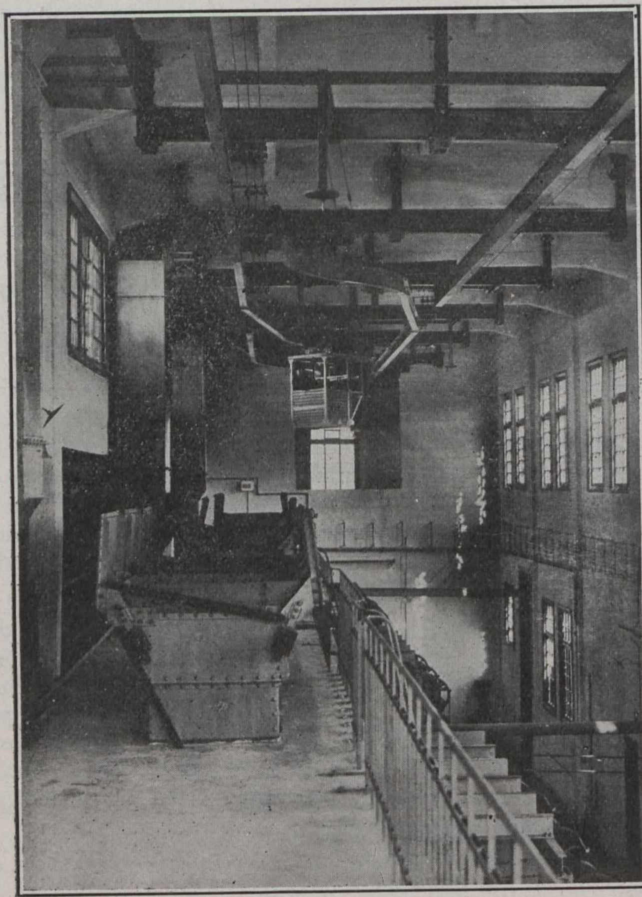
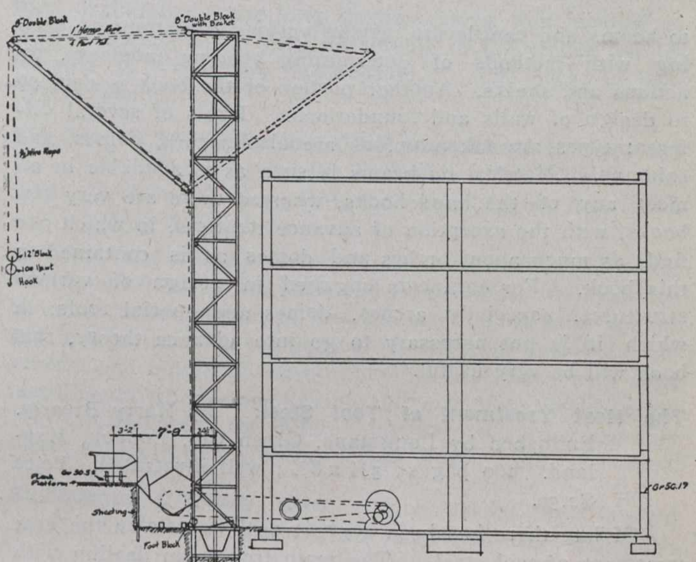


**Fig. 3.—Charging Floor Showing Top of Containers from Which Refuse is Charged.**

ing direct into the furnace is withdrawn by means of a winch operated from the clinker floor, and the contents are promptly precipitated into the furnace.

## THE CONCRETE PLANT OF A FOUR-STORY MACHINE SHOP JOB.

During the course of last winter the Aberthaw Construction Company, of Boston, erected a four-story reinforced concrete machine shop at Lowell, Mass., for the Lamson Consolidated Store Service Co. This reinforced concrete building is 150 by 50 feet in plan and has brick curtain walls. The general policy of the contractors is to heat both the sand and stone in freezing weather. However, on this only the sand was heated, as the owners who provided the heat has not sufficient steam capacity to heat the stone also. The stone was received in cars, and while the car was on the siding precautions were taken to keep snow out of it by canvas covering. The sand was delivered in wagons and dumped directly onto steam pipes laid on the ground and furnished with a continuous supply of steam during the day time only at about 12 lbs. pressure. To supplement this the contractors used flexible rubber steam hose and iron pipes which were thrust into the sand heaps in specific places where there was reason to doubt the temperature of the sand. The water was heated by having a steam-pipe reaching to the bottom of the water barrel, and salt was added generally in the proportion of about 2 per cent. of weight to the amount of the cement used, the percentage being varied slightly as the temperature changed.



PLANT LAYOUT
Lamson Consolidated Store Service Co
ABERTHAW CONSTRUCTION CO Boston

After examining the ground it was decided to place the mixer and hoisting tower at the north side of the building and to omit the building of one bay at the west end of the ground floor, so as to allow industrial cars with the coarse aggregate to be pushed through at the proper grade. Quick unloading chutes, extending from the side of the standard gauge cars were used, the material being dumped into a square-bodied dump car.

After being mixed the concrete was dumped into the Aberthaw hoisting bucket which is standard with this concern in all their construction work. The Aberthaw iron hoisting tower was used with the boom, moving the steel and centering to the upper floors. The distributing of the concrete was done with V-shaped Koppell cars, the length of carriage from the mixer to the point where it was placed on the job in question averaging less than 100 feet. The method of distribution with cars, which take an entire four-bag batch at one time, is very much more conservative in retaining the heat in the mass than when concrete is distributed in barrows. It should be added that salamanders were used after placing the concrete in each floor and the building enclosed in canvas floor by floor. The building was designed by Lockwood, Greene & Co., Boston.

## BRITISH COLUMBIA'S RAILWAYS.

Sir Richard McBride estimates the amount to be spent in railway construction in British Columbia during the next four years at $100,000,000 and expresses the opinion that the expenditure will in all probability be over that amount. Mention of the figures brings one to a realization of what is being done and what is contemplated by the different railway companies that are anxious to do business on the Pacific seaboard. Activity is not confined to any one road, but to all of the four which already have lines in British Columbia, namely, the Canadian Pacific Railway, the Great Northern, The Canadian Northern and the Grand Trunk Pacific, and also the Pacific Great Eastern, which is reckoned practically as the Grand Trunk Pacific. Work was begun this week on the large pier of the Canadian Pacific Railway which will cost three-quarters of a million dollars, and excavation is proceeding on the site of the new depot. The Canadian Pacific Railway will expend more in British Columbia during the next few years than for many years past. The Great Northern will double track its lines between Vancouver and New Westminster.

Mayor Findlay's proposition is that the city prepare to take over the lines of the British Columbia Electric Railway Company within the city, according to the terms of the existing agreement, in 1918. The members of the greater Vancouver transportation committee interviewed the premier this week, and mayor Findlay made his pronouncement upon his return. "Since the company will not compromise in any way in the matter of consolidation of agreements the city said he should decide upon a fixed policy to acquire the lines by arbitration at the termination of the agreement with the city." This suggestion was made in the city council last year, and the proposal that passed then was that the city set aside $500,000 each year so that it would have something to start with in 1918. The uncompromising attitude of the railway company is winning many to the principle of municipal ownership of this great public utility. More would be in favor of the acquisition of the lines but for the reason that they believe, that some other method of transportation will have been evolved by that time, and that the people will not be dependent on a company that has a monopoly of transportation in the whole of the lower portion of southwest British Columbia.

Vancouver has not had to trouble about its water supply, since there was plenty for every kind of use. Now that the city has grown, regulations are being enforced which people, accustomed to what prevailed previously, regard somewhat as a hardship. Residents in the outlying districts are sometimes practically devoid of water during the middle of the day, when it is required most. A large fire took place in South Vancouver this week and the supply of water there was insufficient. Such a condition will mean high insurance rates. The necessity of more water is presenting itself, a large watershed area in Seymour Creek Valley, above the city's reservoir might be secured and thus ensure the permanence and continuity of the supply. There is considerable timber on this area, and the owners have approached the British Columbia Electric Railway Company to construct a line to take the timber off. It is conceded that if this is done the water supply will be materially affected. Last fall the water committee took up the matter of purchase of these lands, comprising several thousand acres, and it was almost decided. The aldermen realize that the purchase must be made sooner or later. Half a million dollars or less will secure the whole of the watershed, timber, land and all, while if the city waits a few years longer double this amount will be required for the same purpose. The acquisition of this watershed has been recommended by the city engineer, the consulting waterworks engineers, in fact by all who have to do officially with the waterworks system.

One hears much of American enterprize and American aggressiveness but few companies have progressed so rapidly and expanded so widely as the Norton Griffiths Steel Construction Company, with British capital and Britishers conducting it. This concern has had the contracts for some of the largest and best buildings in the city, including the famous Burns block, and secured this week the contract for the construction of the new ten-story structure to be erected by Henry Birks and Sons at the corner of Granville and Georgia streets. The operation of a large company like this means the investment of considerable Old Country capital here.

# ENGINEERS' LIBRARY

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

## BOOK REVIEWS.

**The Design of Mine Structures.** By Milo S. Ketchum. Published by the McGraw, Hill Book Co., New York. Cloth; size 6½ x 9 inches; 544 pages; 77 tables; 300 illustrations in the text, and eight folding plates. Price $4.00.

It is a pleasure to record the publication of another book by Prof. Ketchum. His books are always examples of what technical treatises should be, and this volume is no exception to the rule. The design of mine structures is systematically discussed. While the design of headworks for mines is given the principal place, the design of buildings, bins, coal-washers and breakers is discussed very fully. Only the structural engineering side of the operation of mines has been considered and, therefore, the design of hoists and other machinery has been omitted. Statically indeterminate structures are briefly discussed, showing the application of the methods developed to the calculation of stresses in head frames. The methods for the calculation of stresses in simple frame structures and the methods for calculating the pressures on retaining walls and the stresses in bins are briefly discussed. Complete specifications are given for steel, timber and concrete mining structures. A brief resumé of the design of reinforced concrete is given in an appendix. While a good deal of the material appearing in this volume has appeared before in the author's other books, nevertheless the repetition has been justified. This volume is a self-contained, concise and valuable text book for the student, or the structural engineer who wishes to become familiar with the design of mine structures.

**Reinforced Concrete Construction.** Elementary course. By M. T. Cannell. Published by E. and F. N. Spon. 125 pages. Price $1.25.

This is a small book which has been gotten out primarily for those engaged in reinforced concrete design, who have a limited technical knowledge. A few pages are given to the construction of form work and the mixing and placing of concrete, also the nature of the ingredients. Several pages which are devoted to structural mechanics give bending moments, shears, abutment reactions, simple and continuous beams with various methods of loading. The design of reinforced simple beams, slabs, tee beams and columns are all taken up.

The book is another case of endeavoring to cover too great a subject in a small space, but it will be found useful for draughtsmen and superintendents unfamiliar with theory.

**The Principles of Structural Mechanics.** By Percy J. Waldram. Published by R. T. Batsford, London. 370 pages. Price $2.00.

This book is gotten out primarily to fill a long-felt want, namely, for a treatise on structural mechanics which is not over-burdened with mathematics, also one that can be understood by engineers or architects with a limited technical education.

The first part of the book deals with the theory of leverages and graphic statics, explaining the method of determining forces by graphical methods. A section is devoted to beams and cantilevers, giving various conditions of loading with methods of determining bending moments, reactions and shears. Another portion of the book is devoted to design of walls and foundations. Roofs of several different types are taken up, as are also arches, domes and columns. Material on beams is such as is available in almost any of the hand books, whereas there are very few books, with the exception of advance treatises, in which one finds as much about arches and domes as is contained in this book. For engineers engaged in design of various structures, especially arches, domes and special roofs, in which it is not necessary to go into advance theory, this book will be very useful.

**The Heat Treatment of Tool Steel.** By Harry Brearly. Published by Longmans, Green Co., London, England. 160 pages; 5½ x 8½; well illustrated. Price $2.50.

Of late there has been a great deal written on the heat treatment of tool steel. The main trouble in dealing with such a subject is to make one's information of practical value, but, unfortunately, as in many other departments, of engineering, those who are well informed practically, are either too busy or have no inclination to put into print what they know.

This book, written by a practical man, contains a great deal of well-written practical information. The theory of hardening and tempering has been well worked into the subject which, to say the least, is a relief to anyone at all accustomed to reading the tiresome learned discussions that appear from time to time. The illustrations also are excellent.

There are thirteen chapters in all, covering structure, fractures, forging and annealing tool steel, hardening and tempering, defective tools, hardening plants, pyrometers, case hardening, and a short discussion of alloy steels.

Anyone interested in the subject of tool steel should have this book.

**Measurement of High Temperatures.** Burgess & Le Chotelier. John Wiley & Sons, New York. Cloth; 510 pages; 6 x 9¼; illustrated. Price $4.00 net.

In the present day, the practical man has come to realize that the old methods of "judging temperature" are absolutely out of date, more so as the pyrometer has been brought to such a stage of perfection that anyone possessed of ordinary intelligence can operate it. This book has evidently been written largely with the object of helping engineers. The information has been very clearly put together, so much so that the book may be read by student, engineer or scientific investigator, and all three find his needs, the illustrations being very well suited to making the text clear.

The first three chapters deal respectively with standard scales of temperatures, gas pyrometry, and calorimetric pyrometry. Chapter IV. on thermoelectric pyrometers, is very complete. Next comes a description of electrical resistance pyrometers, following a thorough discussion of the laws of radiation. The radiation pyrometers are described, as are pyrometers in the next chapter.

The department of recording pyrometry, in which a great advance has been made of recent years, is very thoroughly gone into. This portion of the book, besides being of value to the student engaged in scientific research, is of interest to the practical man. One of the instances given where the value of having these instruments in works is that of an annealing oven fired by an old and new hand, the record showing how the more experienced hand saves time and money.

A final chapter treats of the standardization of pyrometers, etc. The bibliography of 24 pages is very extensive. The authors are to be congratulated upon the conciseness of their explanations, the long theories being well isoalted in such a manner as to give no trouble to the reader not interested in "such dry information." The book, in fact, "gives results."

**The Transit Theodolite, and Other Instruments Mechanically** Considered. By H. W. Vallé. Published by the author. Cloth; 4 x 6½ inches; 76 pages; illustrated. Price $1.00.

Mr. Vallé was for twenty-three years instrument maker to different firms in England, and is, therefore, well-qualified to write on the subject of instruments. This little volume has been written for the purpose of assisting surveyors, engineers and others in those difficulties associated with their instruments where help has not hitherto been forthcoming. The adjustments of the different instruments are covered very thoroughly and their general design is thoroughly discussed.

**Engineering Directory, 1912.** Published by the Crawford Publishing, Chicago, Ill. Cloth; size 4 x 6¾ inches; 1496 pages. Price $5.00.

The book aims to be a complete directory of the plumbing, heating, lighting, power plant and mill supply industries in the United States. It contains a list of wholesale dealers in plumbing, heating and lighting supplies; list of jobbers and dealers in mill, steam, mine and railway supplies, tools and machinery and in addition there are reliable mailing lists of waterworks and gas companies power plants, wholesale dealers in hardware and in electrical supplies and purchasing agents of railroads. The book will be found invaluable to the manufacturer and the engineer.

**Modern Illumination Theory and Practice.** By H. C. Horstmann and Victor H. Tousley. Published by Frederick J. Drake & Co. Leather; 4½ x 7 inches; 265 pages; illustrated. Price $2.00.

This volume is intended as a hand-book of practical information for the users of electric light, architects, contractors and electricians. Only as much of the theory is given as is needed for a comprehension of the underlying principles. Emphasis is placed upon the practical points which must be considered in the laying out of illumination.

**Farm Gas Engines.** By H. R. Brate. Published by The Gas Engine Publishing Co., Cincinnati, Ohio. Cloth; 5 x 7 inches; 190 pages; illustrated. Price $1.00.

This is a practical treatise on the action of the parts necessary to the successful running of a gas engine and is intended for the non-technical man. Chapters are given on carburation, compression, ignition, lubrication and cooling, and descriptions are included of the different types of gas engines in common use.

**Problems in Engineering.** First series. Edited by Sydney G. Turner. Published by St. Bride's Press, Limited, London. Cloth; size 5 x 7½ inches; 186 pages; illustrated. Price $1.25.

This is a compilation of the questions and answers printed from the assistants' and students' section of the the "Surveyor and Municipal and County Engineer," of London. The present volume is published in response to requests from readers of this section. The series of questions and answers will be found of assistance in the solution of many knotty points which arise in the daily work of the municipal engineer, for the series cover practically every phase of the municipal engineers' work.

## PUBLICATIONS RECEIVED.

**American Waterworks Association.** Proceedings for 1911 of the Thirty-first Annual Convention, held at Rochester, N.Y., June 9-10, 1911. Secretary-treasurer, John M. Diven, 47 State Street, Troy N.Y.

**Association of Dominion Land Surveyors.** The annual report, together with the papers read at the sixth annual meeting, held at Ottawa, on the 5th and 6th of March, 1912. Secretary-treasurer, E. M. Dennis, B.L.S., Ottawa.

**Canal Statistics for the Season of Navigation, 1911.** Issued by the Department of Railways and Canals. A. W. Campbell, Deputy Minister, Ottawa.

**Memoir No. 28, Department of Mines, Geological Surveys** Branch, The Geology of Steep Rock Lake, Ontario, by Andrew C. Lawson, and Notes on Fossils from Lime Stone at Steep Rock Lake, Ont., by Charles D. Walcott. R. W Brock, Director.

**An Investigation of the Coals of Canada, With Reference** to Their Economic Qualities, as Conducted in McGill University, Montreal, under the authority of the Dominion Government. In six volumes, Vol. 2 by J. B. Porter and R. J. Durley, issued by the Department of Mines, Mines Branch. Eugene Haanel, Director.

**Commission of Conservation, Canada, 1912.** The third annual report of the annual meeting held at Ottawa, January 16, 1912. James White, Secretary.

**Illinois Water Supply Association.** Proceedings of the fourth meeting held at the University of Illinois, March 5-6, 1912. Published by the society, Urbana-Champaign, Illinois.

**Association for Standardizing Paving Specifications.** The proceedings of the third meeting held at New Orleans, January 8-13, 1912. John B. Hittell, secretary-treasurer, 5917 Winthrop Avenue, Chicago.

**The Test of Clay Refractories with Special Reference** to Their Load-Carrying Capacity at Furnace Temperatures. By A. V. Bleininger and G. H. Brown, being No. 7 of the Technologic papers of the Bureau of Standards, Department of Commerce and Labor, U.S. S. W. Stratton, director, Washington.

**The White River Development.** A description of the construction of the Power Plant and system of Lakes at Puget Sound. Copyright, 1912, by Stone & Webster Engineering Corporation, Boston, Mass.

**Electric Power from the Mississippi River.** Being Bulletin No. 5, March, 1912, of the Mississippi River Power Co., Keokuk, Iowa.

**Vitrified Brick Pavements.** The National Paving Brick Manufacturing Association, Engineers' Building, Cleveland, Ohio, forward pamphlet illustrating the use of vitrified brick pavements for city streets and country highways.

## CATALOGUES RECEIVED.

**Circular 1155,** entitled Series Arc Light Systems with Westinghouse-Cooper Hewitt Rectifiers, has just been issued by the Westinghouse Electric and Manufacturing Company. This publication deals very thoroughly with series arc light systems, describing in detail the rectifier apparatus, the arc lamps, and shows a number of views of detailed parts of the apparatus together with installations of same.

**Descriptive Leaflet 2499,** issued by the Westinghouse Electric and Manufacturing Company, describes their type Q M direct-current commutating pole motor for driving air compressors, pumps, and large blowers. These motors are particularly adapted for this class of service on account of the excellent commutation and the long life of the brushes and commutators. A special feature is the ventilation, as air can reach every part of the machine. The leaflet describes and illustrates the various component parts of the machine.

**Descriptive Leaflet 2497,** issued by the Westinghouse Electric and Manufacturing Company, covers the Westinghouse underwriter's motors, which have been completed and built in accordance with the specifications and requirements of the Chicago Local Board of Fire Underwriters. This motor has a blower attached to the outer end of the shaft for ventilation and will operate continuously at rated load and voltage with a temperature rise not exceeding 40 degrees centigrade. Its particular application is driving fire pumps and sprinkler systems in buildings.

**Milling and Gear Cutters.** Weir and Napier, engineers, 58 West Regent Street, Glasgow, forward catalogue illustrating milling and gear cutters, twist drills and splitting saws, in carbon or high speed steel. The firm desire agents in all the leading cities of Canada to represent their various lines.

**Specialties for Marine Work.** W. H. Allen, Son & Co., Limited, Bedford, England, forward catalogue illustrating different types of centrifugal pumps, electrical generating machinery, oil engines, steam turbines, etc. A. L. Melville, resident engineer, 69 Victoria Street, Toronto.

**Industrial Railway System.** The C. W. Hunt Company, West New Brighton, N.Y., forward folder illustrating different applications of the Hunt Industrial Railway System.

**Concrete Machinery.** The London Concrete Machinery Co., of London, Canada, forward catalogue illustrating different types of concrete mixers, concrete block machines and moulds, and the different concrete machinery manufactured by them.

**Electrical Fixtures and Shades.** A new supply catalogue issued by the Canadian General Electric Co., Limited, Toronto.

**Crushing, Quarrying and Road-Building Machinery.** The Hamilton Machinery Co., Limited, Hamilton, Ont., the Canadian distributors for the American Road Machine Company, forward catalogues illustrating different types of crushing, road-building and quarrying machinery

**Steel Valves.** The Nelson Valve Company, Chestnut Hill, Philadelphia, Pa., forward catalogue illustrating various types of valves manufactured from bronze, iron and acid open-hearth steel.

**Pumping Engines.** The Standard Pump and Engine Co., Cleveland, Ohio, forward pamphlet entitled Standard Pumping Engines for Water Supply, descriptive of different methods of their apparatus.

**Steam Turbines.** The Kerr Turbine Company, of Wellsville, N.Y., forward pamphlet called The Economy Steam Turbine, being their catalogue No. 25, illustrative of different types of steam turbines manufactured by them.

**Railway Signals.** The General Railway Signal Company, of Rochester, N.Y., forward new binder for their loose-leaf catalogue.

**Engines.** Ruston, Proctor & Co., Limited, Lincoln, England, forward pamphlet entitled The Process of Ruston, Proctor & Co., Engineers, Lincoln, England, which illustrates the different engines, suction gas plant, gas engines, road rollers, centrifugal pumps, etc., manufactured by them.

**Conveying Machinery.** The Jeffrey Manufacturing Company, Columbus, Ohio, forward their new general catalogue No. 82, illustrating Jeffrey elevating conveying power transmission machinery and coal mine equipments. The Jeffrey Manufacturing Co., are placing this catalogue in the hands of their customers and intending purchasers.

**Electric Locomotives.** The Railway and Lighting Department of the Westinghouse Electric Manufacturing Company, East Pittsburg, Pa., forward pamphlet describing the Baldwin Westinghouse Electric locomotive.

## MACKENZIE-MANN GET DOMINION POWER COMPANY.

The Mackenzie-Mann interests are negotiating an important transaction by which they will obtain control of the Dominion Power and Transmission Company, the holding corporation of twelve electrical, generating, transmission, and consuming companies. The official ratification of the deal has yet to be made.

The companies controlled either directly or indirectly by the Dominion Power & Transmission Company are as follows:—The Hamilton Radial Electric Railway Company. The Hamilton Street Railway Company. The Hamilton and Dundas Street Railway Company. The Dundas Electric Company. The Hamilton Electric Light and Power Company. The Lincoln Electric Light and Power Company. The Brantford and Hamilton Electric Company, the Western Counties Electric Company, with its subsidiary corporation. The Brantford Electric and Operating Company. The Hamilton Terminal Company. The Welland Electrical Company. The Hamilton, Grimsby and Beamsville Electric Railway Company.

The authorized capital of the Dominion Power and Transmission Company, with head office at Hamilton, is $50,000,000. Of the preference stock, which is entitled to 7 per cent., $3,673,100 was subscribed and paid-up at the date of the latest annual report of the company, December 31st, 1911. Of the limited preference stock, (which has preference as to dividends over common of 10 per cent. in dividend in all of which 1½ per cent. has been paid), $5,100,000 has been subscribed and paid-up. Of the common stock, $2,622,500 has been subscribed and paid-up. The authorized bond issue is $25,000,000, of which $3,012,000 are outstanding. Bonds of subsidiary companies, amounting to $3,855,000, are outstanding.

The following are figures from the latest annual statement of the company:—

| | |
|---|---|
| Gross earnings | $ 2,251,247.47 |
| Interest | 1,635.94 |
| | $ 2,252,883.01 |
| Operating expenses | $ 1,232,239.49 |
| | $ 1,020,643.07 |
| Bond interest | $ 335,258.42 |
| | $ 684,884.65 |
| The liabilities total | $20,045,040.98 |
| **Assets.** | |
| Properties accounts | $19,713,986.81 |
| Accounts receivable | 163,343.92 |
| Stores on hand | 117,692.00 |
| Trustees of bonds | 50,018.25 |
| | $20,045,040.98 |

**Profit and Loss Account.**

| | |
|---|---|
| Balance from 1910 | $ 1,019,689.63 |
| Surplus earnings, 1911 | 684,884.65 |
| Adjustments | 18,882.93 |
| Transferred to replacements | 12,821.85 |
| Transferred to reserve account | 550,000.00 |
| Dividend declared | 350,263.21 |
| Balance | 764,606.29 |
| | $1,704,574.28 |

The incorporation of the Dominion Power and Transmission Company, Limited, was the result of necessary increase in the financial capacity of the Hamilton Cataract Power, Light and Traction Company, Limited, which became inadequate to meet the expansion of that company's business and the probable extension of its field of operation, and this company's charter from the Dominion of Canada was framed with a view to the acquisition by this company of the control, and practically the taking over of the business of the Hamilton Cataract Power, Light and Traction Company, Limited. In view of the fact that four-fifths of the stock of the Hamilton Cataract Power, Light and Traction Company, Limited, has been acquired by this company it may be regarded as a successor to that company and its business, but on a larger scale. The mileage of the company consists of 22 miles of double track in Hamilton and 23 miles of interurban lines, including an extension to Brantford over a private right-of-way.

Large shareholders have been requested to sign the agreement for the sale, and it is understood that all the stockholders are to receive $125 a share for their preference stock, $110 for their second preference, and $100 for their common stock. Stockholders seem to be satisfied with the terms.

The directors and officers of the company are as follows:—J. R. Moodie, president, Hamilton; James Dixon, vice-president, Hamilton; J. W. Sutherland, Hamilton; John Knox, Hamilton; Wm. C. Hawkins, Hamilton; Lloyd Harris, Brantford; Wm. Southam, Hamilton; Sir John M. Gibson, Toronto; secretary and general manager, Wm. C. Hawkins. The present directors will probably remain in charge until the annual meeting next February.

## RAILWAY SIGNALLING EXPERIMENTS.

Interesting experiments have recently been made near Birmingham, England, with a remarkable invention designed by the inventor, Mr. H. von Kramer, with the object of preventing train collisions. The inventor's method is to have earth-buried wires laid alongside and parallel with each line of permanent way, which will communicate with the signal boxes all along the line. The guard's coach on the train is fitted with a coil framework whence electricity emanates, connecting with the buried wire. The signal is picked up from either the wire of the train by a "detector," and automatically magnified, so that it is capable of operating a bell, hooter, or even a brake.

In the guard's van are several electric "solenoids," erected on a marble slab, which are entirely automatic. When the detector operates, one of these rings a hooter, while another is used for pulling a lever in the van which puts on the brakes and stops the train. On the other hand, the train can signal from station to station, sending out a current which operates alarm bell and lamps.

If the signalman forgets to pull back a lever after a train has passed from one block section into another, this omission is automatically rectified by the current. If the train over-runs a signal at danger it will be automatically stopped, and will not be able to proceed until a seal has been broken in the signal box, where the incident is recorded. This automatic signal will not be blindly relied upon by the engine-driver and signalman, but rather increase their alertness, as they are certain of having their mistakes recorded without the question of doubt. There is a recording instrument in each box which, when straight, indicates that all is right, but if any trouble occurs it goes up at the exact moment of the incident, and remains in a position of danger.

An outstanding feature of the invention is the extreme delicacy of the detector, which can be tuned to any pitch and only respond to a similarly tuned instrument. For instance, one tuned to 100 frequencies (vibrations) per second would not respond to others of even 95 or 105 frequencies. Moreover, the detector is tunable to such an extent that the signalman can distinguish between goods, slow passenger, and fast trains.

It is impossible for two trains to collide in the same section. If one gets in legitimately it is all right, but if a second runs over the block both trains are automatically stopped.

The experiments are being carried on over a ten-mile stretch of the Stratford and Midland Junction railway between Stratford and Kineton, and so far have proved a striking success.

## PERSONALS.

MR. ADAM P. LINTON, of Regina, has been appointed assistant chief engineer for the Province of Saskatchewan.

MR. E. W. MURRAY, of Regina, has been appointed district surveyor and engineer for the Province of Saskatchewan.

MR. L. G. COLEMAN has been appointed superintendent of the Ottawa division of the Grand Trunk Railway, with office at Ottawa, Ont.

MR. H. G. PHILLIPS, of Regina, has resigned his position as district surveyor and engineer of Saskatchewan to engage in private practice.

MR. M. K. ALLAN has been appointed city engineer of Regina, to succeed L. A. Thornton, who was recently appointed city commissioner.

JAMES IRWIN, of Montreal, has been appointed to succeed G. G. Hare, civil engineer of the Kingston & Pembroke Railway Company, who has been transferred to the Dominion Atlantic Railway.

HON. FRANK COCHRANE has been appointed representative of the Federal Government to represent that body at the International Road Congress to be held in London, England next June.

MR. W. REES JEFFREYS, Honorary Secretary of the International Road Congress, is at present in Toronto arranging details of the meeting of that body to be held in London during June, 1913.

MR. R. O. WYNNE-ROBERTS has been asked by the Government of Saskatchewan to report on the lignite deposits of the province with reference to the possibilities for use as fuel, and for the development of cheap power.

MR. H. L. DRAYTON, K.C., has been appointed Chief Commissioner of the Dominion Railway Board to fill the vacancy caused by the death of Judge Mabee. Mr. Drayton's present position is Corporation Counsel for the city of Toronto.

## OBITUARY.

We regret to announce the death of Mr. Cecil B. Smith, senior member of the firm of Smith, Kerry & Chase, consulting engineers.

## MEETINGS.

The members of the Ontario Motor League held a dinner in honor of Mr. W. Rees Jeffreys, of the Road Board of Great Britain in Toronto on the evening of June 26th last. Mr. Jeffreys explained the workings of the Road Board with which he is connected, and at the conclusion brief addresses were made by Messrs. W. A. McLean, highways engineer of Province of Ontario; Dr. P. E. Doolittle; Willis Chipman, president of the Engineers' Club ,and Dr. John Galbraith, dean of the faculty of engineering, University of Toronto. Among those present were Messrs R. P. Fairbairn, Deputy Minister of Public Works, Ontario; A. S. Forster, Reeve of Oakville; W. G. Trethewey, of the York Highway Board, and A. M. Rankin, M.P.P., Collins Bay.

## COMING MEETINGS.

THE WESTERN CANADA IRRIGATION ASSOCIATION.—Sixth Annual Convention Kelowna, Okanagan Valley, B.C., August 13, 14, 15 and 16, 1912. Secretary, Normon S. Rankin, P.O. Box 1317, Calgary, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

## ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

### MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton; Secretary-Treasurer, Mr. K W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

### CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

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