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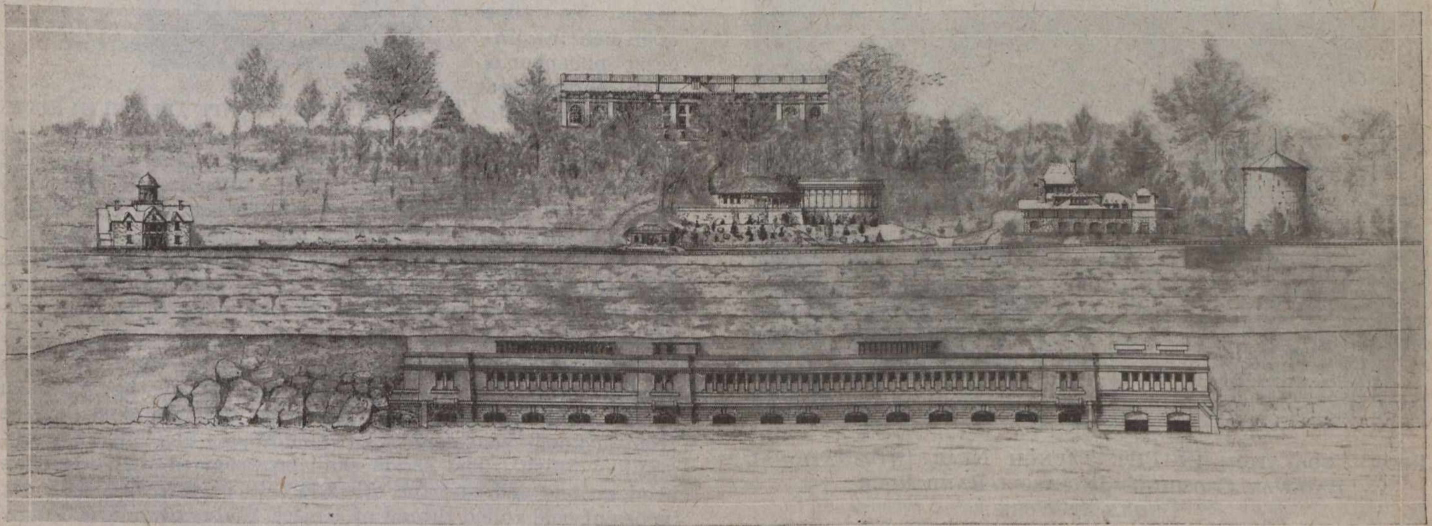
The Canadian Engineer

A weekly paper for civil engineers and contractors

Extension to the Ontario Power Co.'s Plant

Construction of 1.3 Miles of 13.5 Ft. Diameter Wood Stave Pipe for 50,000 H.P. Capacity, and of One of the Largest Differential Surge Tanks Ever Built—Power House Designed to Withstand Water Pressure to Crane Rail

By THOS. H. HOGG
Assistant Hydraulic Engineer, Hydro-Electric Power Commission of Ontario

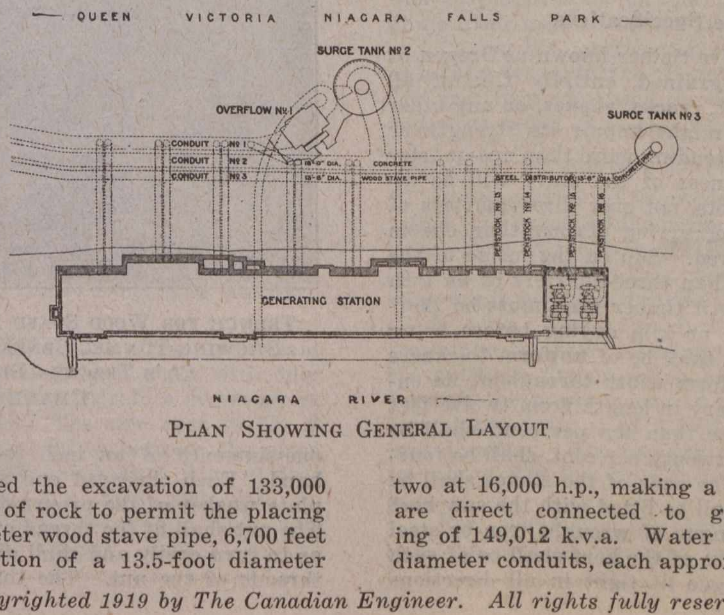


Elevation Showing Power House at Foot of Cliff—Extension at the Right—On Bank, From Left to Right, Table Rock House, No. 1 and No. 2 Surge Tanks, Refectory, and New Surge Tank at Extreme Right—Above, Distributing Station

IN 1918 the shortage of power for essential war industries became critical, so an extension to the hydro-electric plant of the Ontario Power Company at Niagara Falls, Ont., was undertaken as an emergency measure.

The two other plants located at Niagara Falls on the Canadian side having reached their limit of capacity, the sole means of increasing the power supply, pending the completion of the Chippewa-Queenston development, was by the extension to the Ontario Power Company plant. This work was commenced in March, 1918, and when completed will furnish an additional 40,000 to 50,000 horse power, the first 20,000 h.p. of which will be ready by the latter end of this month, and the remainder a few weeks later. The whole 50,000 h.p. will therefore have been made available in less than twelve months, constituting a very creditable war construction record.

The construction, which is being handled by the Engineering and Construction Departments of the Hydro-Electric Power Commission, involved the excavation of 133,000 yards of earth and 14,000 yards of rock to permit the placing and erection of a 13.5-foot diameter wood stave pipe, 6,700 feet long; the fabrication and erection of a 13.5-foot diameter steel distributor 179.5 feet long, and of a steel differential surge tank, 60 feet in diameter, and 94 feet high; the installation of four valves, two penstocks each 10.5 feet in diameter, and two new 20,000 h.p. turbines with direct connected generators, together with the necessary excavation for the building of the additional power house to house these units.

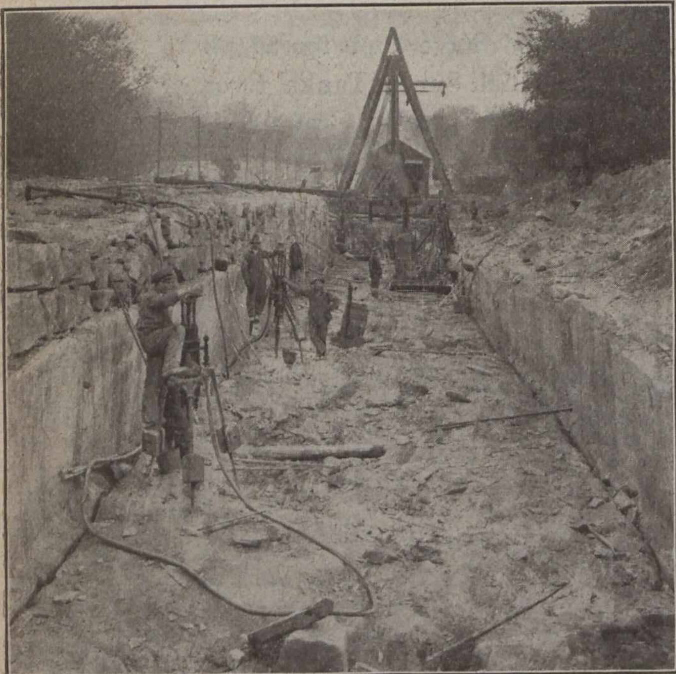


Plan Showing General Layout

The installation is unique in several particulars. The wood stave pipe is one of the largest ever built; the differential surge tank has the greatest diameter, and the barrel of the same is the highest, of any similar tank not equipped with an auxiliary spillway, while the design of the power house was governed by extraordinary conditions which necessitated protection against a 40-foot rise of tailwater level.

The present plant of the Ontario Power Company, as now controlled and operated by the Hydro-Electric Power Commission, consists of an installation of fourteen turbines, seven with a rated capacity of 11,800 h.p., five rated at 15,000 h.p., and two at 16,000 h.p., making a total of 189,600 b.h.p. These are direct connected to generators with a total rating of 149,012 k.v.a. Water is supplied through two 18-foot diameter conduits, each approximately 6,600 feet long, having a combined maximum carrying capacity of about 162,000 h.p.

The first conduit, installed in 1903, was steel plate encased in concrete while No. 2 conduit, installed in 1910, was constructed of reinforced concrete 18 inches thick laid on a continuous concrete saddle. This second conduit, when inspected in April, 1918, after being in service eight years, showed no signs of cavitation or deterioration, although a velocity



ROCK EXCAVATION IN PIPE TRENCH NEAR INTERNATIONAL RAILWAY CROSSING—INGERSOLL-RAND ROCK DRILLS AT WORK

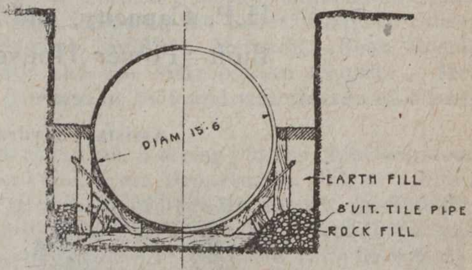
of 25 to 28 feet per second had been maintained during operation. A remarkable feature in connection with this pipe is the fact that there is no vegetable growth whatever appearing on the walls. This is undoubtedly due to the high velocity of the water.

The third pipe line now being installed is 13.5 feet interior diameter. The staves are B.C. fir, 4 inches thick by 6 inches wide. The pipe is banded with ⅞ inch steel bands made in two sections with two shoes. The spacing of the bands varies, according to the pressure head, from 8¾ inches at the forebay end to 2½ inches at the power house end. The following is a digest of the specifications covering the material furnished for this conduit:—

Wood Stave Pipe Specifications

"Staves shall be made of live timber known as Oregon or Douglas Fir, sound, straight-grained, entirely free of all deadwood, rotten knots, dry rot, cracks, shakes, or any other defects or imperfections that might impair its strength or durability. Pitch seams not extending more than one-quarter of the way through the thickness of the stave will be allowed. Small, tight, sound knots, not over three-quarters of one inch in diameter and not occurring oftener than one in four feet of stave will be allowed. Sap on the inside of the stave and not extending more than three-quarters of an inch in thickness will be allowed. All timber used must be thoroughly seasoned by either air or kiln drying before being milled into staves. The staves shall be of uniform thickness and each stave shall be of uniform width throughout its entire length. The staves may vary in length from twelve feet to thirty-two feet, but not more than ten per cent. shall be twelve feet, and not more than twenty per cent. shall be fourteen feet and less in length. The ends of the staves shall be cut square with the side and shall be fitted with the saw kerf for the insertion of a metal tongue of wrought iron or steel plate of No. 12 B.W.G. The size of the kerf shall be of such dimension as to make the tongue fit tight in all directions and cut across the ends of the stave in exactly the same position. The saw kerf in the end of the stave shall be one-sixteenth of an inch less in depth than one-half of the width of the metal tongue to be inserted in the staves. The staves shall be dressed on both sides to true circles of the inside and outside diameter of the pipe and the edges shall be dressed to conform to the radial lines of the pipe.

"The steel or wrought iron metal tongues shall be one and one-half inches in width, measured with the length of the pipe, and in length shall be one-eighth of an inch longer than the width of the saw kerf across the end of the stave so that when the tongue is in place it will project one-sixteenth of an inch into the adjoining staves.



TYPICAL SECTION OF PIPE TRENCH IN ROCK

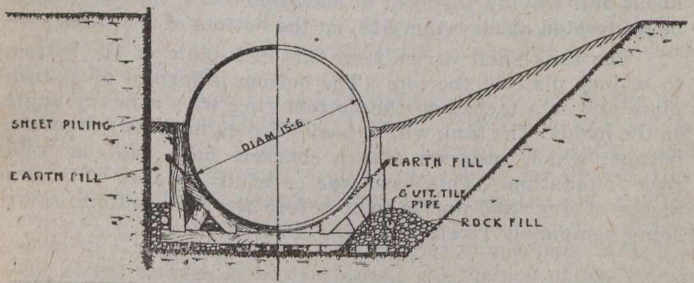
"Steel in the bands shall be made by the open hearth process; phosphorus shall not exceed .06. The ultimate strength shall be from 55,000 to 65,000 lbs. per inch. The yield point shall be not less than one-half of the ultimate strength, and shall be determined by the drop of the beam of the testing machine. Elongation is to be a minimum per cent. in eight inches of 1,400,000 divided by the ultimate tensile strength. For each increase of one-eighth inch in diameter above three-quarter inch, a deduction of 1 shall be made from the specified percentage of elongation.

"The rods or bands shall be capable of bending 180 degrees around a diameter equal to the diameter of the specimen tested without fracture on either side. Bands must be free from any injurious seams, flaws or cracks and have a workmanlike finish. The bands shall be provided with a button head on one end and the other end to be provided with six inches of cold rolled thread of United States Standard Gauge. Each threaded end shall be provided with a hexagonal nut one-sixteenth of an inch thicker than the diameter of the band. Each threaded end shall also be provided with one plate washer of the proper diameter and standard thickness. The nut shall fit the thread of the band and in such a manner as to turn easily and shall give the full bearing on all of the threads of the nut. The threads shall be of such strength

TRENCH FOR WOOD STAVE PIPE THROUGH ROCK SECTION, SHOWING TUNNEL BENEATH INTERNATIONAL RAILWAY CO.'S TRACKS—BOTH SIDES OF CUT ARE CHANNELLED HERE as to insure that the band will break in the body or shank before breaking in the threads.

"The shoes to connect the ends of the rods shall be of malleable cast iron of the most tenacious character, such as will stand a great amount of hammering without fracture, and shall have a tensile strength of not less than forty thousand pounds to the square inch of section. They shall be sound, smooth castings of the size and form as required for the purpose, and shall be well adapted to receive the strain induced by cinching on the bands.

"All steel bands and malleable cast iron shoes shall be



Typical Section of Pipe Trench in Earth

thoroughly coated prior to shipment with manufacturers' standard protection coating."

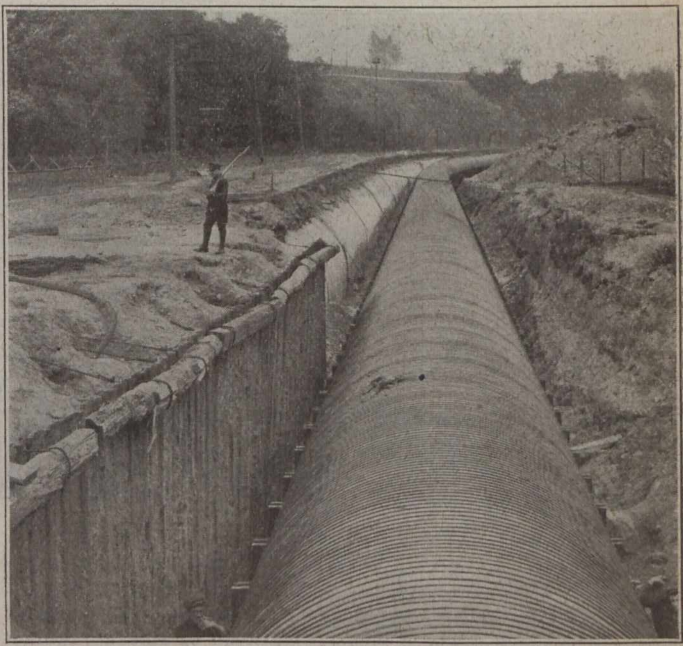
Construction of Wooden Conduit

The gate house as constructed provided a twenty-foot diameter steel thimble projecting about three feet. Connection of the 13.5 foot diameter wood stave pipe to this steel thimble is made by a taper section 25 feet in length, built of reinforced concrete surrounding the steel thimble previously placed and ending in another steel thimble 13.5 feet in diameter, 6 feet long. The staves are lapped 18 inches over this plate, which projects about two feet from the concrete envelope, and the connection is made when the ⅞-inch bands are tightened on the staves.

The difficulties of excavation along the pipe line were varied and in some places severe. At the gate house, and for

Erection of Wood Stave Pipe, Using Saddles as Forms

1,200 feet below, the excavation is in rock. The pipe is laid parallel to No. 2 conduit and at its widest point with only 40 foot centres. The utmost care was therefore necessary in shooting and taking out the rock. The side next to No. 2 conduit was channelled, and when centres between the pipes decreased to 24 feet, both sides were channelled. A great deal of water was encountered in the first 800 feet to the crossing of the Dufferin Island Channel. This was successfully handled with an 18-inch suction centrifugal pump driven by a 50 h.p. motor. The material was handled from the cut by shovels, derricks and locomotive cranes; a portion of the excavated material was deposited along the sides of the cut for back-fill, while the remainder was placed on dumps located at convenient points. The construction of the pipe itself presented no particularly difficult problems, and was erected under the supervision of a representative of the Pacific Coast Pipe Co.



No. 3 Conduit Completed, Showing Method of Bracing Lackawanna Steel Sheet Piling Between Conduits Nos. 2 and 3

The saddles used to support the pipe, view of which is shown on this page, are built-up timber sections so constructed as to make a continuous form for the lower half of the pipe. The outward thrust along the horizontal diameter of the pipe, caused by the tendency of the pipe to flatten when filled with water under a low head, is taken care of by two ¾ inch diameter round rods. These rods pass around the lower half of the pipe, and the end reactions of the rods are carried to both sides of the saddle by means of cast iron washers. These saddles were spaced at 4.5 feet intervals, except in certain locations where the pipe is concreted in place.

Through the earth cut, mud sills were used under the saddles to distribute the load and thus prevent as far as possible any settlement of the pipe. Through the rock cut the mud sills were left out and the lower timber of the saddle was placed directly on the rock, which was evened up to grade after excavating the trench.

During the construction of the pipe these saddles served as a form for laying up the lower half of the pipe, due to the fact that they supported the entire lower portion of the same and were set at close centres.

Ample Drainage Provided

It was necessary to provide ample drainage for the pipe trench on account of the bottom of the trench being below the water level in the Niagara River for a large portion of its length. As shown on this page, vitrified tile drains laid with open joints in crushed stone are provided, one on either side of the pipe. These two drains run from Sta. 9+00 on the conduit to the steel distributor, where they are connected to the penstock drains which carry the drainage water down through the power house to the lower river. The first 350 feet of the drain is of 6-inch diameter and remainder of 8-inch diameter. The two drains are connected together at intervals of 200 feet by 6-inch laterals which pass under the pipe.

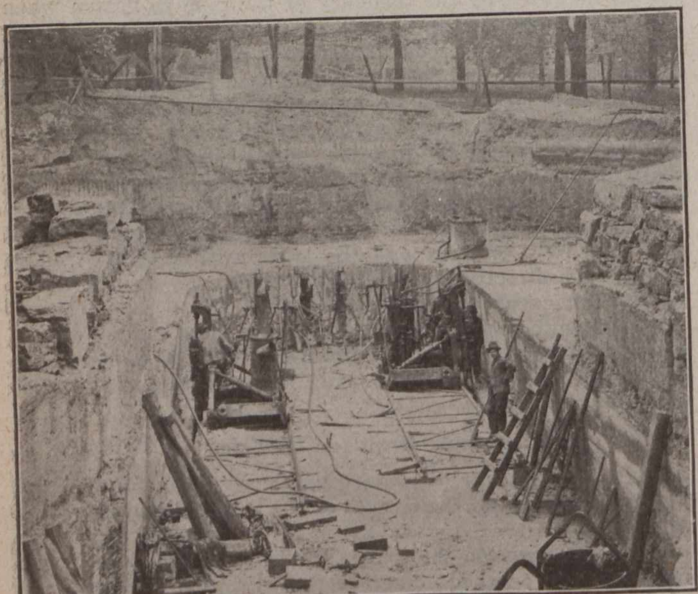
For 1,000 feet at the upper end, and 825 feet at the lower end, the pipe is concreted in place. This is necessary by reason of the fact that these sections are in particularly exposed parts of the Queen Victoria Park much frequented by tourists. It was, therefore, desirable to restore the surface of the park to its original condition after the pipe had been placed.

At Station 65+77 the wood stave pipe ends, and the distributor begins. The distributor is made of steel plate ⅝ inches thick, 13.5 feet in diameter, and 179 feet 6 inches long.

No. 3 Conduit, Showing Mudsills in Position—No. 2 Concrete Conduit Exposed

To this distributor four penstocks are connected by means of bell-mouthed tees. These tees are built up of steel plate bent to shape, and are riveted to the distributor. The distributor is completely encased in concrete and the surface of the park above it will be restored to its original condition as soon as it is placed.

At the end of the distributor is a section of reinforced concrete pipe 13.5 feet in diameter and 77 feet long, joining the distributor to the surge tank. This reinforced section is laid on a horizontal curve with a short section of tangent,

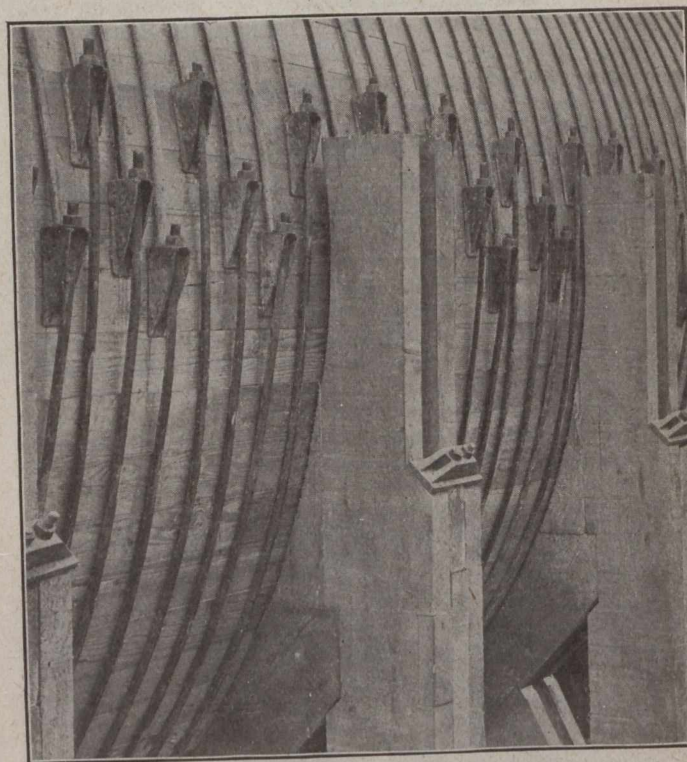


Excavation for Surge Tank and Riser—Sullivan Channellers at Work

and at the end is turned upward in a ninety degree bend to form a connection for the riser of the surge tank.

The surge tank is of the Johnson differential type. The surge-tank riser is fabricated of ½-inch plate with circular angles riveted to the shell to act as stiffeners to withstand the collapsing pressure when the surge in the riser is downward. The weight of the riser is carried on steel brackets riveted to the base and resting on the tank bottom. The bottom ports are formed of an annular opening 9 inches wide, since the diameter of the riser is 12 feet and the diameter of the distributor at the elbow is 13.5 feet. This annular orifice is divided into eight equal parts, each of 3.75 sq. feet area, by the supporting brackets and spacers, which hold the base of the riser rigid, and also carry its weight. Two of these ports at the short turn of the elbow will be blocked, since only 22.5 sq. feet gross area is required for the load changes expected. Another series of port-holes is provided about half way up the riser at elevation 552.4, the lower ports being located at elevation 518, on the bottom of the tank.

The tank shell varies from one-inch plate at the bottom to ¼-inch plate at the top. The bottom is formed of ½-inch plate and is attached to the bottom ring with a heavy angle on the inside. The tank will be back filled eight feet up from the bottom, which rests on a thin concrete base, laid on solid rock foundation. This base was carefully levelled with two inches of dry sand and cement before the tank bottom, after being completely riveted up, was lowered.



Wood Stave Pipe, Showing Details of Bands, Shoes and Saddles

The riser is tied to the roof trusses by tie rods, with turnbuckles for adjustment, to provide stiffness against vibration during load changes. The elevation of the top of the riser is at 587.16, while the top of the tank is at elevation 596. The roof trusses are steel, while the roof itself will be of wood construction. Air is admitted to, and escapes from, the tank through an open space left between the top of the tank and roof. An area of 100 sq. feet of opening is provided for this purpose.

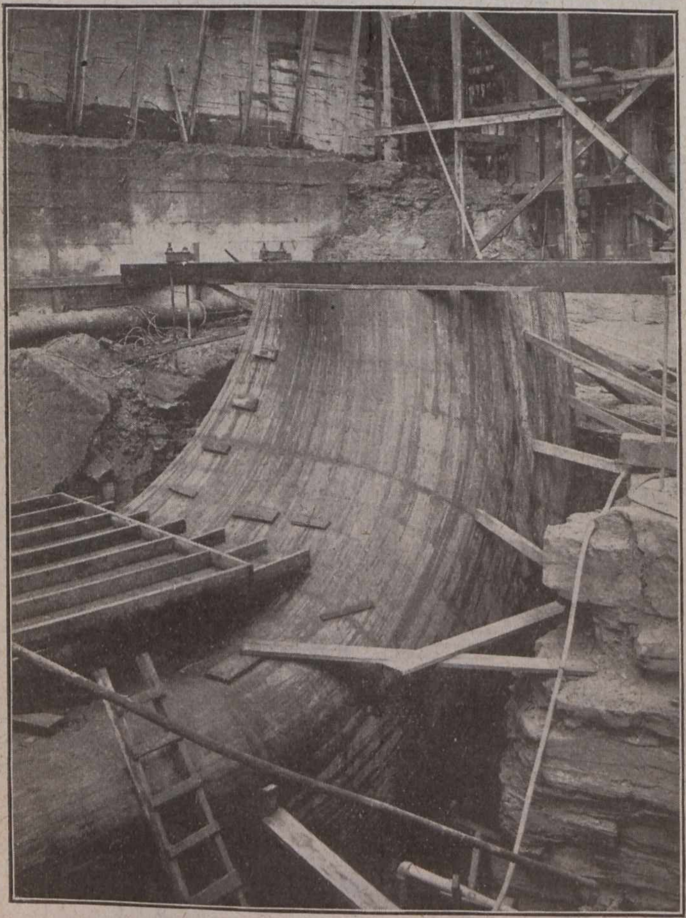
It is not expected that it will be necessary to provide frost proof protection for the outside of the tank, but if such protection is found necessary during operation, it can be readily provided.

The bell-mouthed tees which connect the distributor to the penstocks are built up of ½-inch steel plates joined together by triple-riveted, double-butt, longitudinal joints. The fabrication of these bell-mouthed entrances was an exceedingly difficult piece of plate work, and for this reason the methods used by the Canadian Des Moines Steel Company, who supplied this material fabricated and knocked down, might be of interest.

The portions of the straight sections of the distributor to which the bell-mouthed entrances are attached, were first assembled and bolted together in the shop. Upon this portion of the distributor was erected a timber frame made up of ribs cut to the proper curves of the mouth-pieces. Beaver board cut to the approximate size of the plates was then carefully fitted to the frame and matched-marked so as to obtain a pattern for the steel plate. The ½-inch steel plates were cut to their required shape from the beaver board pattern, after which they were rolled and forged to the required curvature. These plates were then fitted and bolted together on the timber frame to form the finished mouth-piece. As the structure was too large to ship riveted up, it was matched-marked and shipped knocked down to the site of the work at Niagara Falls.

Penstocks Nos. 15 and 16 deliver the water to the two new turbines in the power house. These penstocks are 216.2 feet in length. They drop vertically 48.3 feet, then turn through a 45-degree elbow for 99-feet tangent to another 45-degree elbow, and from the lower elbow run out to the turbines in a horizontal plane. Each penstock ends in a supply pipe with two taper connections bolted to the spiral casings of the turbines. At the end of the supply pipe is located a 36-inch pressure regulator, which is directly connected to the turbine governor. Each penstock has a 16-inch drain discharging into the draft tube.

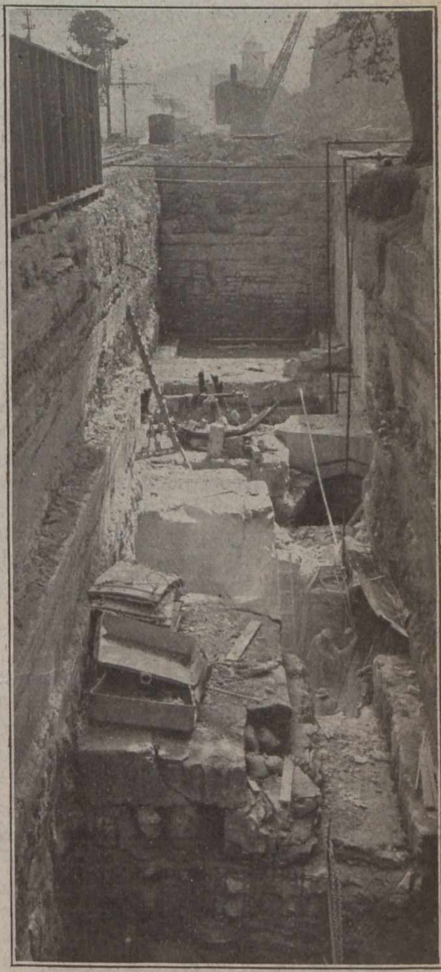
The steel plate used in the construction of the penstocks varies in thickness from ⅜ inch at the upper end to 13/16 inch at the lower end. The penstocks were designed for a pressure equal to 150 feet head of water at the upper end, increasing to 320 feet at the lower end at entrance to the turbines. Allowance for the pressure rise due to a turbine gate closure time of three seconds, with relief valve closed, has been included in the pressure limit given above. The types of joints used on the longitudinal seams for ⅜-inch and 7/16-inch plate were triple riveted lap, and for 9/16-inch plate and thicker, triple riveted butt, and on the girth seams, single riveted lap.



No. 15 Draft Tube Forms in Position, Ready for Concreting

Unit stresses of 15,000 lbs. per sq. inch in tension, 10,000 lbs. per sq. inch in single shear and 20,000 lbs. per sq. inch in compression were used in designing the penstock. On top of this an allowance was made in the thickness of the plate to take care of corrosive and erosive action.

From the distributor trench to the power house the excavation for the two penstocks was entirely in tunnel and consisted in each case of a vertical, an inclined, and a horizontal section. The excavation for the vertical shaft, with the exception of a few feet at the lower end, was through Niagara limestone, while the inclined and horizontal sections are through shale and limestone.



Excavation for Distributor and Valve Chamber

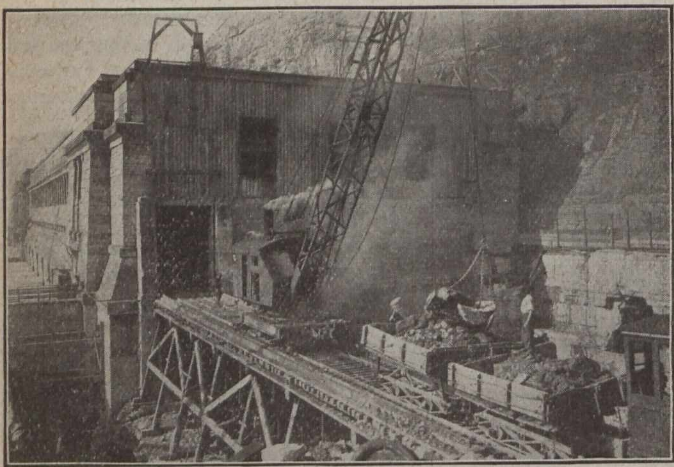
The space between the outside of the penstock and the rock is filled up with a lean concrete which holds the penstock in position and protects the outside from corrosion. All the plates for the penstock were shipped to the site knocked down, with one shop coat of paint.

The water wheels, built by the S. Morgan Smith Co., are double runner, central discharge turbines with spiral casings, running at 187.5 revolutions per minute and delivering 20,000 horse power under 180 feet head.

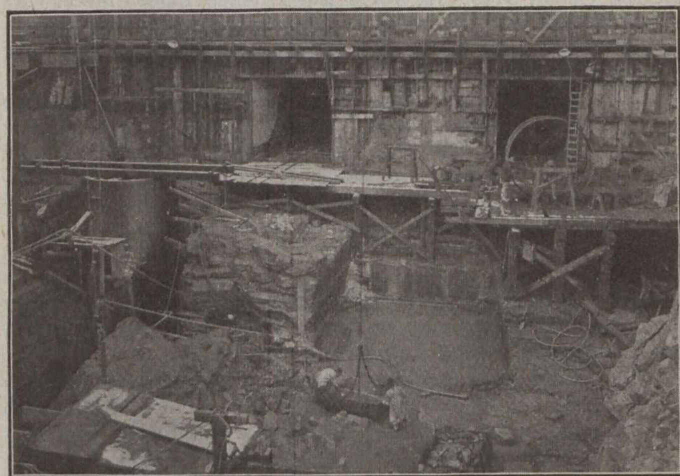
The draft tubes are moulded in the concrete foundation of the power house, changing from a circular shape in a horizontal plane to rectangular shape in a vertical plane, and reducing the high velocity of the water at point of outlet from the runner to a velocity of four feet per second at point of outlet to the tail bay. The gates are operated by vertical servo-motors, which are in turn controlled by 60,000-foot pound actuators. These actuators are mounted on the gallery above the turbines and are equipped with distance speed controllers, hydraulic hand controllers, gate limiting device, over-speed, shut-down device, manual speed adjuster, gate-opening indicator and tachometer. The centrifugal elements are of the leaf spring type mounted directly on centrally located vertical speed shafts supported on double race ball bearings and projecting downwards centrally through the actuators to a position below the gallery floor, where they connect to a gear and belt drive off an extension of the main turbine shaft. Helical gear rotary pumps, delivering 62.5 gal. per minute against 200 lbs. pressure at 187.5 revolutions per minute, furnish the pressure oil. These pumps are equipped with unloading valves of such design that when the pressure is up to normal the unloading valves open, and the pumps discharge directly into the sump tanks at atmospheric pressure. The sump tanks are each of 350 gallons capacity and are provided with the necessary screens for cleaning the discharged oil before it is returned to the system.

The power house is of concrete and structural steel construction. In the substructure plain concrete has been used throughout except for the concrete over the draft tubes, which has been reinforced for the upward pressure which will occasionally occur with high water in the river. The generator pits, air ducts and sump well are also reinforced to prevent injury developing from the temporary severe loading of portions of the structure during the erection of the units and from vibration when the plant is in operation. In the superstructure reinforced and plain concrete and structural steel is used. The front wall, north end wall and roof are of reinforced concrete, the rear wall of plain concrete, and the roof trusses, crane girders and columns of structural steel. The structural steel portion of the building is self-contained and independent of the concrete walls for stability. This condition, coupled with the fact that the steel was the first material in the superstructure to be erected, made the power house crane available for handling the erection of the units and other material as soon as the steel was erected. The erection of the units was therefore carried on coincidentally with the erection of the rest of the superstructure, this being one

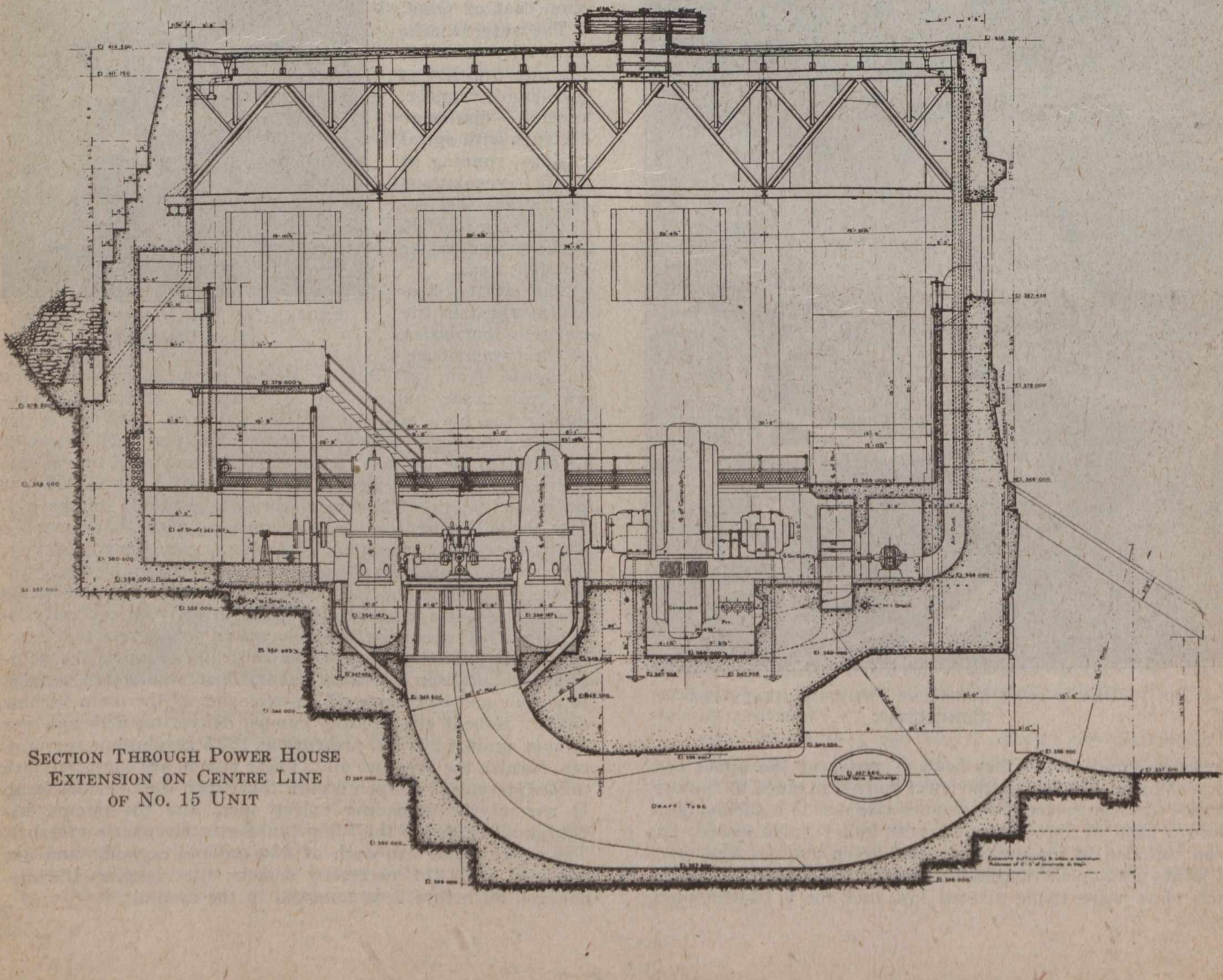
(Continued on page 149)



Excavation at Site of Power House Extension



Power House Extension Site Ready for Forms—Two Tunnel Portals Appear in Background, with Penstock No. 16 Being Assembled—Draft Tube Form for No. 15 in Position at Left



Section Through Power House Extension on Centre Line of No. 15 Unit

BITUMINOUS SURFACES IN YORK COUNTY, ONT.*

By E. A. James
Engineer, Toronto & York Highway Commission

THE title of the subject assigned to me suggests that I am expected to deal with surface treatments only, but if you are to receive an adequate conception of bituminous surface treatments in York County, Ontario, it will be necessary for you to understand the construction work leading up to surface treatment, and the conditions which make this treatment, whether heavy or light, necessary.

First, let me state, however, that we do not consider dust laying as surface treatment. Dust laying and dust prevention are two distinct problems, and we take it that it is with dust prevention that we are here concerned.

The good roads movement in York was a matter of debate long before the motor car became a common vehicle on our roads, but it was the motor car that compelled this district to improve their roads.

There were seven stone roads leading out of Toronto into York County, and with the coming of many motor cars, the old method of reconstruction and maintenance fell down, and travel on these roads became well nigh impossible.

The city and county united to improve conditions, and in 1911 a serious attempt was made to improve the main county roads that lead to the city of Toronto.

All known types of road were considered, and almost all kinds built, but by far our greatest mileage is waterbound macadam and bituminous-bound macadam, and it is in connection with the building and maintaining of these two types of macadam roads that we have developed certain ideas in connection with "bituminous surfaces," although during the last two years we have treated gravel roads.

For our own purposes we have divided bituminous surfaces into two classes:—

(*a*) Surface Mats.
(*b*) Wearing Surfaces.

It must not be expected that surface mats will bring a poor road back to good condition. They will, however, keep a good road from going to pieces.

Whether the road be gravel or waterbound macadam, it should be well drained, well built and properly crowned to shed the water easily, as water tends to deteriorate a bituminous mat.

If, however, the road has become worn, it should be properly repaired before it receives surface treatment. If a gravel road, by adding gravel and loam; if a macadam, broken stone bound with bituminous binder.

Each strip of road requires different surface treatment, depending upon the traffic it has to carry; the character of the material used in construction, and its previous treatment. So you will readily see that methods required here are only general, and must be modified to suit local conditions.

Surface Mats

In a general way our method is as follows:—

First, sweep the road with a power broom and have a man with a stable broom follow to clean off any incrustation or clean out depressions that the power broom might miss.

If it is the first treatment the road is to receive, a light material should be used, you secure better penetration, and your succeeding treatments appear to revive the bituminous substance to the depth of the first penetration. Some have said penetration is not possible or necessary, but we have found it always possible and highly desirable.

In mat surface treatment we only cover one-half of the road at one time. This makes it possible for careful team and motor drivers to keep out of the bitumen.

When possible, we keep the traffic off the material for several hours, and before the traffic is allowed on the road, we sprinkle the treated surface with a sharp sand.

Do not sweep back the dust you cleaned from the road. It absorbs the bitumen, whereas the sharp sand and pea gravel allows it to penetrate while keeping the traffic out of the bitumen.

The first application will require about one-third of a gallon of bitumen per square yard, and it requires to build up the mat about one cubic yard of sand for each 250 square yards of sand.

By having a man follow the oil wagon with a stable broom to spread out possible puddles of the material and by the proper use of sand and pea gravel, you can cut your use of bitumen so as to more than pay for the sand. Last year we cut down both the quantity of sand and the cost of applying by equipping a couple of hoosier wagons with boxes and rollers underneath to spread the sand. We find, however, that whether you use spreaders or put the sand on with shovels, a man must go over the road the next day to re-spread the sand where the bitumen has been bleeding.

The second and succeeding years, clean the road in a similar manner, but use a heavier material, which may be applied in less quantity.

You will usually find that the quantity of material required depends on the kind of spring. If the snow goes early and spring is slow in coming, your bituminous surface will get all chopped up and will finally be washed away.

We always apply our bituminous material hot. It spreads more evenly and penetrates better, and of course if you want penetration do not apply when the roads are wet.

You will have noticed this, however, that your clean swept, firm roads are dry when the other roads are wet.

These successive applications will build up a bituminous carpet that will take both heavy and constant traffic, so that the stone of your road does not wear down, and it is after five years' use apparently as good as when first placed.

Wearing Surfaces

While we have many miles of surface treated roads that were economical to build and cheap to maintain, there has been a disposition to experiment with a type of road that would not require annual surface treatment. We in York thought at one time that we could keep our roads up to standard by surface treating every other year. This we found was very poor economy, so we took up the question of a semi-permanent bituminous surface.

Our first venture was with a bituminous macadam penetration method, and each year since 1914 we have added a limited mileage of this type of pavement to the system. The base is built as for waterbound macadam but with less crown. Then 1¼ inch stone varying in depth from 2½ inches to 3½ inches is carefully spread, and into this hot bitumen is sprayed at the rate of 1¾ gallons per square yard. This is then sprinkled with ½ inch stone chips and the road consolidated. As a seal coat this surface is then sprayed with a lighter bitumen and again sprayed with stone chips.

The wearing surface thus presented is good for some four or five years, when it will have to be again surface treated with the light bitumen and fine stone.

Four years of service with this type of road service leads us to believe that under certain conditions this surface is most satisfactory, but if the traffic is very heavy and intense a higher type of road may be required, and perhaps we have this in the bituminous macadam mixed method which was used in reconstructing Dundas Street during 1917.

Dundas Street was improved in 1909 through the cooperation of the Ontario Department of Highways and Sir John Eaton, and the section thus improved became known as the Eaton Road.

This road was built, having in mind as I take it, the preponderance of iron tired horse drawn vehicles, and gave good service until the traffic changed and the rubber tired, self-propelled vehicles became almost the only traffic.

In review, our experience in York has been as follows:— We commenced by sprinkling with light bitumen, we then went to heavy bitumen; to penetration methods; to mixed me-

*Paper read at the last annual meeting of the Ontario Good Roads' Association.

thods, and let me close by saying I believe that for seventy-five per cent of our country roads, we are going to use water-bound macadam or gravel roads with heavy surface treatment.

Q.—What does it cost per mile to treat an old water-bound macadam with a bituminous surface?

A.—The great cost in surfacing, of course, is the material you buy. We have covered ourselves for all this year's (1918) supply at less than 11 cents. At that price our roads will cost us treated: For 15 feet wide, $125 per mile; and for 18 feet wide, about $160. That is for either asphalt or tarvia. That is for annual treatment of old waterbound macadam.

Q.—What did it cost to build up some of the roads that you had to re-surface?

A.—A road that had been used as a waterbound macadam road for seven or eight years, it was found necessary to rebuild. We put a surface top on it last year for $1.10 per square yard. That price included ditching and the shaping of the road 27 feet wide. The road itself was 21 feet and then there were the shoulders.

Q.—You put on about two and a half inches?

A.—Two and a quarter inches consolidated.

Q.—Did you put the surface over the whole road or just in places?

A.—The contract called for the whole road being covered with one-inch stone to the depth of an inch and a quarter on top of the scarified material. That was to act as a binder.

Q.—Did you put that surface treatment right on top of the new work?

A.—Yes, put two and a half inches on that and consolidated it.

Q.—What was that lined with?

A.—Sand.

Q.—Was there any peeling off?

A.—No, the Eaton Road was not a surface treatment, it was really a new road.

Q.—How soon would it be safe to treat a limestone macadam?

A.—You should not treat it with bitumen until the fine limestone film that forms over the road has worn off, or you must sweep it off. Put on your power machine and sweep it off. If you oil on top of that film, the oil will only blow away.

ENGINEERING INSTITUTE ELECTIONS

At a meeting of the council of the Engineering Institute of Canada held in Montreal, December 17th, 1918, the following elections and transfers were announced:—

Members—A. D. Campbell, Cobalt; G. J. Jeffrey, Vancouver; W. F. McLaren, Hamilton; W. T. Moodie, Winnipeg; H. A. Russell, Dartmouth; J. A. Stairs, Wayne, Mich.

Associate members—K. C. Berney, Hamilton; J. G. Cameron, Finch, Ont.; W. F. J. Cosser, Schumacher, Ont.; J. S. Galletly, Oshawa; H. W. Harris, Winnipeg; F. I. Ker, Montreal; A. E. Kerr, Hamilton; Albert Levvy, Winnipeg; Donald Lewis, New Glasgow; Edwin Markham, Regina; E. H. Morse, Norwood, Man.; C. A. Newton, Magnolia, Maryland; R. F. Palmer, Winnipeg; F. W. B. Scholefield, Winnipeg; W. J. Stuart, Vancouver; I. J. Tait, Montreal.

Associates—William McNeill, Vancouver; G. S. Roxburgh, Winnipeg.

Juniors—H. D. Holland, Montreal; T. E. G. Sissons, Montreal; Hercules Smart, Ottawa; A. W. Swan, Sherbrooke.

Student—Jules Comeau, Montreal.

Transferred from junior to associate member—S. W. Carson, Ottawa; C. V. Johnson, Quebec; G. D. Mackie, Moose Jaw.

Transferred from junior to associate member—S. W. Crowell, Yarmouth; H. W. Mahon, Great Village, N.S.; Maj. A. B. McEwen, Montreal; Peter Scott, Glasgow, Scotland; B. O. Smith, London, Eng.

Transferred from student to junior—J. F. Harkom, Melbourne, P.Q.; J. O. Rolland, Montreal.

REINFORCED CONCRETE PRESSURE PIPE*

By Coleman Meriwether

Although concrete was used as long ago as 2,300 years to build an aqueduct from the city of Carthage and later for the construction of aqueducts for Rome, it is only recently that pre-cast reinforced concrete pipe has been developed to meet the principal requirements of pressure lines. Experience gained lately shows that concrete properly made and sufficiently reinforced will resist safely internal and external stresses up to 100 pounds per square inch. Correct methods of manufacture will produce pipe with a low co-efficient of friction, experience having shown that a greater discharge was obtained from concrete lines than was anticipated. Leakage through the walls of pre-cast pipe has been almost nil and leakage through the joints has been less than is usually allowable for water mains.

As the construction of pipe lines is usually carried on at temperatures higher than that of the water which will flow through the conduits, it necessarily follows that contraction will occur. This will produce cracks at the joints through which considerable leakage will occur if provision has not been made to care for the contraction.

It may be assumed that the maximum temperature at the time of construction will be near 100° F. and that during the

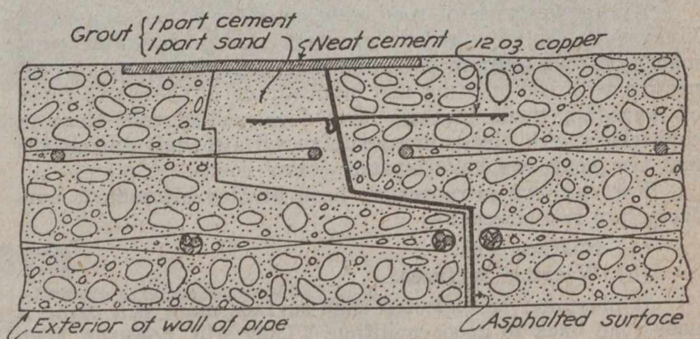


Fig. 1—Expansion Joint

winter in some parts of North America the temperature will drop as low as 50° or more below zero. Pipe lines should be covered with the earth backfill before work is suspended for the winter and all openings in the pipe line should be tightly closed to prevent circulation of air in the conduit. With such precautions the temperature of the pipe line is not likely to drop below 40° F. Flowing water will have a temperature very little under 32° F. The above assumptions will give an idea of the range of temperatures and the consequent contraction and expansion in water conduits.

Winnipeg Water District Pipe

One of the joints now used, Fig. 1, is constructed with a crimped copper band which is continuous throughout the circumference of the joint. As the pipe contracts the crimp opens and as the pipe expands the crimp closes. This joint is used in pipes 36 to 108 inches in diameter and is a true expansion joint, having been found successful in different parts of North America. To reduce the number of joints it is well to make the pipes as long as is practicable and trench conditions such as bracing, etc., may be limiting factors. The practice so far has been to make pre-cast units of a maximum laying length of 8 feet. It has also been determined in practice that it is necessary to equip each pre-cast unit with the copper expansion joint.

The installation of a plant for manufacturing 66-inch reinforced concrete pressure pipe for 10 miles of the Greater Winnipeg water conduit in Manitoba, Canada, and some of the details of manufacture are described below. The layout of such a plant is a matter of no small importance, for incessant care must be used in all the details from the installa-

*Read before the Illinois Section of the American Water Works Association.

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Index to Volume 35

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The Canadian Engineer

INDEX TO VOLUME 35

July 1 to December 31, 1918

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

F

G

H

I

J

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

P

Q

R

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

S

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

T

U

V

W

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

tion of the plant and its equipment until the last pipe is laid and the line tested.

Pipe are cast on end and the molds of sheet steel and cast iron must be erected on substantial foundations of reinforced concrete, the surface of the foundations being truly level and finished smoothly so that when the cast iron base mold is set and the sheet steel casings are erected the casings will be truly vertical.

The process of assembling consists, first, of cleaning, oiling and setting the cast iron bases on the concrete foundations. Second, the inner sheet steel casings are set on the bases and on the top of them is placed a steel filling platform used to centre and hold truly circular the inner casings as well as to receive concrete from the conveying buckets. Third, the inner cage of reinforcement is placed, with its bottom strand set in an annular slot in the cast iron base; the slot is then filled with dry sand which forms a core and prevents concrete flowing into the space and thereby binding the base to the pipe. Fourth, the outer cage of reinforcement is set and the outer steel casing placed and clamped. The mold is then ready to receive concrete.

Excellent Grading of Aggregate

A batch of neat cement grout is dumped on the filling platform and flows into the mold, splashing over the two rings of reinforcement in its descent to the bottom of the mold. There a portion of the grout remains until the first batch of concrete is deposited, when this surplus grout rises with and is incorporated into the concrete and thereby replaces any grout which may have been abstracted from the concrete by the reinforcement. This is necessary to secure a pipe dense throughout its mass. The first batch of concrete is dumped on the filling platform almost as soon as the last of the grout flows into the mold, and each mold is filled very quickly, not enough time elapsing to cause any line of separation between batches. The filling is continuous from start to finish. All parts of the molds are cleaned and oiled between each filling.

In the manufacture of most pre-cast concrete pressure pipe it is necessary to use 1 volume of Portland cement, 1½ volumes of sand and 2½ volumes of coarse aggregate; this means that 2½ barrels or 950 pounds of cement is used per cubic yard of concrete. In the manufacture of pre-cast pipe for the Winnipeg Aqueduct it was found necessary to use but one sack of cement to 3.8 cubic feet of mixed aggregate, or approximately 2 barrels or 700 pounds of cement per cubic yard of concrete. (The Canadian barrel weighs 350 pounds gross or 346 pounds net.) This small quantity of cement was found sufficient because of the very excellent grading of the mixed aggregate. The concrete is mixed to a quaking or jellylike consistency, which will easily flow into place when slightly puddled.

On the Winnipeg work, the concrete was mixed in batch mixers at each end of the manufacturing plant, and after being dumped into conical buckets was transported by travelling derricks to the molds. A simple ball valve easily and accurately controlled the flow of concrete from the buckets, which carried grout, concrete and mortar equally well. Molds were filled simultaneously in pairs, one member of each pair being on opposite sides of the derrick track, which was located in the centre of the manufacturing site.

Use of Steam

When the concrete in the molds reached the top of the outer casing, a cast iron spigot ring was set and the spigot mortar deposited, tamped in place and the copper expansion joint set.

The mortar for spigots on this contract is made of 1 part cement to 2 parts sand. It is mixed to the same consistency as the concrete so as to obtain the same rate of setting and settlement, as nearly as possible. As the spigot mortar settles, more mortar is added until the settlement ceases, when the joint is finished.

Each expansion joint is mounted on a steel spider which remains in position until the concrete has set and the forms are to be stripped from the pipe. The spider is centred accurately by means of a pin and a hole in the centre of the filling platform.

To maintain a constant and uniform rate of setting in the concrete, as well as to protect the concrete from the low night temperatures sometimes attained in Canada, wet steam was used in order to obtain a moist, warm atmosphere about the pipes. The steam mains were laid underground in a way to prevent excessive radiation as well as to place them out of the way. A riser connected each steaming set of five vertical jets with the mains. One of the jets was placed in the centre of the concrete foundation so as to be in the centre of the cast iron base and the other four jets were spaced equidistant around the circumference of the base, sufficient space being allowed for clearance between the jets and the edge of the base. To confine the steam to the pipes, canvas jackets and hoods were used, the jackets being suspended by hooks from an iron pipe ring supported on two hard wood arms which were raised above the copper expansion joint strip by hard wood blocks on each end of the arms. The jackets were laced vertically and a canvas hood placed over the top of the steam cover spider, the wood arms and the iron ring of the spider preventing the hood from resting on the light copper expansion joint. The hood was tied to the jacket by means of rope and rings, and the jackets were held snugly in place by rope run through eye-bolts secured in the concrete bases. The canvas steam covers were removed with the spider when the forms were stripped, and were replaced as soon as the casings had been removed. The steam was again turned on and the pipe steamed for three to four days.

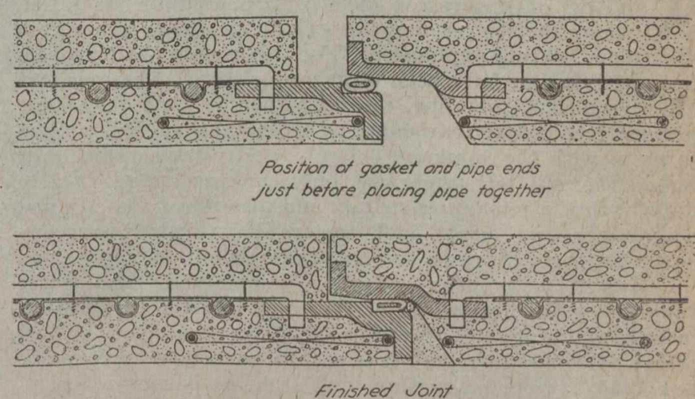


FIG. 2—NEW TYPE OF JOINT

LEAKAGE TESTS ON COMPLETED PRESSURE CONDUITS

Location	Diameter	Length of line	Pressure Head	Leakage Per 1000	Leakage Per mile
	inches	feet	feet	gallons	gallons
Baltimore, Md.	108 and 84	8,700	82	1,494	7,888
Dallas, Tex.	36	14,000	70	121	639
Ft. Worth, Tex. ...	36 and 48	1,200 12,800	70	1,143	6,035
Seattle,* Wash.	42	8,000	135		

All that has been said heretofore refers particularly to the copper expansion joint type of reinforced concrete pressure pipe. There has recently been developed a new type of expansion joint, and at the time of writing this paper reinforced concrete pressure pipe 36 inches in diameter with this type of joint has been manufactured and tested with satisfactory results.

It is proposed to construct reinforced concrete pressure pipe 10 to 48 inches in diameter and 12 feet long, each section being provided with a cast iron spigot ring at one end and a cast iron bell ring at the other, the rings being cast integrally with the concrete. Fig. 2 shows the joint. The faces of the rings which bear upon the lead gasket will be accurately machined, providing a very true circular surface. The spigot ring

*The pipe line in Seattle was a trunk water conduit to operate under a head of 90 feet and every pipe was tested to 135 pounds pressure. Tests were made on short sections of completed line and the leakage was nil.

is provided with a seat for the lead gasket, the face of which seat forms half of a dovetail, the object being to provide a greater thickness of gasket at the seat of the dovetail. This prevents the gasket being withdrawn when the pipe contracts or when the pipe is deflected.

The lead gasket consists of a lead pipe filled with compressed fibre and then flattened to an elliptical section, the proper length of gasket being turned to a circle, which is joined forming a ring. This ring is placed in the bell and the pipe is then ready to receive the spigot end of the next pipe to be laid. As the pipes are shoved home the lead gasket is changed from the elliptical section to a section which fills the dovetail space and the space between the dovetail of the bell and the outer face of the spigot. After this has been done a light rope of cotton or jute is placed and a weak joint filler of cement mortar is applied, filling the calking space. This space is provided in the event it should be necessary to calk the lead gasket joint. Such calking is not expected to be necessary.

ACTION OF WATERS ON METALS*

By S. W. Parr

WATERS of this region have certain peculiarities which show themselves more especially in steam generation and steam heating appliances. For this reason their properties and behavior have been largely overlooked. These waters are classified as alkaline, meaning thereby that they have present free sodium carbonate or more than enough sodium to unite with the sulphate, chloride, and nitrate radicals or ions. There is left, therefore, only carbon dioxide, CO_2, to unite with the remaining sodium and also all of the calcium, magnesium and iron. Such waters have only temporary hardness, there being no sulphates of calcium or magnesium.

Now it so happens that the Champaign-Urbana water supply was the first water of this type to come into use or, indeed, to the notice of water chemists, who were at first rather reluctant to report free sodium carbonate in conjunction with carbon, magnesium and iron, as being an incompatible combination. However, it is seen at once that all of the carbonates are in the bicarbonate form and while readily soluble in the cold are readily decomposable on the application of heat.

This water supply for the two cities was brought into use about 1884. It comes from the drift at about 165 feet below the surface. Since the first development of this type of water in 1884, the local area has been greatly extended. As a result of study, about 1900 to 1905, of the water supplies of the Illinois Central, the Chicago & Alton and the Big Four Railroads between Peoria and Indianapolis, an area producing such waters could be roughly indicated by drawing a line from a point somewhere between Paxton and Gilman on the Illinois Central Railroad, proceeding westward to include Normal, thence southward through the centre of Bloomington somewhere between the Chicago & Alton junction and the pumping station of the Big Four Railroad near Centre Street, thence south and east to include Bement, Tolono, Philo, Veedersburg, Ind., and thence westward again to include Hoopeston and Paxton, the starting point.

Some of the Reactions

In addition to this area, the Illinois State Water Survey has found waters of this type very widely distributed and far more commonly in use than when the supplies came from shallow wells. Bulletin 4 of the Illinois State Water Survey gives the distribution of such waters throughout the state.

In order to understand some of the unusual or unsuspected properties of these waters it will be well to note some of the reactions involved when these waters are in use in steam generators. The first stage in the decomposition of the bicarbonate by heat would of course be the simple reaction:—

$$2(NaHCO_3) = Na_2CO_3 + CO_2 + H_2O.$$

However a study of the actual conditions in the boiler showed that the reaction did not stop here, but a partial hydrolization of the sodium carbonate occurred, thus:—

$$Na_2CO_3 + H_2O = NaHCO_3 + NaOH.$$

It will thus be seen that the residual water within the boiler becomes an active reagent for the precipitation of fresh incoming bicarbonates, thus indicating why such waters are self-purging and develop no scale whatever within the boilers. In this discussion, however, the author wishes to call attention to another reaction which accounts for the liberation of ammonia as a gas along with the steam; thus:—

$$NaOH + NH_4Cl = NaCl + NH_3 + H_2O.$$

Now a word as to the extent to which ammonia may be delivered under the conditions such as are found in the local water supply. If we take, for example, the local power station of the Illinois Traction System, which uses approximately 100,000 gallons of water per day, then on a basis of 0.1 pound of ammonia as NH_3 per 1,000 gallons of water, the output would be 10 pounds per day or in the form of ammonium carbonate, 50 pounds daily.

Of course, upon cooling, a combination of the ammonia and the carbon dioxide occurs forming the ammonium carbonate salt. Evidence of this is occasionally shown in the complete stoppage of risers in dwellings where the steam has been shut off for some time.

Corrosion of Brass Parts

This brings us directly to an explanation for a serious corrosive action which occurs in the heating system of the University, especially in connection with the brass parts of the steam traps to the radiators. The number of these parts thus affected would have to be expressed by three figures, but no very exact data are at hand showing the approximate number.

In making a study of the conditions that accompany these failures, it was found that in those buildings where the return water was most strongly impregnated with ammonia, the corrosive action was greatest. These variations in the content of ammoniated condensate that accumulates in certain buildings to a greater extent than in others is a peculiarity that is found to exist also with the variation in content of carbon dioxide gas that accumulates in the radiators.

So far no explanation for these variations has been found, other than that due to their place on the line or the method of taking off the steam supply from the mains. These features, however, are not essential to the main fact that the condensation water becomes sufficiently impregnated with ammonia to become a strongly corroding reagent for brass.

*Paper read before the Illinois Section, American Water Works Association.

The Warren Bituminous Paving Co. have entered suit at Osgoode Hall, Toronto, against the Construction and Paving Co., Ltd., Toronto, for alleged infringement of a Warren patented pavement.

The first passenger train has left the new South End terminals at Halifax. Its departure was the occasion of an inspection of the terminals by the premier of the province and a number of other prominent citizens. The old North Street station has been handed over to the Militia Department for use in making up troop trains and hospital trains.

At the end of November, 199 sailing vessels of 44,135 gross tonnage had been built in Canada since 1914; also 160 steamers of 69,612 tons gross. For the Imperial Munitions Board, Canadian shipyards built 15 ships, each of 1,440 net tons and seven of 6,200 net tons. The government is now having 42 ships built under contract, aggregating 255,250 tons. The total capacity of Canadian yards is 460,000 tons a year.

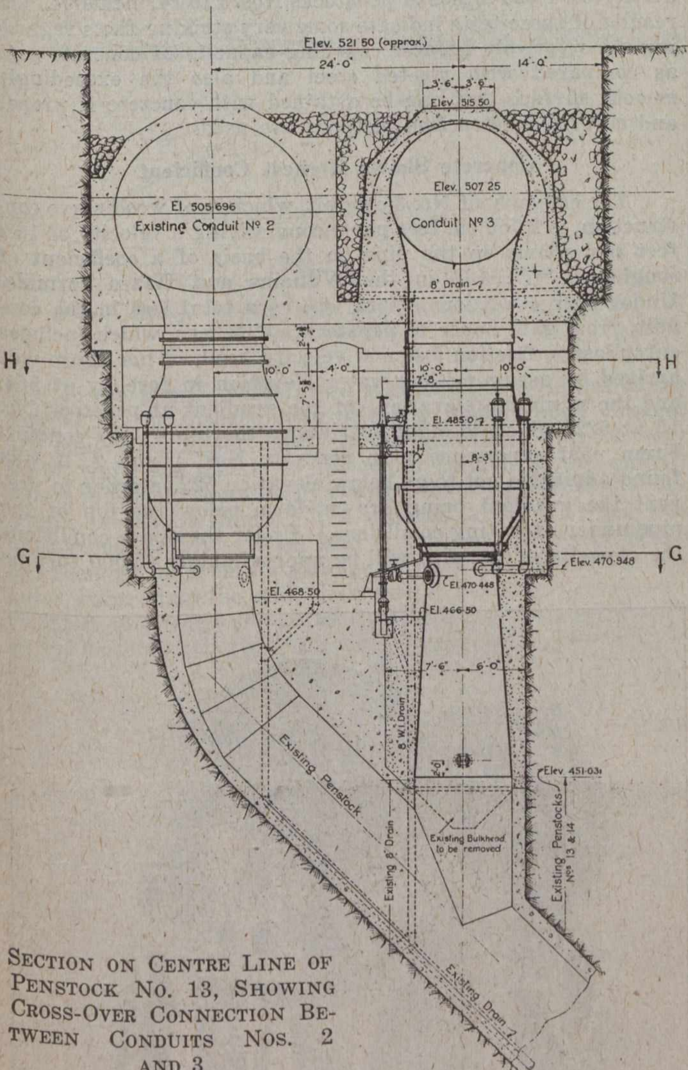
The improvement of the St. Lawrence River, from Lake Ontario to St. Regis, N.Y., was disapproved by United States army engineers in reports recently submitted to the United States Congress by Secretary-of-War Baker. "No improvement should be considered," says Major-General Black, chief of engineers, "until the completion of the enlarged Welland Canal and of tangible plans for the deepening of the Canadian St. Lawrence River channel."

EXTENSION TO THE ONTARIO POWER CO.'S PLANT

(Continued from page 144)

of the chief advantages of having the crane carried on a structure independent of the walls themselves.

In the construction of the power house for units No. 1 to No. 14, a weir was placed at the end of the draft tube outside of power house wall, which holds the tailwater level on the units at elevation 353 approximately, except under high water conditions in the Niagara River, when the river level is above this elevation. The normal level of the Niagara River below the Falls is at elevation 343, which means an average 10-foot loss of head on the whole plant. In order to gain this head on the present extension, turbine units No. 15 and No. 16 were set 10 feet lower than units Nos. 1 to 14, inclusive, previously installed. This puts the power house extension floor level at elevation 358, or ten feet below the old floor level.



SECTION ON CENTRE LINE OF PENSTOCK No. 13, SHOWING CROSS-OVER CONNECTION BETWEEN CONDUITS NOS. 2 AND 3

In order to protect the power house against a recurrence of the high water conditions which prevailed in 1909 and which flooded the power house by breaking through the windows in the front wall, the window sills were raised to elevation 388 and the walls strengthened to take the full water pressure up to this elevation. In subsequent extensions, including the present one, this elevation of sill has been maintained and the front wall designed as a retaining wall to take the full water pressure up to the window sills, which in the present extension is that due to 40 feet of head. The front wall of the present extension was designed as a reinforced cantilever wall similar to the walls on the previous work, but on account of lowering the power house floor 10 feet, the wall was increased in height a similar amount. As the thickness of the concrete in the front walls was controlled by the thickness of the walls in the previous work, the design was made somewhat difficult. In order to overcome these difficulties, an excessive amount of reinforcing had to be used in the wall. In the north wall the same height had to be taken care of in

SCALING LOOSE MATERIAL FROM CLIFF ABOVE POWER HOUSE SITE—INTERNATIONAL ARCH BRIDGE IN DISTANCE

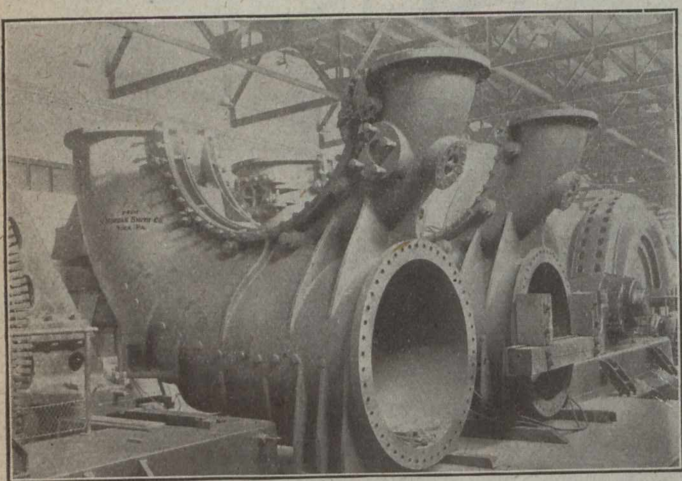
the design as in the case of the front wall. but here there was no limit in the thickness of the wall. After a study of several different types of walls, the semi-reinforced cantilever and gravity-wall was chosen as the best suited for the conditions.

SURGE TANK FLOOR ASSEMBLED READY TO LOWER ONTO FOUNDATION

In the north wall an opening is left of sufficient size for taking a railway car into the power house at elevation 368. A standard gauge track runs the full length of the power house at this elevation, and passing through the north wall continues on an incline up the side of the cliff, connecting with the International Railway at the top. This opening is provided with stop logs that can be dropped in place by the power house crane in case of high water.

The rear wall, which is located next to the cliff, was designed as a straight gravity section and with a profile similar to the back wall in the existing power house. This rear wall is somewhat cut up by cable recesses and in order to compensate for the concrete taken out by these openings a certain amount of reinforcing was used.

The power house roof consists of a 6-inch reinforced slab designed to carry a live load of 150 pounds per sq. foot.



Bottom Sections of Spiral Casings of Turbines Nos. 15 and 16

This loading was used so as to take care of any accumulation of ice on the roof or falling rock fragments from the cliff due to weathering of the cliff.

Ample drainage is provided for all parts of the power house structure. The drains along the front part of the roof are carried down through the concrete of the front wall, and discharge into the draft tubes, while the drains in the back part of the roof run down through the rear wall concrete and discharge in the rear wall drain, which is two feet wide and five feet high, and runs along adjacent to the back of the rear wall at elevation 377.5, and discharges at the north end of the building. In case the north end of the drain blocks, an overflow is provided into the rear wall drain for units Nos. 13 and 14. The system of drainage used was to run all the drains from the various sumps and pits, along with the floor drains, into a common sump which runs the full width of the building between units Nos. 15 and 16. At the end of the sump nearest the rear wall a sump well is provided for the suction pipes of two 10-inch centrifugal pumps which are used to drain the sump. These pumps are placed at elevation 360, directly above the sump well. Each pump is driven by a direct connected 35 h.p., 25 cycle, 220-volt motor, and has a capacity of approximately 1,500 gallons per minute. One pump is figured to take care of the drainage, while the second one is a spare.

Comparison of Hydraulic Characteristics

Air for cooling the generators is supplied by centrifugal fans located in the power house near the front wall, under the railway track, and at elevation 558. The air supply is obtained from outside the building through ducts leading from the lower part of the front window down the inside of the front wall to the air chamber beside the fans. Provision has been made at the inlet end of the air ducts for taking the air, if desired, from the power house instead of from outside during the extremely cold weather.

The hydraulics of the plant are of more than ordinary interest due to the fact that each of the three pipe lines and surge tanks that have been installed differ considerably. For this reason an excellent opportunity is presented of making a comparison of their respective hydraulic characteristics and capacities.

No. 1 tank has very little capacity and is of the simple tank type. Its only function is to limit the surge pressure on conduit No. 1 during load changes, and provides entrance to a spillway for discharge of water at times of load rejection.

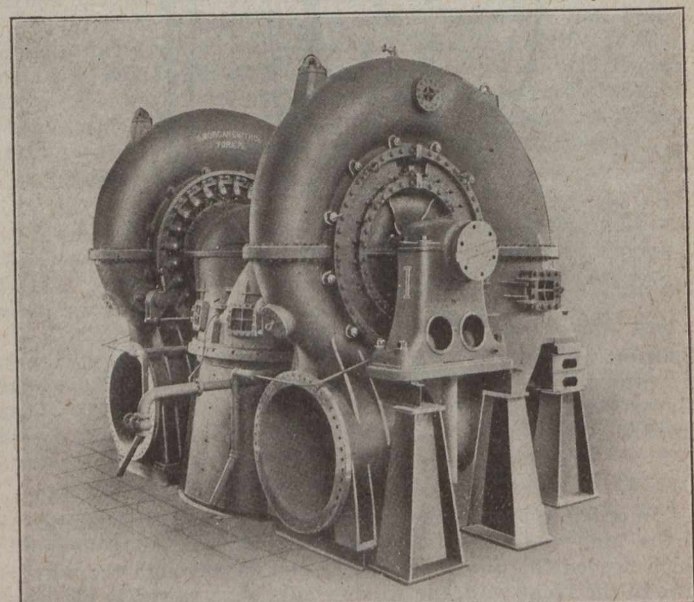
No. 2 surge tank, of the Johnson differential type, was the first tank of this character ever built. This tank serves the double purpose of relieving pressure surges and furnishing or storing water during load changes while the velocity in conduit No. 2 is being accelerated or decelerated. It is also equipped with a spillway as an additional safeguard, to prevent spilling over the top at times of abnormal surge, and to limit the height which would have been required without this provision.

No. 3 surge tank is of the same type as No. 2, but has no spillway. Its design is such that full load rejection under the most abnormal conditions will not cause overflow.

During 1913 a series of tests were made to determine the hydraulic characteristics and carrying capacities of conduits Nos. 1 and 2, also of penstocks Nos. 1 to 14, inclusive. The results of these tests indicate some very striking facts regarding the relatively greater carrying capacity of concrete pipe as compared with riveted steel and also the exceedingly smooth surface that can be obtained with concrete if proper and careful construction methods are used.

Concrete Shows Highest Coefficient

The capacity of No. 3 conduit, which is of wood stave construction, is 2,750 cu. feet per second, giving a velocity of 19.2 feet per second in the pipe on the basis of a coefficient of roughness "C"=135 in the Williams and Hazen formula. Under such conditions, there will be a total loss in the conduit, from gate house to penstock, of 32 feet, which includes entry losses, friction loss and velocity head. This figure was arrived by assuming low water elevation in forebay at 554, and the minimum elevation of the gradient at penstock No. 15 at 522, which is eight feet above the top of the conduit. From past experience with conduits Nos. 1 and 2, it was found advisable not to go below elevation 522 in order to prevent the gradient being drawn down below the top of the pipe under operating conditions. Under the above conditions the capacity of the pipe will be approximately 45,000 turbine

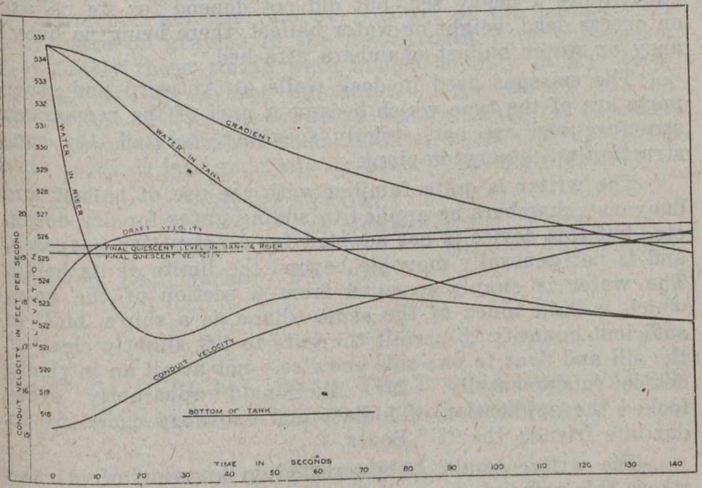


Shop Assembly of Turbines Nos. 15 and 16

horse power. With a coefficient of roughness C=150 in Williams and Hazen, which value is within the limits of possibility, and the same total loss of 32 feet, the discharge capacity would be 2,930 cu. feet per second with a velocity of 20.5 feet per second in the pipe. This quantity of water in turn would give approximately 48,000 turbine horse power. In comparing the coefficients of roughness of the concrete and steel pipes, as obtained by test, and the assumed coefficient of roughness for the wood stave pipe, based on the tests published by the U.S. Department of Agriculture, it appears that the concrete pipe has the highest coefficient, with the wood stave pipe a good second, and the steel pipe a poor third.

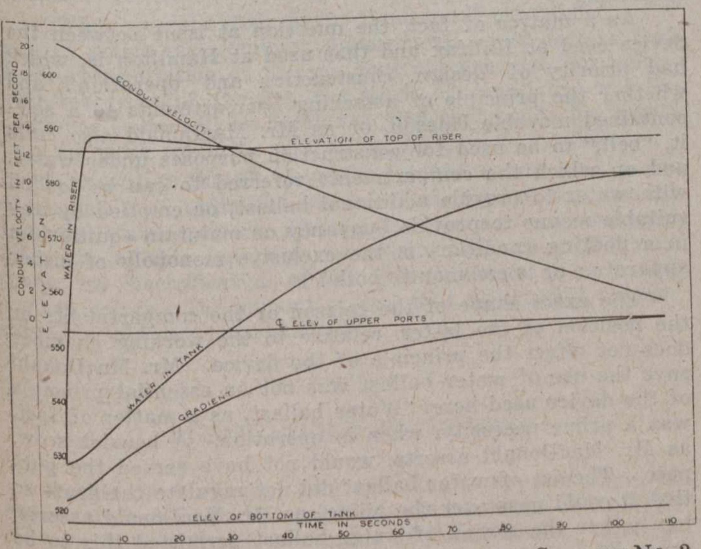
A coefficient of roughness of 100 in Williams and Hazen formula was used in figuring the losses in the steel penstocks. The use of this coefficient was based on the result of tests on the other penstocks.

The function of the differential surge tank on conduit No. 3 is to regulate the velocity of flow during changes of



Surge Tank Study for 20% Velocity Increase, Conduit No. 3

load on the plant. Close speed regulation is essential to the success of the modern hydro-electric plant. Load changes are quick and, under short circuit conditions, may be very large, while the inertia of the water column in the conduit causes relatively slow energy changes to keep pressure changes within reasonable limits. The differential tank serves this purpose admirably. When load is rejected, the water which has been cut off from its passage through the turbines by the gates, surges into the tank riser until it has accumulated sufficient head to force the surplus water through the port holes at the base of the riser into the storage tank. It holds at



Surge Tank Study for Full Load Rejection, Conduit No. 3

this level while the velocity in the conduit is being gradually reduced by the retarding head, due to the difference in elevation of the water in the riser and the hydraulic gradient. In the meantime, the outer tank level is gradually rising, until at the end of the cycle the water levels in the outer tank and riser coincide, and a condition of equilibrium results. Following a demand for more power, the riser level drops sufficiently to allow the port holes to deliver the additional water from the outer tank, while the conduit velocity is accelerating to its new required value.

It was, of course, necessary to design the tank for a drop of full load on No. 3 conduit, under which condition the tank will receive all water without the provision of a spillway, and on the assumption that some of the pressure regulators on the turbines in the power house are in service. The condition of design for load thrown on, was that of an increment of load equivalent to a 20 per cent. velocity change from 80 per cent. up to full capacity of the conduit.

The accompanying diagrams show the action of the water in the surge tank and riser, and the velocity change in conduit No. 3 for the first quarter cycle under these conditions.

Materials and Machinery Purchased

The wood stave pipe material was furnished by the Pacific Coast Pipe Company, of Vancouver, the bands and cast washers being supplied under a sub-contract by the Steel Co. of Canada, of Hamilton, and the shoes equally by the Canadian Malleable Iron Co., of Owen Sound, and Pratt and Letchworth Co., of Brantford. The Canadian Des Moines Steel Co., of Chatham, furnished the steel distributor, surge tank, penstocks, valve casings and supply pipes. Their contract included only the erection of the surge tank, the remainder being erected by the Construction Department of the Commission. The Larner Johnson Valve and Engineering Company, of Philadelphia, supplied the four Johnson valves, and the Wellman-Seaver Morgan Company, of Cleveland, the two 36-inch pressure regulators. The Lombard Governor Company, of Ashland, Mass., furnished the governors for the two turbines, the Canadian Allis-Chalmers Company, of Toronto, manufacturing the servo-motors on the Lombard Governor Company designs. The 36-inch gate valves were supplied by the Chapman Valve Manufacturing Co., of Indian Orchard, Mass. The turbines were originally built in 1914 by the S. Morgan Smith Company, of York, Pa., for the Southern Aluminum Co., for installation at Baden, N.C., on the Yadkin River development, and were purchased from the Aluminum Company of America, who had taken over this development and altered the plans before the installation of the machines. The Canadian Allis-Chalmers Company, of Toronto, supplied the two 10-inch drainage pumps for the power house. The Canadian General Electric Co., of Toronto, built the two generators. The structural steel for the power house extension was fabricated by the Standard Steel Construction Co., of Port Robinson.

Personnel

The work was handled by the regular staff of the Hydro-Electric Power Commission of Ontario, of which Sir Adam Beck is Chairman, and F. A. Gaby, Chief Engineer. H. G. Acres is Hydraulic Engineer; T. H. Hogg, Assistant Hydraulic Engineer; M. V. Sauer, Designing Hydraulic Engineer; E. T. Brandon, Electrical Engineer; A. H. Hull, Assistant Electrical Engineer. A. V. Trimble is Construction Engineer, under whom J. F. McGraw is Construction Superintendent, and F. A. Burgar, Assistant Field Superintendent. Walter Jackson is Resident Engineer.

Elwood W. Macdonald, waterworks engineer of Ottawa, Ont., has been offered a position by the General Supply Company of Canada, Ltd., which includes a salary considerably more than Mr. Macdonald is receiving from the city, but the Board of Control have decided to retain Mr. Macdonald's services if possible, and are offering a counter proposition.

At a special general meeting of the shareholders of the Riordon Pulp and Paper Company to be held in Montreal on January 31st, they will be asked to authorize an issue of $4,000,000 of bonds to finance new developments at Timiskaming. No particulars regarding the issue will be given out until after the meeting. The company is at present building a pulp mill at Timiskaming, the first unit of which will have a capacity of one hundred tons of bleached pulp per day.

Letter to the Editor

HALIFAX DIVING BELL

Sir,—In the November 21st, 1918, issue of *The Canadian Engineer*, I note a reply from Mr. MacDonald to my letter which appeared in the October 31st, 1918, issue, with reference to the caisson or diving bell used at Halifax Harbor. It would be interesting to know the name of the individual who actually originated the idea of using the outfit of the type employed, and whether the design of the walls was prepared having in view the use of a caisson of the particular type used.

Mr. MacDonald asserts that the device used by me in Hamilton was lacking in novelty, so far as the regulation of draft is concerned. In making this statement, Mr. MacDonald must be speaking without information as to the actual facts. The device, as used by me here, was capable of being used in depths of water varying between 1 ft. 6 ins. and 7 ft., and with slight structural modifications, not affecting the principle of the apparatus, this depth could have been increased.

The method of obtaining this difference in draft is not in any way fundamentally different from that used in the Halifax outfit. Mr. MacDonald calls the outfit used here simply a scow with a bottomless central well for working about 3 ft. below the surface, and asserts that any change in draft was impossible. This is not the case. The fact that the Halifax device rested on the bottom when working has nothing whatever to do with the buoyancy and water ballasting principles of the apparatus, except in so far as it aids in maintaining the equilibrium of the apparatus when in operation.

The principle of the bottomless central well is inseparable from diving bells or caissons in any form used in construction work. As a matter of fact, the long air shaft as applied to Mr. MacDonald's device for use in deep water, is not at all original as applied to deep water marine work, and the form of the lower part of the caisson is of the general type used on bridge pier foundations. The only part of the device apparently for which Mr. MacDonald claims originality, are the buoyancy and water ballast chambers. The use of such chambers was made by me on the device used here for floating and moving the outfit when required, and for carrying water ballast to increase the dead weight of the apparatus and for regulating the draft of the caisson, or bell, when in operation.

The matter of the exact name, or names, which are applied to the device does not alter their functions in any way, and whether Mr. MacDonald calls his device a mobile, pneumatic caisson, or a diving bell, or simply a plain, floating caisson, as the writer prefers, does not matter and does not affect the fundamental principle in any way. Strictly speaking, the word "bell" should not be applied to the device. The diving bell proper, so called from its approximate similarity in outline to a bell, has no air lock or shaft, and depends for its ballast on its own dead weight, being suspended in the water from suitable hoisting and lowering apparatus placed above water.

As Mr. MacDonald refers to European practice, it is relevant that I should refer to it also, from personal experience in my own particular case. Probably the most extensive recent work carried out by the diving bell type of this device was the construction of the breakwaters at the Dover Naval Harbor by the contractors, S. Pearson & Son, of London. The principles of its operation are too well known to require explanation here.

Another device of the type of caisson proper with a shaft and air lock was that used at Plymouth Harbor by the contractors for the removal of a large rocky shoal there, for the Admiralty. The writer was at one time a member of the staff of the company carrying out this work, so does not need to generalize or use text book information. In this particular outfit, the air shaft passed through a well in the centre of a large steel scow, which was fitted with air compressors, etc., and the air driven rock drills were carried on a track in the working chamber, which was larger than in the Halifax outfit. This particular device, however, was ballasted by the dead weight of the scow. When it was desired to float the caisson, the ballast connections between the scow and caisson were liberated, and the air pressure in the caisson brought it towards the surface. This device was simple and stable in all conditions, and was able to withstand quite a heavy sea, but did not depend for its ballast on excess dead weight or water ballast, there being no buoyancy or water ballast chambers attached.

The caissons used in dock walls at Antwerp and other ports are of the type which became a part of the permanent structure and are not, strictly speaking, part of the construction machinery or plant.

The writer is quite familiar with the use of ballast and buoyancy chambers as applied to sliding gates for dry docks, etc., but this device is not adapted for construction purposes, and is not generally movable beyond the limits of its berth. The water is simply expelled from a section of the gate, which is built much of the same shape as a ship's hull, in sufficient quantity to permit the gate to lift slightly clear of the sill and float to one side endwise,—not at all an intricate device fundamentally. Mr. MacDonald apparently overlooked the application of ballast and buoyancy chambers to our late friends, the "U"-Boats.

The writer would be interested in knowing of a case where this principle is applied to scows carrying construction plant in tidal waters, as Mr. MacDonald states, and what purpose this is supposed to serve. The writer is aware of a self-dumping deck scow of Norwegian origin, which unloads its deck cargo by alternately flooding and unwatering portions of the subdivided hull, but this has no bottomless central well, and he fails to see where the flooding and emptying of the hull of an ordinary scow, or use of a bottomless central well, presumably for the purpose of turning air in it, serves any purpose.

Mr. MacDonald states that the problem of flotational stability while in a submerged condition was entirely absent, etc. A little superficial examination will correct this statement. Has Mr. MacDonald made any actual calculations in support of this statement, or is this merely an unsupported assertion?

As a matter of fact, the question at issue between the device used at Halifax and that used at Hamilton is, which had priority of design, construction and operation? and whether the principle of attaching compartments to a self-contained movable caisson, or as Mr. MacDonald also calls it, "bell," to be used for construction purposes under water, and on which the compartments referred to can be loaded with water to provide additional ballast, or emptied by any suitable means to provide buoyancy or maintain equilibrium in a floating condition, is the exclusive monopoly of either apparatus, or is common to both?

The exact shape of the caisson or the compartments or the position of the latter relative to the working chamber does not affect the principle of the device. Mr. MacDonald says the use of water ballast was not an essential principle of the device used here. Water ballast, as a matter of fact, was a prime necessity, when in operation. A heavier scow, as Mr. MacDonald asserts, would not have served the purpose. The *use* of water ballast did not regulate the draft so that it could pass over the piling, as Mr. MacDonald asserts, but rather the *absence* of water ballast permitted this to be done.

Mr. MacDonald makes this statement: "In order to float the Halifax caisson when it was required to be moved, the buoyancy chamber was added and this was its only function."

Does this mean that the buoyancy chamber shown in figure 5 of Mr. MacDonald's article is not also used as a ballast chamber by the admission of water into it? and is it not the case that the ballast chamber, as indicated in the same drawing, is also, when required, used as a buoyancy chamber? and that this is simply a matter of juggling with names?

The Hamilton apparatus was finally designed in May, 1913, and put in operation in August, 1913, as previously stated, and Mr. MacDonald states he got the idea in 1913, the exact month not being stated, and the design was gotten out in 1914,—rather a remarkable coincidence, to say the least.

In my previous letter in connection with this matter, which was written somewhat hurriedly, I made an error in dictation, and got the relative position of the meta centre and centre of gravity in the device used here misplaced. Fortunately these points were misplaced only in my letter and not in the actual apparatus. The theory of the equilibrium of floating bodies to ensure stability, in other words, to make sure of them floating right side up, is no doubt more or less generally understood by engineers.

JOHN TAYLOR,
of McAllister and Taylor,
General Contractors.

Hamilton, Ont., January 9th, 1919.

TORONTO OFFICIAL SAYS THAT SOLDIERS FAVOR CANALIZING OF THE ST. LAWRENCE

IN a recent issue of the Toronto "Globe," there was printed the following interview with an official of the city of Toronto, whose name was not quoted by the "Globe":—

"Returned soldiers who typify the desirable nation-building element in Canada are dropping into my office for a friendly chat from day to day, and they express doubt as to opportunities for procuring suitable employment when they are released for civilian life.

"They hold to the idea that their employment in the immediate future depends upon the possibilities of a boom in business through Canada sharing in the export of supplies, manufactured and otherwise, for the rehabilitation of Europe. Consideration of failure to finance this business leads these returned soldiers to expect an alternative measure for their employment, and that is a vigorous policy by the Dominion government of public works.

"What appeals strongly to these returned soldiers is a plan by which the Dominion government would declare that if the rehabilitation of Europe does not energize the industrial resources of Canada, the work of canalizing the St. Lawrence route will be continued, and that bonds for financing the work would be offered to the Canadian public.

"Canalizing the St. Lawrence route would also mean development of unlimited electrical energy at the several potential water powers, making possible an early revenue from sale of this energy to manufacturers, and to the railroads, for electrification of the lines between Toronto and eastern points. The amount of coal that would thus be conserved would be considerable."

PUBLICATIONS RECEIVED

DRAINAGE METHODS AND FOUNDATIONS FOR COUNTY ROADS—Issued by the United States Department of Agriculture, as Bulletin 724 of the Bureau of Public Roads. Eighty-six pages and cover, 6" x 9", numerous illustrations. Written by E. W. James, general inspector; Vernon M. Peirce, assistant engineer; and Charles H. Moorefield, senior highway engineer. Two pages are devoted to primary soils, fifteen pages to drainage, six pages to design of surface drainage gutters, four pages to drop inlets and catch basins, eleven pages to sub-drainage, thirty-seven pages to foundations, and eleven pages to notes on specifications. Copies of this publication may be secured from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 20c. per copy.

EASTERN ONTARIO GOOD ROADS ASSOCIATION

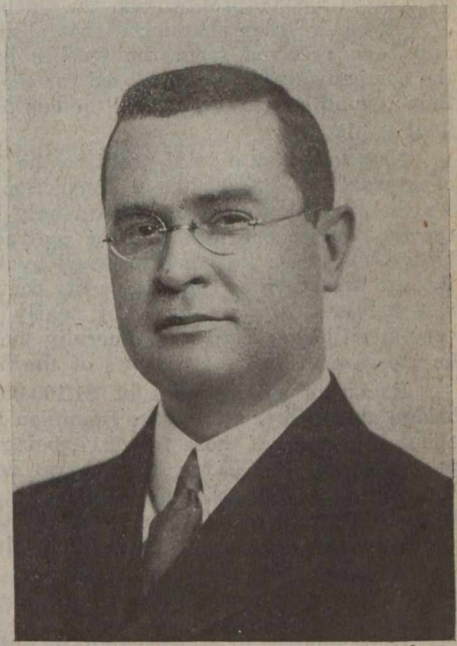
Loses Its President, Who Has Moved to Toronto—Resumé of the Good Work Accomplished Since Last July By This Energetic Organization

WILLIAM FINDLAY, of Ottawa, Ont., president of the Eastern Ontario Good Roads Association, has severed his Ottawa connections and has moved to Toronto to accept a position as advertising manager of the "Toronto Globe."

Mr. Findlay received his inspiration in good roads work from his late uncle, Andrew Pattullo, publisher of the Woodstock "Sentinel Review," who is said to have been the father of the good roads movemment in Ontario.

As a member of the legislature, Mr. Pattullo secured the passage of an act appropriating a million dollars for good roads. Before it was possible to convince the legislature that this act should be passed, it was necessary to bring before the legislature a great many county and township officials. Mr. Findlay acted as secretary of the commission in charge of the production of this evidence.

The act as passed, about 1898, made provision for the abolition of statute labor in townships and for the creation of county roads, which at the time was a long step in advance in road work. To-day the province contributes 60 per cent. to what are known as county provincial roads; and in the case of the more important roads, the province has taken them over entirely from the counties and has established them as provincial highways.



WILLIAM FINDLAY

The provincial highways in Ontario to-day extend from Windsor to the Quebec boundary, from Toronto to the Niagara frontier, and from Ottawa to Prescott; and more will be added.

Coming to the conclusion that Eastern Ontario was backward in designating roads to which the provincial government would contribute, and seeing that counties were developing road systems without any reference to the adjoining counties, Mr. Findlay last July organized the Eastern Ontario Good Roads Association. This association has been recognized by the Ontario government. At its last demonstration, held in Ottawa last September, Sir William Hearst, Hon. Howard Ferguson, Hon. T. W. McGarry, Dr. Preston and other members of the provincial government were in attendance.

As a result of the work of this association, the road along the St. Lawrence and the road from Prescott to Ottawa have been designated as provincial highways, and the following roads were designated as provincial county highways:—

Morrisburg to Ottawa, through a rich farming country; from Point Fortune, on the Quebec boundary, following the Ottawa River through Hawkesbury to Ottawa; from Kingston to Ottawa, through the Rideau lakes country; and from Ottawa to Pembroke and Petawawa military camp.

The association believes that the building and maintenance of leading roads through large centres should be undertaken as a provincial or national measure. The association has secured the passage by every county council within its district of a resolution asking the Ontario government to amend the law in such a manner as to permit the province to build and maintain main roads wherever the counties concerned so request.

The annual meeting of the Eastern Ontario Good Roads Association will be held February 4th and 5th, when a successor to Mr. Findlay will be elected. The first vice-president of the association is John Brennan, reeve of the town of Arnprior; the second vice-president is Dr. T. W. Smith, president of the Board of Trade of Hawkesbury; the third vice-president is W. F. Barker, reeve of the township of Bastard and Burgess. W. Y. Denison of Ottawa, is secretary-treasurer. The executive committee are the officers and C. J. Foy, reeve of the town of Perth; W. J. Fisher, warden of the counties of Stormont, Dundas, Glengarry and Winchester; Bower Henry, warden of Carleton County; and A. M. Rankin, M.P.P., of Collins Bay.

PROFITS FROM QUEBEC BRIDGE

DISCUSSION at the annual meeting of the shareholders of the Dominion Bridge Co., Ltd., held last week at Montreal, brought out the fact that included in the $2,477,009 profits for the year ending October 31st, 1918, was an item of $1,100,000 profits from the Quebec bridge contract.

It was further announced that a sum of about $770,000 had been received from the Quebec bridge contract since the company's books were closed for the last fiscal year, and that a small balance would still be due to the company in the final settlement.

This indicates a total profit to the Dominion Bridge Co. of upwards of $2,000,000 in connection with this contract. As the Dominion Bridge Co. own only half of the stock of the St. Lawrence Bridge Co., the contractors for the Quebec bridge, the other half being owned by the Canadian Bridge Co., of Walkerville, Ont., it seems that the Quebec bridge contract has shown a profit of nearly $4,000,000, which is very much larger than was generally thought would prove to be the case in view of the loss of the first central span.

Exclusive of the item of $1,100,000 from the Quebec bridge, the 1918 profits of the Dominion Bridge Co. were just about the same as those for 1917, being $1,377,009, as compared with $1,360,533 for 1917. Large deductions were made for doubtful accounts, depreciation, etc., leaving net earnings amounting to 28.7 per cent. on the capital stock as compared with 18.2 per cent. earned the previous year.

The inability of a workman to enter suit against his employer in the courts of his own province on account of injury sustained while outside that province, recently came up for discussion in a Quebec court before Justice Greenshields. An employee of the Foundation Company, Limited, engaged at their head office in Montreal, was injured while working for them at Amherstburg, Ontario. He entered suit for compensation in accordance with the Workmen's Compensation Act of Quebec. The defendant company showed that the plaintiff had no right of action in Quebec province. As he was injured in Ontario and as they pay premiums in that province to the Workmen's Compensation Board, his only action would lie against the Board. The Court's judgment was reserved.

Negotiations have been opened by the minister of finance with representatives of the French Government in the United States, looking to the establishment of a credit here for French purchases. It is expected that the members of the Dominion Government, now overseas, and representatives of the Canadian Trade Mission, will complete some arrangement. The whole question, however, awaits the determination of the Allies as to whether inter-allied securities will be issued to cover the expenditures for reconstruction in France and Belgium. A despatch was received last week, however, stating that Premier Borden has made, through the Canadian Mission in London, a promise to advance $25,000,000 of credit to the Roumanian Government for the purpose of purchases in Canada. The report has not yet been confirmed.

WORK OF CANADIAN RAILWAY TROOPS

In France After the Armistice—Report for Month of November—When Retreating, the Huns Used Three Methods of Demolishing Railways

OPERATIONS of the Canadian Railway troops in the field were of the utmost importance in connection with the final advance, according to an official report received from France by the Department of Militia and Defence, Ottawa.

During the month of November, 1918, the Canadian Railway troops laid 308 miles of track, all of which was in the area evacuated by the enemy, and necessary to aid in the advance for the forwarding of food and supplies. It was necessary in that time to repair 300 miles of grade. To perform this work there was a force of 6,783 men of the C.R.T., aided by 9,980 men attached from other units, a daily working force of 16,763 being employed on railway work under Canadian direction.

In addition to this force there were employed for maintenance duties, 1,309.

The care of narrow-gauge lines required 1,231 men for construction and 1,358 for maintenance. In all a force of 20,661 was required to further the activities of the Canadian Railway Troops.

The report of the work for November comments that at the beginning of that month, while the enemy was retiring very rapidly and was being hard pressed by our advancing troops, he yet managed to carry out a very systematic demolition of railway lines and bridges. In order to cope with this, all the battalions of the C.R.T., with the exception of a few small detachments, were concentrated on standard-gauge construction work, for the most part in the area between Le Cateau and Turcoing.

The Enemy's Methods

Dealing with the action of the enemy, the report continues:—

The enemy, in his retirement, used three methods in the demolition of railways:—

Firstly, by the use of a track destroyer, which tore up the rails and bunched the ties together in such a manner that to re-lay the track it was necessary to remove the rails from the ties, lift the ties, take out the ballast and then re-lay ties and steel and re-ballast.

The second method employed was to blow out every other joint on each track. In this way one end of each rail was damaged, and before it could be used again it was necessary to cut and re-drill the damaged end.

The third method was to place mines in the grade at a distance of about 100 yards apart. These mines, which sometimes took the form of heavy trench mortar or airplane bombs, caused large craters in the grade, and all track and ties surrounding the crater were absolutely demolished.

In some instances the enemy used all three methods, while in others, apparently there was only time to use one method. Continual difficulty was experienced with delay-action mines. These had been placed in important places, such as road crossings, bridge abutments, culverts, etc., and the repairing of the track, clearing away the debris and rebuilding the bridges entailed very heavy work.

A considerable amount of time and expense was saved by salving material from damaged steel bridges and using it for reconstruction. Broken girders were taken out by the use of oxy-acetylene welders. Temporary abutments were placed and trestle piers made to receive the shortened girders, the remaining part of the spans being made up of timber.

The report mentioned that all the gaps in the required standard-gauge lines have been completed up to undestroyed lines in the territory recently occupied by the Germans.

Imperial Oil, Ltd., are erecting thirty large cottages in the vicinity of their new refinery at Regina, Sask., in order to relieve the scarcity of dwellings in that city, and to provide homes for certain employees.

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PRINCIPAL CONTENTS

PHELPS JOHNSON RETIRES

PHELPS JOHNSON has retired from the presidency of the Dominion Bridge Co., Ltd. Mr. Johnson says farewell to business worries at the height and climax of his career,—just when final settlement of the Quebec Bridge contract is being made. Although not born in Canada, he is a naturalized Canadian, has spent the major portion of his life in this country, and stands pre-eminent among those Canadian engineers who have brought the Dominion to the front in the efficiency of its structural engineering. Mr. Johnson has earned many years of enjoyable recreation. His sterling business integrity, his daring ingenuity, his great engineering ability and his organizing capacity have been stamped indelibly upon our national life. To the land of his adoption, to the ethics of his profession, to his business and to his friends, Mr. Johnson has always been as true as the metal with which he has worked.

THE "O. P. C. EXTENSION"

ON account of the problems met in design, the magnitude of the work and the difficulties incidental to construction, more than passing interest attaches to the article in this issue on the extension to the plant of the Ontario Power Company at Niagara Falls. This article has been ably prepared for *The Canadian Engineer* by T. H. Hogg, a former editor of *The Canadian Engineer*, who is now the assistant hydraulic engineer of the Hydro-Electric Power Commission of Ontario. As a result of the extension, the Ontario Power Company has the greatest installed capacity of any plant in operation to-day, as it can now carry a load of over 210,000 h.p. In the past, very little has appeared in the technical press regarding the plant of the Ontario Power Company, and on this account we are all the more pleased to be able to present this very thorough description of the extension to that plant, including, as it does, considerable valuable information regarding the plant as previously constructed.

MUNICIPAL FINANCES RECOVERING

NOW that the insatiable monetary demands made by active warfare have materially lessened, even though they have not yet entirely stopped, municipalities in Canada are finding it easier to obtain money. With certain minor exceptions, there should be but little difficulty regarding Canadian municipal finances in the future.

Since the war, practically no Canadian municipal bonds have been sold in England, and since March, 1917, almost none in the United States, the sales in the United States for 1918 having been only $1,710,000 as compared with $35,483,114 for 1915, and $32,335,764 for 1916.

Both the English and American markets for municipal bonds should now revive. Moreover, the buying power and bond-buying habits of the Canadian public have greatly increased. This is evidenced by the fact that Canadian municipal bonds sold in Canada in 1915 totalled $42,149,312 as compared with $19,640,778 for 1916, and $17,955,714 for 1917. The municipal bond sales in Canada last month broke the record for the month of December. They totalled $2,536,434 as compared with $1,676,693 for December, 1915 (the highest previous record for December since 1910), and as compared with a December average of $860,182 for the past seven years.

In 1918 the Canadian municipal bond sales totalled $43,859,312 as compared with $110,600,936 for the year before the war (1913). Of this $110,600,936 there was sold in England no less than $69,632,250 and in the United States $20,418,447 and in Canada $20,550,239. With the Canadian demand more than doubled, and with the rapid recovery of the American market now materializing, Canadian municipalities should not experience any difficulty in financing even if the English market should prove to be slow in its revival.

CANADA'S FINANCIAL OBLIGATIONS

BEFORE the war the annual running expenditure of the government was about one hundred and twenty-five million dollars. Capital expenditure was nearly sixty million dollars. Apart from the principal of war expenditure, which will continue in diminishing scale for the next year or more, as compared with pre-war figures there will be added to the ordinary running expenses of the government (which are met principally by the revenues from taxation), a sum which will probably exceed one hundred million dollars, this representing yearly interest payable upon Canada's war debt, and pensions to soldiers and their dependants.

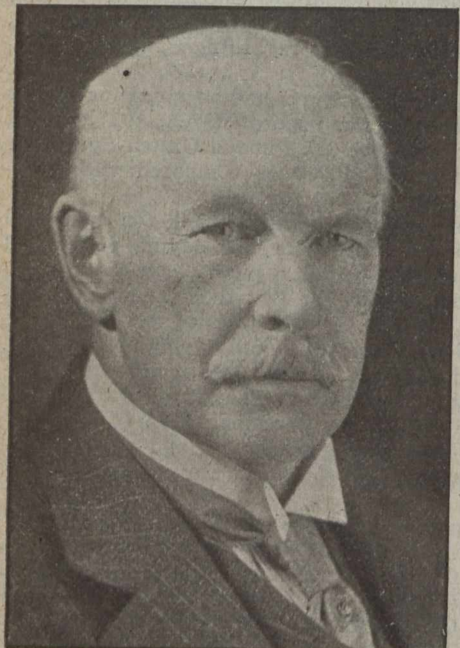
How is this one hundred million dollars per annum to be secured? Unless a large indemnity can be collected from the enemy, is it not evident that the Dominion government must go into business upon a big scale and develop the natural resources of the country in such a manner as to bring in revenue from all possible sources? The Cabinet should be slightly reconstituted to include the ablest business men who can be secured, some experienced contractors and a number of able engineers. There are too many lawyers in high places in Ottawa. A business and engineering administration would be the salvation of the country just now. Premier Borden has an opportunity of showing broad-visioned statesmanship of the highest character. He is running the biggest business in the country. If he measures up to the demands of the crisis, he will get rid of any and all dead wood with which the country's "Board of Directors" may now be encumbered.

It is likely that $50,000 will be included in this year's estimates for the city of Toronto for an experimental activated sludge plant, as Toronto will probably install at some future date a sewage treatment plant which Works Commissioner Harris estimates will cost $4,000,000.

PERSONALS

C. V. PUTMAN, formerly assistant engineer, waterworks department, city of Ottawa, is now in the efficiency department of the Civil Service Commission.

PHELPS JOHNSON has resigned the presidency of the Dominion Bridge Co., Ltd., although he remains on the Board of Directors. Mr. Johnson wished to resign a year ago, but at the annual meeting held early in 1918 he agreed to remain in office for another twelve months. Mr. Johnson joined the company in 1882 as vice-president, after having had several years' experience with three different bridge companies in the United States. Having acted for some years as vice-president, he undertook the duties of chief engineer, and for a considerable period was very active in the design and erection of many of Western Canada's most important structures. Subsequently he returned to Montreal as vice-president and general manager of the company, which office he retained until 1912, when he became president upon the death of the late James Ross. Mr. Johnson has also been president of the St. Lawrence Bridge Co., Ltd., since the incorporation of that concern in 1910. He conceived and proposed the "K"-web system used for the Quebec bridge, having become convinced that the initial cause of failure of the Phoenix Company's bridge was the high intensity of pressure and consequent distortion and displacement of material at the bearing edges of the lower chord sections of the anchor arm. He was the organizer of the St. Lawrence Company, having been the man who decided that there should be at least one bid from a Canadian company for the building of such an important Canadian structure. He evolved the idea of floating the suspended span and hoisting it into position, and he was the executive head of the big organization that planned and carried out the design and construction of the whole bridge. Mr. Johnson was born October 23rd, 1849, in Warwick, N.Y., and was educated at the public schools of Springfield, Mass., and at Goldthwait's private school, Longmeadow, Mass. He was vice-president of the Canadian Society of Civil Engineers in 1907 and was president in 1913. He also served as a member of the council from 1904-6 and 1910-12. Mr. Johnson is a bachelor and has resided for many years at the Windsor Hotel, Montreal. On the ground floor of this hotel he has had, for many years, a private office at which he could nearly always be found at certain periods of the day. This office was frequently used for board meetings and other important business, but was also popular as a meeting place for scores of structural engineers and old business friends of Mr. Johnson, few of whom ever failed when in Montreal to call and pay their respects.



ROLAND C. HARRIS, works commissioner of the city of Toronto, will address the Engineers' Club of Toronto at 8 o'clock to-morrow evening. Mr. Harris' subject will be "The Bloor Street Viaduct."

B. E. NORRISH, formerly superintendent of the Commercial Exhibits Branch, Department of Trade and Commerce, Ottawa, has been appointed as official in charge of moving picture publicity work for the Dominion Government. Mr. Norrish is making arrangements for the exhibition of films showing Canadian water powers and other natural resources. These pictures will be shown in the United Kingdom, the United States and the British Dominions.

W. S. HARVEY, until recently construction engineer for Leaside Munitions, Ltd., has been appointed engineer of sewers, Toronto Harbor Commission. Under the direction of George Clark, designing engineer to the Commission, Mr. Harvey will prepare plans for the drainage of the Ashbridge's Bay Industrial Area and for the extensions to the city's main sewer outlets beyond the fill along the waterfront. Mr. Harvey spent several years in the sewer section of the Department of Works, Toronto, and was formerly assistant city engineer of Lethbridge, Alta.

G. H. DUGGAN, vice-president and managing director of the Dominion Bridge Co., Ltd., was last week elected president of the company in place of Phelps Johnson, who has resigned. Mr. Duggan graduated from S.P.S., University of Toronto, about 1883. A few years later he entered the employ of the Dominion Bridge Co., becoming chief engineer in 1891. In 1902 he resigned to become assistant to the president of the Dominion Iron & Steel Co., and in 1904 was appointed second vice-president and general manager of the Dominion Coal Co. About six years later he rejoined the Dominion Bridge Co. as general manager. During the design and construction of the Quebec Bridge, Mr. Duggan was chief engineer of the St. Lawrence Bridge Co., Ltd. He is also a director of the Royal Bank of Canada, the Montreal Trust Co., the Hillcrest Collieries and many other engineering and business concerns.

OBITUARY

JULIUS E. WATEROUS, one of the founders of the Waterous Engine Works at Brantford, Ont., passed away last Saturday at the age of 75. Mr. Waterous was vice-president of the company. He took an active part in the early development of Western Ontario municipalities by the installation of waterworks, which was a specialty of the Waterous company in its earlier career. Mr. Waterous is survived by two sons who arrived home from France only a few days before his death, by a widow and by three brothers, two of whom are connected with the firm in Brantford and one of whom is a prominent manufacturer in St. Paul.

Archibald and Holmes, Ltd., contractors, have moved to new offices in the Continental Life Building, Toronto.

The date of effect of the recent order of the Canadian Railway War Board providing for payment of all transportation charges in cash, has been postponed from January 1st to March 1st in order to give business firms sufficient time to make the necessary arrangements for complying with the new conditions. All transportation charges, including demurrage and storage costs, must now be paid for in advance just as in the case of ordinary passenger traffic. Ninety-six hours credit may, however, be given upon the furnishing of a bond attested to by a bank, trust company or guarantee company.

The eleventh general annual assembly of the Royal Architectural Institute of Canada will be held to-morrow and Saturday at Montreal. The inaugural address will be delivered by G. A. Monette, president of the Province of Quebec Association of Architects. The response will be delivered by J. P. Ouellet, president of the Royal Architectural Institute. To-morrow evening there will be a joint meeting with the Province of Quebec Association of Architects at the Arts Club, at which there will be a discussion on housing and lectures by Charles H. Whitaker, secretary of the Post-War Committee of the American Institute of Architects; and by Thomas Adams, town planning adviser to the Commission of Conservation. Alcide Chausse is the honorary secretary of the Royal Architectural Institute of Canada.