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# THE VANCOUVER ISLAND POWER COMPANY, LIMITED JORDAN RIVER DEVELOPMENT.

## PART II.

The flume traverses a heavy belt of timber along the entire route, and the clearing necessary for adequate protection of the structure was very extensive. A wide clearing was made, all trees being taken down along the upper side which would reach the flume in falling, and all leaning and dead trees were cut along the lower side.

The fallen timber was hand-logged down the hill from the zone to be occupied by the flume proper and the flume railway, and the loppings and branches, as far as the season would permit without danger, were piled and burned as the work went forward. About 6,000,000 feet, board measure, of timber were cut in making the clearing.

The flume box, which is designed for an ultimate carrying capacity of 175 cubic feet per second, is 6 x 6 feet in size, and has a grade of one foot to 1,000 feet. It is supported by bents spaced 15 feet centre to centre, set upon ample footings, either of cedar blocks or concrete, according to the nature of the underlying material, the maximum bearing upon a square foot of the supporting ground surface being not greater than one ton. The sizes and dimensions of the different members of the flume are as follows:—

Junction of "Y" Creek Flume With Main Flume.

| | | | |
|---|---|---|---|
| 2 Bent posts | Cedar | 8″ x 8″ | battened |
| 1 Cap | Fir | 8″ x 8″ | gained. |
| 2 Stringers | Fir | 6″ x 14″ | lapped |
| 6 Sills | Fir | 4″ x 8″ | gained |
| 12 Box posts | Fir | 4″ x 6″ | |
| 6 Yokes | Fir | 4″ x 6″ | gained |

The box is of fir and spruce planking, 2 inches thick, 12 inches and 18 inches wide, and surfaced on one side, with flat battens, ½″ x 3½″, nailed over the cracks.

Side planks to carry 75 cubic feet of water per second have been installed, and additional planks may be added as greater capacity is required, at which time intermediate bents, or at least supporting posts will be installed at the middle points of the stringers, reducing the span to 7½ feet.

In the construction of the flume 3,500,000 board feet of lumber were used, to supply which, a saw mill was erected at the lower end of the flume and adjacent to the forebay reservoir. The capacity of the mill was about 30,000 board feet per day, and the equipment included machinery for surfacing, sizing, gaining and trimming the flume lumber for erection with a minimum of hand labor.

The total amount of lumber cut in the mill for the entire construction work was about 6,000,000 feet, board measure.

To facilitate the construction of the flume, a 36-inch gauge railway, with 30-lb. rail, was built parallel to the flume along its entire length, and at an elevation about 15 feet above it. Lumber and other material for the flume, as well as for the diverting dams and storage dam, were delivered over this track, which connects directly at its lower end with an inclined tramway of the same gauge. This inclined tramway begins at a landing wharf on the shore, is two miles in length and after overcoming a difference of elevation of 1,200 feet, connects with the flume railway near the saw mill.

The operation of the inclined tramway is accomplished by means of a powerful haulage engine placed at the upper end of the tramway, and a second and lighter haulage engine near the lower end, slight grades at sections preventing the cars from overhauling the cable by their own weight.

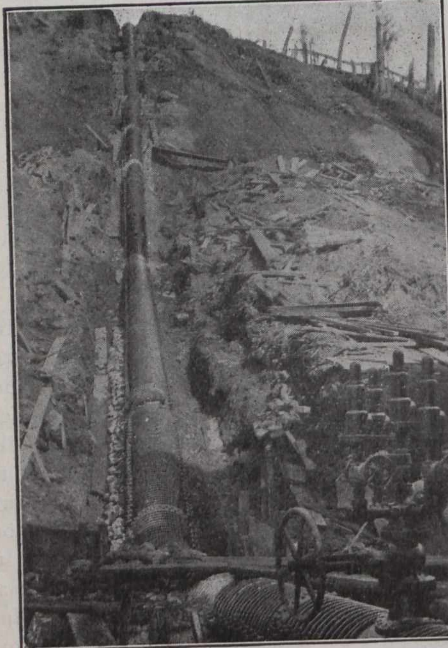
In building the flume, all members were sized and cut to true length, including bent posts, and all daps and gains were made at the saw mill by machine. The footings were accurately located and placed to elevation with transit and level, somewhat in advance of the erection; the length of the posts required for each bent was determined, and the information forwarded to the framing yard at the saw mill where the various parts were prepared. In this way, confusion and crowding was avoided on the work, and a greater rate of progress made possible.

The system worked out quite satisfactorily, very few errors occurring in the process.

Five combination sand and waste gates are provided along the length of the flume at approximately equal intervals, and a standard weir was built at the lower end where several measurements were taken to determine the carrying capacity with different depths of water. The results of these tests indicates a value of about 122 for the coefficient in Chezy's formula: $v = c \sqrt{rs}$.

The flume has been in continuous operation since November, 1910, and has proven tight, safe, and reliable in every respect, only one short interruption having occurred, due to the loss of one bent destroyed by a small landslide.

**Forebay Reservoir.**—The forebay reservoir site consists of two small, gently sloping, heavily wooded depressions leading in opposite directions from a low saddle or ridge, lying 1,150 feet above sea-level. Two earth dams were built across the valleys, the material for the embankments being all excavated from the higher ground between. Each embankment is about 35 feet in height, and 1,000 feet in length. The total volume of fill in the two dams is 35,000 cubic yards.



**Pipe Line at Entrance Power House.**

The material available for the embankments was semi-cemented gravel, or hardpan, which required drilling and blasting to loosen. A double-sheathed timber diaphragm of cedar planking, connecting with a concrete cut-off wall sunk well into the impervious hardpan, was installed in each dam to insure water tightness, the material from which the dams had to be built not being sufficiently impervious to make them adequately water-tight without diaphragms.

Dam No. 1 was built with wheelbarrows and heavy sleds, hauled with a donkey engine, and hoisted and dumped from an overhead cableway. Dam No. 2 was built under contract, with horses and carts.

No particular attempt was made on either embankment to puddle or compact the material during construction, except that a limit of three feet was placed upon the layers deposited, and a small amount of puddling with water was done immediately in front of the timber diaphragms.

A concrete intake structure, surmounted by a structural steel gate tower, from which were operated two roller bearing 54-inch hydraulic sluice gates, was erected inside the reservoir at the head of the pipe line. Two 44-inch steel riveted pipes are installed through the base of the south dam. From the intake structure to the core wall, the pipes are imbedded in a reinforced concrete casing, and from the core wall to the lower toe of the dam, two open culverts, with common centre wall, and roofed with reinforced concrete slabs, are installed around the pipes, insuring perfect drainage, and allowing access for inspection. Two 6-inch standpipes extending up to the floor of the gate tower are installed at the upper end of the pipes.

The reservoir, when full, covers an area of about 12 acres, and the capacity available—4,800,000 cubic feet—is sufficient to operate the single generating unit installed for a period of about 30 hours. To prevent damage to the slopes from wave action, a light timber boom is floated about four feet from the water's edge, and braced at intervals from the bank.

An emergency spillway with flash boards and apron is built in the solid ground at the east end of dam No. 2.

The function of this forebay reservoir is to increase the peak load capacity of the power plant by liberal storage immediately at the head of the pipe line; and also to furnish a reserve supply of water to run the plant for a considerable period in event of accident to the flume line.

**Pipe Line.**—The pipe line leading from the forebay reservoir to the power station is 9,800 feet in length, and follows a gentle slope for the greater part of its length, the lower 300 feet descending abruptly to the power house. The upper third of the length of this line is designed to deliver water for two generating units of 4,000 kilowatts each, and consists of one riveted steel pipe 44 inches diameter, ¼ inch to ⅜ inch plate. At the lower end of this section a cast-iron "Y" piece, fitted with two 36-inch cast steel gate valves is installed, providing for the extension of two lines to the power house. The lower section of the pipe is designed to deliver water for one generating unit only, and the single line installed consists of lap-welded steel, with riveted round-about joints, in approximately equal lengths of 36-inch, 34-inch, 32-inch and 30-inch diameter, and varying in thickness from 5/16 inch at the "Y" end to 9/16 inch at the lower end.

The pipe line was designed with an ample factor of safety according to current practice in the extensive use of lap-welded pipe. However, owing to the apprehension aroused in the minds of the officials of the company by a reported failure of a similar lap-welded pipe elsewhere, the lower end of the pipe line for a distance of 2,200 feet was reinforced by one inch round steel bands, after the manner of a wood-stave pipe with spacing from 3¾ to 4 inches.

Several hours after first filling the line with water the 36-inch valve on the dead end at the "Y" burst without warning and the water in the 44-inch pipe above was suddenly discharged. No damage, however, resulted to the pipe line, ample air openings having been provided for its protection. The valve was split almost centrally through the body and bonnet, the lower half being blown a distance of 20 feet away. An investigation of the design of the body showed that an ample section of metal had been provided throughout for a large factor of safety and no flaws or other defects were disclosed. The valve had been ordered tested before shipment, but this had not been done. The accident emphasizes the unreliability of cast-iron, even for moderate pressures. The cast-iron valve bodies were then discarded, and cast-steel parts installed in their places, and, as an additional precaution, two expansion joints, one in the 44-inch pipe above the "Y" and one in the 36-inch pipe below, were introduced in the line to eliminate any strains due to expansion or contraction to which the cast iron parts might be subjected. Eight 4-inch air valves and 4 manholes were installed along the length of the pipe, and immediately back of the power house a cluster of four automatic pressure relief valves was mounted.

Concrete anchor bolts and supporting piers were erected at proper intervals along the pipe line.

The inclined tramway was installed parallel to the line along its entire length, from which the pipe and other materials were delivered.

The entire pipe line installation, including the furnishing of material and the erection, was done under contract by the Jens Orten Boving Company, Limited, of London, England.

**Power Station.**—The power station faces the ocean and is erected on low ground at the foot of the pipe line hill, which slopes very abruptly for the lower three hundred feet of its length. The ground surface is elevated only slightly above extreme high-tide elevation, but the waterwheel nozzles are placed 5.5 feet above the maximum high-tide level. A very heavy growth of cedar, spruce and hemlock timber was removed from the site in preparation for the construction work.

The power house building is 49 feet by 97 feet, sufficient space being provided for the installation of two complete generating units, with exciters, transformers, switchboards, low-tension and high-tension switches, etc. Concrete and steel were used exclusively in the construction of the building, account being taken in making the location for its extension to contain an ultimate installation of four generating units.

The pipe line previously described enters the power house at the back and is connected to the generating unit through a 24-inch gate valve, there being an effective head of 1,100 feet. The water is controlled by a needle regulating nozzle in conjunction with an auxiliary needle nozzle, the needle of which is mechanically connected to the main needle and is so arranged that it opens automatically as soon as the main needle closes rapidly or beyond a certain predetermined point. In this way the auxiliary nozzle maintains a sufficient vent to avoid a dangerous rise of pressure in the pipe line. The auxiliary nozzle is also fitted with an independent slow-moving adjustable time element mechanism which gradually closes the nozzle when the main needle stops moving, thus conserving the water supply.

A Lombard, Type Q, oil pressure governor is used for speed regulation and is directly attached to the main nozzle needle.

The main generating unit consists of a 4,000 kilowatt generator and a 6,000 horse-power impulse water-wheel. This unit is of the two-bearing type, having the revolving field of the generator mounted on the shaft between the bearings and the water-wheel overhung at one end. The speed is 400 revolutions per minute.

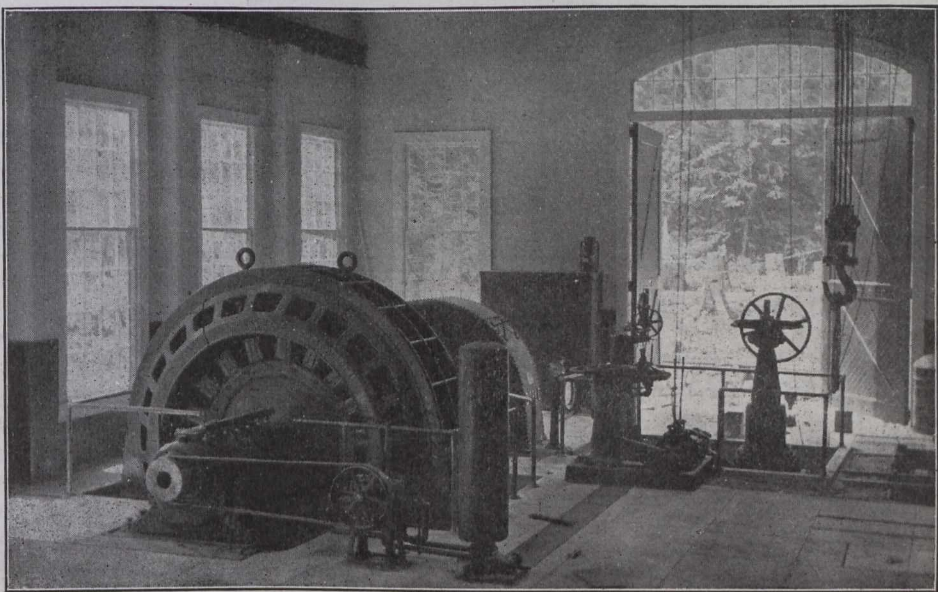
One exciter is installed which has sufficient capacity to supply maximum field current for two generating units. The extended shaft carries on one end an overhung impulse water-wheel, and is connected at the other end to an inductor motor, which operates at the generator voltage, and has sufficient capacity to drive the exciter generator continuously. The exciter water-wheel is equipped for hand control only, as the motor serves as a speed regulator and no governor is necessary.

A four-panel marble switchboard, provided with a complete equipment of instruments and controlling devices, including Tirrell regulator, is mounted on the switchboard floor, which is elevated about 6 feet above the generator floor.

The current delivered by the generator at 2,300 volts is stepped up to 40,000 volts by means of three 1,400 kilowatt-ampere oil-insulated water-cooled transformers, which are installed in fire-proof compartments back of the generator. These transformers are now operating with delta connection, delivering current to the transmission line at 40,000 volts. This voltage will be raised upon the installation of the second unit to 60,000 by changing the delta connection to star connection with grounded neutral.

The water-wheel equipment was furnished by the John McDougall Caledonian Iron Works, Limited, of Montreal, and manufactured under the Doble patents; the generator and exciter by the Allis-Chalmers-Bullock Company, Limited, and the transformers, switchboards, switches and lightning arresters by the Canadian General Electric Company, Limited.

A 75,000-volt three-pole oil switch with disconnecting switches, and arranged for hand operation from the generator floor, is installed in the high-tension room. A complete equipment of three-phase aluminum cell, 40,000-volt lightning arresters has been provided to protect each end of the transmission line.



**View of Inside of Power House.**

At Victoria the sub-station used in connection with the operation of the transmission line from the old Goldstream hydro-electric station has been utilized. Extensive alterations were made in the old building, including the erection of transformer stalls for two banks of transformers, and high-tension switch-room of reinforced concrete, space being provided for bringing two transmission circuits into the building.

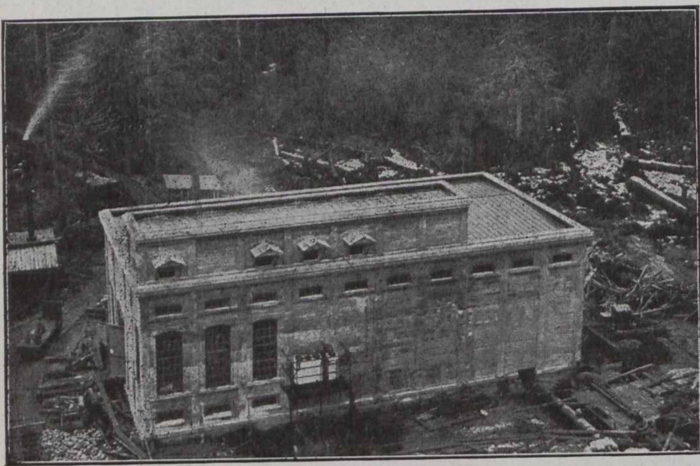
An unfortunate and very unusual set of conditions were encountered in the power station foundations, the remedying of which was fortunately taken in hand in time to prevent serious delay in putting the plant into operation.

In the construction of the building and the setting of foundation, unusual precautions were observed; the excavation for the foundation walls and the machine settings were carried to a depth of about 21 feet below the floor level. Some seams of peat, varying in thickness from 2 inches to 2 feet, were encountered. At the bottom of the trench a fairly stiff, blue, sandy clay was found, into which borings were made for a distance of 12 feet, showing the same class of material throughout this distance.

Tests of the bearing power of the ground were made, which showed that a load of five tons per square foot would not cause any settlement.

Having taken these precautions in predetermining the bearing power of the soil, it appeared that this material was entirely safe for foundation purposes with the load to be imposed.

After the building was completed observations taken indicated that a slight settlement was taking place. These observations were continued for several months in order to establish beyond a doubt that the building and machinery



**View of Rear of Power House.**

foundations were actually settling, and to determine as nearly as possible the rate of settlement.

In June, 1911, a series of test holes were put down at points around the building, which showed that a soft muck bed from 5 to 15 feet in thickness lay some 50 feet below the floor level, and about 25 feet below the bottom of the foundations. The layer of clay on which the foundations were set had been stressed beyond its supporting power, and had gradually compressed the stratum of muck and peat beneath.

This most extraordinary condition could not have been found by any means of testing other than sinking deep drill holes, and, even if this had been done previous to the setting of the building, the strength of the clay seam could not have been determined by any test, except the application of a load approximating the entire weight of the structure and contents, which was, of course, impracticable. Only such a weight would have caused the bending of the clay stratum and the consequent yielding of the peat seam.

In the course of the original investigation, test piles 45 feet in length were driven adjacent to the power house, the bearing power of which, computed from the penetration under the hammer blow, was from 12 to 15 tons per pile. It is evident that if a pile foundation had been installed with piles driven to apparently ample depth based on penetration, the condition would not have been discovered in advance, nor the settlement obviated.

The underpinning of the machine foundations was begun July 15th, 1911, and carried on continuously night and day until September 10th, when the plant was put in operation.

Standard pipe or casing 12 inches in diameter was sunk with well rigs to the bed-rock beneath the peat seam around the machine foundation and pipe line immediately behind the power house.

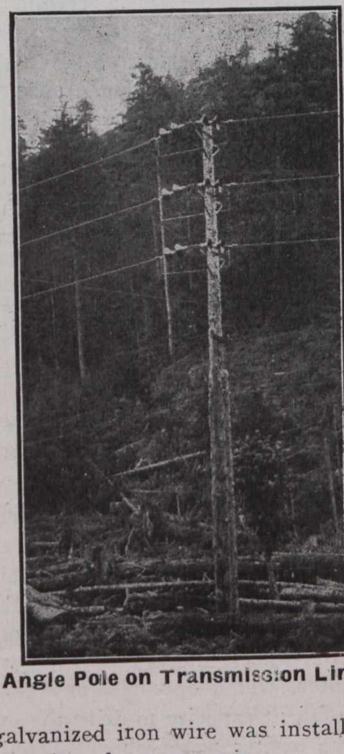
The pipes were pumped out, cleaned, and after inserting steel reinforcing bars, were filled with concrete, forming a system of some 26 steel and concrete piles. Steel I-beams were placed on top of the piles supporting the concrete foundation, wedges being driven as tight as possible between the tops of the beams and concrete of the foundation, and the whole surrounded with concrete. No settlement has been observed since the completion of this underpinning.

The building foundations proper were not strengthened, and no settlement has taken place since the clay stratum was relieved of the weight taken by the piles.

**Transmission Line.**—The transmission line leading from the power station to the city of Victoria traverses the rough, heavily timbered country along the west coast of the island for a distance of about 40 miles. The first 15 miles of its course is located along the bluff shore line of the Straits of Juan de Fuca, the wires in some places overhanging the sea. No road or trail existed along this section at the time the line was built, and the materials, except poles, which were cut from the adjacent forest, were delivered with small boats along the beach. The remaining 25 miles of the line follows generally the Provincial Government highway, with more or less diversion to avoid acute angles and to shorten the distance.

The current is transmitted at 40,000 volts, 3-phase, 60 cycles.

Cedar poles (with a minimum diameter at the top of 9 inches) are used throughout, 50 feet, 55 feet and 60 feet in height, and spaced from 300 to 400 feet apart. Three steel galvanized cross-arms, each composed of two 1¾-inch by 1¾-inch angles 9 feet long with 1¼-inch angle iron branches are mounted on each pole, all bolts, lag-screws and washers being galvanized. The initial circuit is hung on one side of the pole, leaving space on the other side for the installation of a second and similar circuit at some future time. Brown glazed, two-piece suspension insulators, Locke Type No. 275, are used, one element only being installed for ordinary suspension. At dead end angle points, two elements were used to avoid trouble in adding the second element when the line voltage is raised to 60,000 volts, upon the completion of the second unit. Dead ends were made at all angles where the conductor is drawn toward the pole. Standard line insulators are used on either side of the cross-arm, and the conductor was taken across in a suspended loop.



**Angle Pole on Transmission Line.**

The conductor is seven strand aluminum cable, No. 00 B. & S. gauge, and is designed to transmit the output of one generator at 40,000 volts, and two generators at 60,000 volts.

A metallic circuit telephone line, No. 9 B.W.G. galvanized iron wire was installed on a short wooden cross-arm below the power wires.

The timber growth along the route of the line is exceptionally heavy, and a very extensive clearing was necessary along and on either side of the line for its protection, all trees being cut that could reach the wires in falling. For many miles a zone from 400 feet to 600 feet in width was cleared through the finest fir belt on the island, and an aggregate of approximately 20,000,000 feet, board measure, of merchantable timber was paid for and cut down in the course of the work, some of which may perhaps be put to profitable use before becoming useless by decay or being destroyed by fire.

**Transportation.**—One of the most formidable problems of this development was that of transportation. All machinery, cement, pipe, provisions and other supplies, as well as all kinds of labor had to be transported by sea from Victoria, 45 miles down the coast to the mouth of Jordan River. The Straits of Juan de Fuca at this point are exposed to the sweep of the open sea from the west and there was no pier and no natural or artificial protection at the point of landing. Bulky freight was loaded on scows at Victoria and towed by a small tug to Jordan River. The scows, on arrival at the Jordan River landing, were hauled up on runways laid on the flat beach until they were out of reach of the waves, and were then unloaded by derricks.

Making the journey to and from Victoria and beaching the loaded scows in stormy weather was precarious in the extreme, requiring a high degree of patience, courage and skill. Passengers, mail and light freight were landed on the beach in dories.

Although much trouble and some minor accidents occurred, not a single piece of the 6,400 tons of material and equipment handled, nor a single one of the several thousand passengers carried was lost.

From an engineering standpoint the development in its present initially completed state perhaps presents by itself no very unusual features. But when consideration is given to all the elements involved in carving out of a wild, remote and almost impenetrable and trackless wilderness a reliable and highly efficient hydro-electric system, planned for large expansion along accurately predetermined lines, this development presents very unusual interest. Very few hydroelectric developments have presented a greater array of formidable obstacles, many closely concealed, and few have been carried through to successful completion on lines as closely adhering to those originally planned, despite the meagre data on which these original plans were perforce based.

The entire work was under the direction of Mr. Wynn Meredith, of Sanderson & Porter, from the first pioneering to the final completion of the initial installation of the first 4,000-kilowatt unit.

The preliminary reconnoissance and surveys were under the immediate charge of Mr. A. B. Carey.

The final location surveys and all construction work were under the immediate charge of Mr. E. E. Carpenter, to whom we are indebted for the data forming the basis of this article.

## ORE PRODUCTION IN MILLIONS.

Metal production at the Consolidated Mining and Smelting Company's smelter at Trail in September reached a value of $715,696, of which 38.2 per cent. was in gold, according to figures recently made public. This is the highest monthly production for the present year and exceeds the average for the previous two months by about $300,000. Ore treated at the smelter totalled 26,099 tons, so that the average value per ton was a trifle over $27. As the greater part of the ore smelted came from the company's Rossland mines which are regarded as low grade properties, this average is considered satisfactory. The Consolidated Company's metal production for the first three months of this fiscal year totals $1,567,867.

Ore production in the Kootenay and Boundary districts for first week in November totalled 51,014 tons, making a total for the year to date of 2,162,902 tons. Smelter receipts for the week were 44,756 tons; for the year, 1,939,934 tons.

## THE HYDRO-ELECTRIC PLANT OF THE SHERBROOKE RAILWAY AND POWER COMPANY AT SHERBROOKE, P.Q.

An interesting hydro-electric plant was recently finished for the Sherbrooke Railway and Power Company, at Sherbrooke, Que. The plant was designed by Messrs. Ross and Holgate, of Montreal, and the work was done under their supervision. Mr. C. L. Cate, described the design and construction of the plant very fully in a paper read before the Canadian Society of Civil Engineers, on October 24th. The following abstracts are taken from the paper:—

The city of Sherbrooke is situated 100 miles south-east of Montreal on the main line of both the Canadian Pacific Rail way—Montreal to Halifax—and the Grand Trunk Railway—Montreal to Portland. It is also the terminus of the Boston and Maine, and Quebec Central Railways. Excellent water power is provided by the Magog River, which joins the St. Francis within the city limits. The population, at present 17,000, is increasing at the rate of 5 per cent. per annum.

The Sherbrooke Street Railway Company was incorporated by Act of the Legislature of the Province of Quebec in 1895 and began operating in 1896. Power was supplied from a power house in the centre of the city on the south bank of the Magog River, about 1,200 feet from is junction with the St. Francis River. About 100 feet above this power house was a timber dam, built in 1860, and the company had rights to half the flow of the river, the other half being used by several factories on the north bank. The head was 19 feet and the power house capacity 350 K.W.

In the spring of 1910 the Street Railway Company was succeeded by the Sherbrooke Railway and Power Company. Following the inauguration of the old company the population had increased 70 per cent., and the railway had become inadequate, but its expansion was impossible because the old plant was barely able to carry the original car equipment and more power could not be obtained at that site.

The Railway and Power Company proceeded at once to secure the entire power at the old dam, and purchased rights higher up the river so that the water could be raised an additional ten feet. A power 600 feet farther down the river, having a head of 18 feet, was also secured, together with the drop between these two powers. The total head available was about 57 feet, and this has all be utilized in the new plant.

The drainage basin of the Magog River has an area of 815 square miles, of which 283 square miles are in Canada and 532 square miles in the United States. The soil is of comparatively slight depth and the small streams are nearly all rapid. This would tend to make the flow of the stream very irregular and not so valuable for power purposes were it not for the two large storage areas contained in the basin. The greater of these storage areas, Lake Memphremagog, is 30 miles long and has an area of 45 square miles. The difference between extreme high and low water in this lake is five feet, but only a little more than a foot is under actual control at present. In designing a plant, allowance was made for an improvement in this respect, which is likely to be realized shortly. The second storage area is provided in Lake Magog, lying some 8 miles down stream from the outlet of Lake Memphremagog, with an area of 4.8 square miles and a controllable variation of 4 feet.

This lower storage is under the control of the city of Sherbrooke, and the Memphremagog storage is regulated by the Magog Manufacturing Company at Magog. This in no way lessens their value to the Sherbrooke Railway and Power Company's present plant as it is to the general advantage that the flow be kept as constant as possible. Moreover, there is an agreement of long standing by which at least 500 cubic feet per second must be passed when available.

In estimating the rainfall and run-off it was desirable to find a stream having its basin as near as possible to that of the Magog River and on which measurements of flow, rainfall and run-off have been made over a considerable period. That portion of the Connecticut River lying north of Oxford, New Hampshire, was found to serve the purpose very well. The centre of its basin is only about 50 miles south of that of the Magog; the soil is of very much the same nature, and although the country slopes a little less abruptly, this can be allowed for. A Government station has been established at Orford for eight years and measurements of flow, etc., have been taken during that time.

The following table gives the rainfall and run-off for the Connecticut River and the estimated run-off for the Magog, allowing for the fact that the Magog Basin is farther north

| | CONNECTICUT RIVER | | | MAGOG RIVER | |
|---|---|---|---|---|---|
| MONTH | INCHES RAIN | INCHES RUN-OFF | RUN-OFF IN % TOTAL RUN-OFF | RUN-OFF IN % TOTAL RUN-OFF | FLOW IN CU. FT. PER SEC. |
| Jan..... | 2.28 | 0.76 | 3.5 | 3.5 | 413 |
| Feb..... | 1.60 | 0.54 | 2.5 | 2.5 | 295 |
| Mar..... | 3.44 | 3.91 | 18.04 | 14. | 1,662 |
| Apr..... | 2.77 | 4.70 | 21.7 | 26. | 3,060 |
| May.... | 2.99 | 3.10 | 14.3 | 17. | 2,000 |
| June.... | 3.78 | 1.69 | 7.8 | 8. | 944 |
| July..... | 4.34 | 1.09 | 5.04 | 4.5 | 531 |
| Aug..... | 3.88 | 1.09 | 5.04 | 4.5 | 531 |
| Sep..... | 3.73 | 1.03 | 4.75 | 4. | 472 |
| Oct..... | 2.77 | 1.24 | 5.74 | 5. | 590 |
| Nov..... | 2.17 | 1.23 | 5.68 | 6. | 708 |
| Dec..... | 2.80 | 1.28 | 5.9 | 5. | 590 |

and the streams somewhat more rapid. Allowance was also made for the fact that in a north-flowing stream the period of heavy flow in the spring is somewhat shorter and more excessive than in a south-flowing stream, because in the latter case the floods from the head waters do not come down until the southern portion has returned to a more or less normal condition. The calculated flow of the Magog in cubic feet per second for each month is also given. In making these calculations a total run-off of 21.5 inches was used instead of 21.66 as given for the Connecticut.

The flow of the river for a dry year is 580 cubic feet per second, and the flow estimated by the power users on its banks was 550 cubic feet per second, a difference of only about 5 per cent.

With the full 5 foot storage in Lake Memphremagog the flow would be nearly 800 cubic feet per second.

The purposes of the new development are, first, to replace the old plant mentioned above, and secondly, to supply about 2,500 H.P. of electrical energy to power consumers within a radius of 20 miles of Sherbrooke. The greater part of this power will be sold to concerns at least 8 miles from the city and will be transmitted at 20,000 volts. This energy is for the most part already contracted for, and the pole line has been erected as far as the Eustis Copper Mines.

The development consists essentially of:—

(1) A concrete dam with a northern bulkhead section 225 feet long and about 20 feet high, a central overflow section 70 feet long and 44 feet high, a stop-log section 14 feet long,—used during construction to pass water for the old Sreet Railway power house, and which can be used in future as an adjunct to the overflow section, should this become necessary during spring freshets,—and a southern bulkhead section 42 feet long and 12 feet high. The dam contains about 3,400 yards of concrete.

(2) A steel penstock 660 feet long and 9 feet 6 inches in diameter with a standpipe 16 feet in diameter and 56 feet high.

(3) A brick and concrete power house 90 feet x 38 feet with hydraulic and electrical equipment for developing 3,000 H.P.

All concrete used on the work was mixed in the proportion of 1-3-5 except in beams and slabs where 1-2¼-4 was used. Suitable gravel was substituted for sand and broken stone.

**Dam.**—A 2-inch steel cableway was strung over the site of the dam and used both for excavating and for placing the concrete, bottom-dumping buckets of 1 cubic yard capacity being employed. A boiler and hoist shed was erected on the south bank. The location of the cable-way is shown by a dotted line on Plate III. and it will be seen that it lies just inside the upstream face, and nearly parallel to it, across the northern bulkhead section. At the overflow section it is about 20 feet back of the fact. This arrangement permitted the placing of 85 per cent. of the concrete without building runways.

The concrete mixer, a Ransome No. 28, was located just under the northern tower of the cableway with the gravel bin behind and above it and the cement shed above to the east. Steam for the mixer was obtained from the boilers of a factory on the north shore.

The new dam has been built 50 feet downstream from the crest of the old timber dam and is 10 feet higher. Plate III. shows its location relative to the old dam, headrace, etc.

The factories on the north shore had power rights which have not yet expired. They were equipped with electric motors and supplied with power from the city power house and the head gates on that side of the river closed, but it was desired to keep the Street Railway power house in full operation until the power from the new development was available, in order to avoid installing motor generator sets and purchasing power for them.

The course adopted was as follows. The northern bulkhead section was first constructed, the old head gates serving as a coffer-dam. The excavation in this section was not very heavy and, aside from blasting a 3 x 4 cut-off trench, consisted for the most part of earth. A great many pot-holes were found in the rock, which must have been worn in some quite remote period as the river has not been running in that portion of its channel since the country was settled.

The work was commenced at the north shore and run southward, expansion joints being made every 35 feet. An opening 14 feet wide was left in this section to provide a passage for the flow of the river while the overflow section was being built. The bottom of this opening was about 2 feet below the crest of the old dam. The penstock thimble, which is located at about the middle of the section, was concreted in, and the first sections of the penstock riveted on and blocked up. The racks, which are of steel 3 inches x 5/16-inch spaced 1⅝-inch apart, were also erected, and stop-logs inserted to about 4 feet higher than the bottom of the opening referred to above, it being considered unsafe to leave the penstock entirely open on account of the thrust which would be caused by the swift flow around the 16° angle 10 feet from the dam.

The old north shore head gates were then blown out, permitting about half the flow of the river to go through the 14-foot opening. During the low water, which occurs on Sundays, due to the fact that the factories higher up the river are shut down, the height of the old dam was raised 4 feet by means of flash boards faced with gravel, thus forcing the entire flow through the 14-foot opening and the penstock.

Unfortunately, the old dam leaked badly, and although a diver was procured and everything possible was done to caulk it, it was necessary to construct a coffer-dam immediately below. A coffer-dam was also built about 10 feet below the tail of the new dam.

A flume 3 feet wide and 4 feet deep was built between these two coffer-dams. The nature of the river bottom (huge boulders and gravel) made it impossible to get these tight: Three turbine pumps, an 8-inch on the upstream coffer-dam, and a 6-inch and a 4-inch on the lower coffer-dam, were installed. The excavation for the overflow section was then begun.

Perhaps the most interesting point in the construction of the dam was the manner in which the first 20 feet of concrete was put into this section. The water situation stood thus:—the leakage of the old dam which was being used as upstream coffer-dam amounted to about 2,000 cubic feet per minute. This was caught by a coffer-dam, as above mentioned, and carried across the site of the dam in a flume. Nearly all the leakage of the coffer-dam was held by a natural wall of gravel and shale, and pumped into the flume by an 8-inch turbine pump.

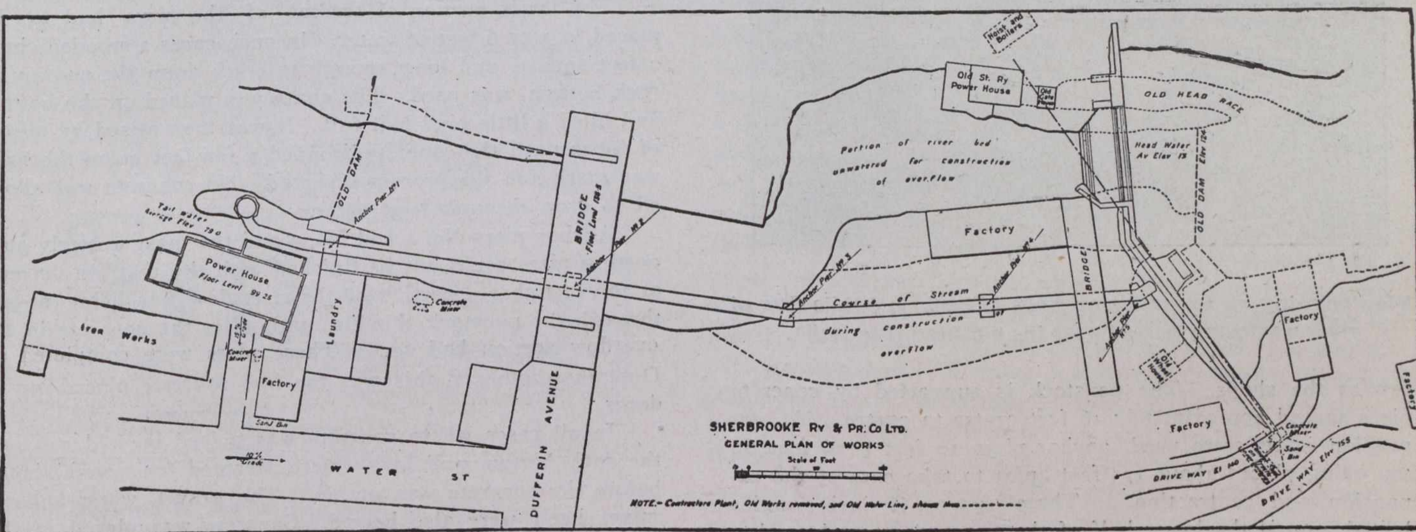
done quickly, as the volume to be filled was so small that the water rose very rapidly.

The concrete was then carried up to about 14 inches below the flume. This permitted the 6-inch pump (No. 2) to be taken out. The flume was cut off at the downstream coffer-dam and the old power house put in operation.

No form for the upstream face had been built up to this time, and although this involved the placing of some 40 yards of concrete in front of the intended face of the dam, it seemed to be the only practicable solution of the problem.

A form of temporary sluice through the dam was then built, the leakage water directed through it and the old flume pulled out. The forms for the upstream face and the remainder of the downstream face were then erected and the overflow section completed. The 70-ft. overflow section is built without an expansion joint, and in order to prevent cracks five 60-lb. steel rails were embedded near the crest. The strength of the concrete mixture was also increased to 1-2½-4¼ in the upper portion.

Four days after the completion of the crest the temporary sluice was closed by a reinforced concrete slab, and filled up through the opening provided. That portion of the Street Railway headrace wall between the dam and the Street Railway head gates was then lowered to the normal head-water level of the Street Railway plant, and the 14-foot opening in




A 4-inch pump, which was moved up from the lower coffer-dam after the river-bed was unwatered, was installed in a sump hole made with sandbags and blue clay just below this natural wall to take the leakage, which amounted to about one-half the capacity of the pump. Below this again, a diaphragm hand pump was placed to take the leakage of the sump hole wall.

The river-bed below the downstream coffer-dam had been pumped out, but the leakage from that side still amounted to about ¾ the capacity of a 6-inch pump. The form for the downstream face was built up to elevation 105, and the suction of the 6-inch pump placed between it and the downstream coffer-dam.

The concrete work was then commenced. A temporary form was built, as shown, just below the sump hole. When the concrete reached the suction of the diaphragm pump, the pump was removed and the leakage of the sump hole wall was forced back through the temporary form by the rising concrete.

When the concrete behind the temporary forms was about 2 feet above the suction of No. 1 pump, No. 3 pump was taken out, the sandbags and clay of the sump hole wall were removed and the temporary form pulled out. This had to be

the northern bulkhead section was closed by means of stop-logs, checks for these having been provided. Additional stop-logs were also placed in the new head gates to prevent too much water passing through the penstock when the water came up.

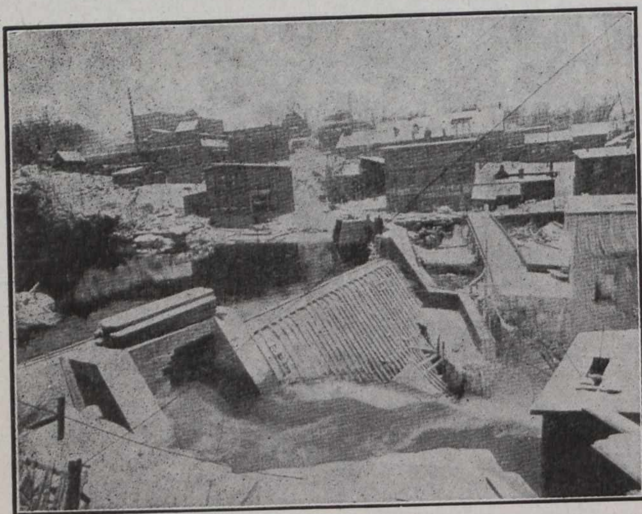
In filling the 14-ft. opening it was found impossible to caulk the stop-logs tight enough to put in the concrete, and the following device was used. The back of the stop-logs was 4 inches in front of the face of the dam. A form made of inch boards was built and a 4-inch iron pipe inserted draining into a box 2 feet square at the downstream face. The concrete was put in and the pipe blocked by means of a wooden plug 3 feet long and a cap. The purpose of the plug was to prevent the pipe from freezing and bursting. The box was afterwards taken out and the void filled with concrete.

Two weeks after the completion of the overflow section, stop-logs were placed in the Railway headrace stop-log section and the water was forced over the overflow. The forms, however, were left on until spring. In putting in the stop-logs a space was left underneath them sufficient to pass the water necessary for the Street Railway, the idea in passing the water underneath being that the flow was in that way kept practically constant in spite of fluctuation of level in the river.

The water would probably have been passed over the Street Railway headrace wall for a much longer period had it not been for the large amount of spray caused by the water falling over the high bank. The weather had become bitterly cold early in December, and this spray froze to the walls of the factory building on the rock in the middle of the channel, to a thickness of nearly five feet, threatening to pull the building down. When the flow was passed over the overflow, this spray was eliminated to a large extent, and the ice was removed by means of steam jets and blasting.

Excavation for the dam was commenced on July 7th, 1910, the first concrete was placed August 14th, and the work completed December 10th.

**The Penstock.**—The penstock is 663 feet long. It is of steel 5-16 inch thick and in 9 feet 6 inches in diameter. The plates are 8 feet long and were riveted up into sections of



**View showing ice formation on walls of factory, (while flow of river was being passed over the old head-race wall).**

two at the shops. The penstock is supported by concrete piers spaced approximately 16 feet centre to centre. No expansion joints were used, anchor piers 10 feet x 16 feet on top being placed about 175 feet apart to take care of the expansion and contraction. Three 4 x 5 x ½ inch angles bolted around the lower half of the penstock at each anchor pier to provide for the thrust.

The piers were built up to one foot lower than the bottom of the finished penstock. Steel rods aggregating 5 square inch cross-section were left sticking in the concrete to secure a good bond. Timbers were placed on the piers and the penstock sections brought to their proper positions, blocked to exact grade, and riveted. 5 inch wrought iron pipe supports were then substituted for the blocking, and the penstock contractor left the job. The concrete contractor built the forms for the upper portion of the piers, constructed a runway on top of the penstock and finished the concrete work.

This method was not adopted in the case of the anchor piers, which were built after the penstock and the ordinary piers were in place, it being specified that the anchor piers were to be of monolithic concrete. In the case of the power house anchor pier, which contains 115 yards of concrete and is 23 feet high, this could not easily be done. Steel rods aggregating 15 square inch cross-section were used in this pier to secure the best possible bond.

The first 8 piers west of the power house are about 15 feet high and average 25 yards each. The power house anchor pier contains, as above stated, 115 yards of concrete. At the time the forms for these piers were completed, the overflow section of the dam was being excavated, and no concrete was being placed at the dam.

The Ransome mixer was brought down to the power house and set up in place of the "Brantford." Steam was supplied from the boiler which had been used to operate the unwatering pumps.

A runway was built across the power house foundations which were at that time nearly complete except for a portion of the floor. The concrete was conveyed from the mixer to the piers in the high wheeled 10 cubic foot buggies which were used for this purpose throughout the work. All piers east of Anchor No. 2 were filled in this way.

Soon after the placing of this concrete the Ransome was required at the dam. The power house walls were also well under way by the time the penstock was in place, and it was therefore impossible to adopt this plan in filling the upper portion of these eastern piers.

A 12-foot Smith mixer was obtained and set up on the river bank between the Dufferin Ave. bridge and the power house and the concrete conveyed on the runway on top of the penstock referred to above. No. 2 anchor pier was also filled from this mixer. It was not practicable to use buggies for this work, as it was considered unsafe to put so much weight on the empty penstock. Barrows had, therefore, to be used.

The concrete for the western penstock piers was mixed by the Ransome at the dam.

The lower portion of several of the piers had to be placed in 5 or 6 feet of water. In such cases a wooden chute 2 feet square, and long enough to reach from the runway to rock bottom, was used. The chute was placed on the bottom and filled a little over half full. It was then raised by means of ropes until the concrete dropped a few feet below the halfway mark and the process repeated. No concrete was allowed to drop through free water.

Anchor piers No. 4 and No. 5 and the most westerly supporting piers could not be finished with the rest, on account of the fact that a portion of the river-flow was being passed through the penstock thimble, until after the concrete in the overflow section had set. These piers were completed on December 20th and this was the last concrete placed out of doors.

In all cases where concrete was placed in cold weather, the rock bottom and forms were steamed for several hours before the concrete was put in. The gravel, water and the mixer itself were also heated. Concrete was placed in this way at a temperature of—10° F. All riveting on the penstock was done by compressed air, pressure being obtained from a small electrically-driven compressor which was set up on the north bank near the power house.

**The Power House.**—The power house is located on the north bank just below the dam of the lower power purchased by the Company and referred to above. Here, as in the case of the dam, it was necessary to provide power for the factories, etc., and tear out the old flumes before the excavation could be proceeded with.

The earth excavation at the power house amounted to 866 yards and the rock to 1,600 yards. This latter was largely in the tailrace. The total length of the excavation in the tailrace is 130 feet. It was carried down 8 feet below river level. A coffer-dam was erected across the east end and the site unwatered by means of a 6-inch turbine and a 3-inch reciprocating pump. The excavated rock was lifted out by means of a derrick. It was placed in side-dumping hand cars and wheeled to the river bank 250 feet down stream where it was dumped.

The power house consists of a main building or power house proper 90 feet by 38 feet, a transformer house and high tension tower 16 feet by 23 feet, a valve room 50 feet by 10 feet, and an oil house and lavatory 10 feet by 16 feet. The power house floor is 21.25 feet above the tail water.

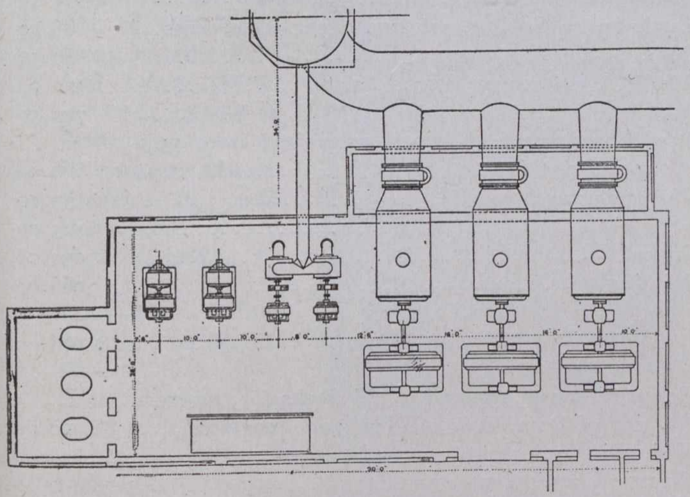
The distributor runs along the south face of the building to the end of the valve room where it is connected to the standpipe.

The valve room is between the distributor and the main building and the transformer house is at the extreme east. The oil house is at the south-west corner.

In the north half of the power house proper the floor is supported on a solid mass of concrete down to the rock. The generators are set on this part of the floor. The south half is suppored by 6 arches with columns running down to the rock. The turbines for the three main units are placed over three of these arches, and the two exciters over the fourth. These four arches have openings through which the draf tubes are let into the tailrace. The motor generator sets are placed over the two other arches.

The valve room floor is a reinforced concrete slab 12 inches thick, supported by four reinforced beams 4 feet by 2 feet, one end of which rests on the columns supporting the distributer and the other on the columns of the main building, with cross beams 3 feet by 18 inches between them.

It was necessary to make this floor very strong, as the 66-inch gate valves for the main units which stand on it weigh 15 tons each.



**Plan showing layout of machinery in power house.**

The transformer house is supported on 17-inch concrete walls. The floor is a reinforced concrete slab with 3 reinforced beams running along the 16-foot dimension. This floor slopes to the east 1 inch to the foot and a drain pipe is passed through the wall at the south-east corner. This provides for the disposal of any oil that might slop over from the transformers.

The stand pipe foundation is octagonal in section, 18 feet in diameter, and about 25 feet high. It is of solid concrete and contains nearly 200 c. yards. The stand pipe, or surge tank, is of steel, 5/8 inch thick at the bottom and 5-16 inch at the top. It is 16 feet in diameter and 56 feet high.

The roofs of the main building and valve house are built of 2-inch by 3-inch spruce strips covered with 28 gauge galvanized iron. The roof of the main building is supported by three steel trusses with columns running down to the foundations. These columns also carry the crane runs and strengthen the brickwork.

The excavation at the power house was begun on July 1st and the form work was commenced on July 31st. The forms here, as at the dam, were of 2-inch spruce and hemlock planed 3 sides and accurately sized to uniform thickness, band iron was used to hold them together. Clamps were also extensively used. The first concrete was placed on August 5th. The mixer used on this part of the work was a "Brantford Ideal," a machine of the continuous type, and the maximum output under the most favorable conditions was 40 yards per day. This mixer was set up to the north of the site on the west side of the entrance lane.

A glance at the contour lines on the plan of the site will show that the entrance lane slopes down with a 15 per cent. grade to the power house door. One floor of the old factory building is at ground level on the street side, and about 10 feet above the ground at the mixer. The cement was accordingly stored on this floor and emptied into the hopper of the mixer from a platform erected outside one of the windows.

The pocket between the street, which has a 10 per cent. slope, and the factory building was used as a gravel bin. About 30 yards could be stored here. The gravel was wheeled down the hill in 2 cubic foot barrows, that being the capacity of the bucket of the mixer. The concrete was conveyed to the forms by means of runways and 10 cubic foot buggies.

**Power House Equipment.**—The power house equipment consists of three 1,325 H.P. twin horizontal Crocker turbines with 30-inch runners, direct connected to 750 K.W. (940 K.V.A. at 80% P.F.), 2,300 v., 360 R.P.M., 60 cycle generators, with exciters, motor generator sets, etc., as below described. The supply of water to the wheels is controlled by balanced wicket gates connected by short links, to a rotating ring which is in turn connected to the gate operating shaft by two connecting rods. The whole setting is contained in a steel plate case with a cast-iron end towards the generators and a taper section in the other end connected with the 66-inch motor operated gate valve on the branch from the main penstock. Immediately outside the wheel case, the main shaft is supported by a ring oiling bearing arranged to take up any end thrust from the wheels. Each unit is equipped with a Lombard vertical type Q. 10 governor. Oil pressure is provided by three triplex pumps, one of which is belted to each turbine shaft. The three pumps feed through a common main, and as any two pumps are sufficient to carry the plant, a shut-down due to lack of oil pressure is practically impossible.

Each unit has a 66-inch gate valve with motor drive, one 15 H.P. 125 v. D-C series motor being arranged by means of a line shaft and disengaging gears to operate the three valves. The exciters are 50 K.W. 125 volt interpole machines direct connected to 100 H.P. Jenckes (Crocker) turbines with Woodard governors and hand operated gate valves. Each exciter unit is of sufficient capacity to excite the three main units.

Direct current for the Railway is provided by two motor generator sets consisting of 375 H.P., 2,300 v., squirrel cage rotor, induction motors with a synchronous speed of 720 R.P.M., and 250 K.W., 575 v. interpole generators.

Three 625 K.V.A. oil filled, water cooled, single phase transformers, with both primary and secondary connected delta, are used to step the voltage up from 2,200 v. to 22,000 v. for transmission outside the city. These are located in the transformer house, and are protected by horn and electrolytic lightning arresters and choke coils. All electrical machinery has overload guarantees of 25 per cent. for two hours.

The switchboard consists of:—three generator panels, one transformer panel, one A. C. feeder panel, one motor generator panel—A. C. side, one motor generator panel—D. C. side, one exciter panel, and one D. C. feeder panel. All cables leading from the machinery to the switch-board are laid in ducts embedded in the concrete floor. The generator panels are provided with main oil switches with overload time limit relays, voltmeters, ammeters, etc. The field rheostats are of the iron gird type, and are located in the cable pit behind the switch-board and operated by sprocket chains.

On the motor generator panel, A. C. side, are mounted the operating levers for the starting compensators which are set behind the board. The equalizer switch is mounted on a pedestal between the two motor generator sets. The equalizer connections are on the minus side.

On the exciter panel, besides the regular eguipment, are placed the switch for the gate valve motor, and the lighting switch. This latter is a D.P. D.T. switch permitting the lights to be connected to either the exciter busbars or a 125 v. lightning transformer located in the pit.

The power house is provided with a 10-ton, hand-operated, disturbances by multiple air gap arresters.

The power house is provided with a 10-ton, hand-operated, steel rope, drum hoist type crane of Whiting manufacture. The height of the crane rails above the finished floor is 15 feet 8 inches, and the height to the bottom of roof trusses is 22 feet. The distance from centre to centre of rails in 36½ feet. This crane was used to install the 15-ton gate valves and has given perfect satisfaction.

The contractors for the work were:—The Bishop Construction Company of Montreal for the dam, penstock piers, and power house building; the Jenckes Machine Company of Sherbrooke for the penstock, stand-pipe and hydraulic machinery; and the Canadian General Electric Company for the complete electrical equipment.

**Transmission Line.**—The 22,000 volts 3-phase transmission line is being built by the Railway and Power Company under the supervision of their own engineer. The line at present under construction runs from the power house in Sherbrooke to the Eustis Mining Company's and the Nichols Chemical Company's works at Capelton.

The poles are of cedar selected under the standard specification of the American Telegraph and Telephone Company both for city and cross country work. The standard length is 35 feet with 40, 45 and 50-foot poles in special locations. They are spaced not less than 50, and not more than 55 to the mile and they extend at least 5 feet into the ground.

The cross arms are 4 inches by 5 inches by 8 feet long with galvanized braces 29 inches by ¼-inch and 1¼-inches. Pins are of oak. The wire used is No. 4-B. and S. solid bare copper with conductivity 97 per cent. of Mathesen's standard. 25,000 volts Locke porcelain insulators will be used entirely for this work.

**Costs.**—The costs given are for the construction of the dam, penstock and power house, with complete equipment. They do not cover the cost of the site and power rights, as these are of purely local interest.

About one thousand dollars expended on a bridge to one of the factories near the dam and an approximately equal amount allowed the contractor on account of certain hold-ups due to legal proceedings are also omitted.

**Dam:—**

| | | |
|---|---|---|
| Excavation: | | |
| Earth, 691 cubic yards at $1...... | $691.00 | |
| Loose Rock, 100 cubic yards at $1.50 | 150.00 | |
| Solid Rock, 799 cubic yards at $2... | 1,598.00 | |
| Solid Rock below Elevation 102 ........ | 3,455.00 | |
| | | $5,894.00 |
| Concrete, 3,430 cubic yards at $7.75 .......... | | 26,582.50 |
| Steelwork .................................. | | 500.00 |
| Stop-logs and fittings ....................... | | 900.00 |
| Total cost of Dam ...................... | | $33,876.50 |

**Penstock and Standpipe.**

| | | |
|---|---|---|
| Excavation: | | |
| Loose Rock, 362 cubic yards at $1.50 | $543.00 | |
| Solid Rock, 388 cubic yards at $4.. | 1,552.00 | |
| | | $2,095.00 |
| Concrete, 744.6 cubic yards at $9...... | $6,701.40 | |
| Concrete, 200 cubic yards at $8.50...... | 1,700.00 | |
| | | 8,401.40 |
| Reinforcing steel, 1,000 lbs. at 4 cents .......... | | 40.00 |
| Permanent protecting cribs, etc. ................ | | 625.00 |
| Straight Penstock, 608 feet at $20 .............. | | 12,160.00 |
| Stand pipe, elbows, thimble, etc., 125,000 lbs. at 6 cents .................................. | | 7,500.00 |
| Total cost of penstock and standpipe ...... | | $30,821.40 |

**Power House:—**

| | | |
|---|---|---|
| Excavation (including tail-race): | | |
| Earth, 924 cubic yards at $1....... | $924.00 | |
| Solid Rock, 1,690 cubic yds. at $1.75. | 2,957.50 | |
| | | $3,881.50 |
| Concrete, 851 cubic yards at $8.50 ............ | | 7,433.50 |
| Concrete in Beams and Slabs, 107 cubic yards at $12 ................................. | | 1,284.00 |
| Reinforcing Steel, 17,200 lbs. at 4 cents ........ | | 688.00 |
| Brickwork, 9,065 cubic feet at 50 cents ........ | | 4,532.50 |
| Earthenware Coping, 216 lineal feet at 40 cents.. | | 86.40 |
| Door ......................................... | | 80.50 |
| Windows, 748 square feet at $1.50 ............. | | 1,122.00 |
| Roof lumber (laid), 16.5 M. feet B.M. at $45...... | | 742.50 |
| Roof Covering of 28-gauge galvanized iron, 55.5 squares at $12 ........................ | | 666.00 |
| Tar and gravel roof ........................ | | 32.10 |
| Structural Steel ............................ | | 2,123.00 |
| Crane ........................................ | | 1,030.00 |
| Painting ..................................... | | 166.00 |
| Total Cost of Power House ............... | | $23,868.00 |

| | |
|---|---|
| Unwatering and removal of old works for the erection of Dam, Power House and Penstock .... | $8,600.00 |
| Hydraulic equipment, complete ............... | 30,640.00 |
| Electrical equipment, complete ............... | 38,000.00 |
| Extras ........................................ | 1,200.00 |
| Total cost of construction complete ........ | $167,005.90 |

## CANADA'S IRON TRADE AND COMPETITION.

The reports presented at the annual meeting of the Canada Iron Corporation, Limited, covered the fiscal year ending May 31st last. During the period, as the president, Mr. T. J. Drummond pointed out the adverse conditions prevailing in the United States were severely felt in Canada. Since that date there has been a great revival in the iron trade, but the effect upon the corporation will not appear until next year's reports.

The mines at Torbrooke, N.S., have been re-opened, and shipments of ore from Port Wade will soon be resumed. Then the second new furnace at Midland, Ont., has been blown in, and both furnaces for the first time are now in full blast.

The financial statement shows profits for the year ending May 31st of $375,140. After the payment of interest on bonds and special loan, $265,426, applied in reduction of bond discount and expense, $6,800; merger expense, $9,505; and provision for sinking fund on original bond issue, $46,841, there was added to profit and loss account $46,566. With the $359,807 at credit from the previous year, the total is $406,955.

## BRANTFORD CONCRETE PAVEMENTS.

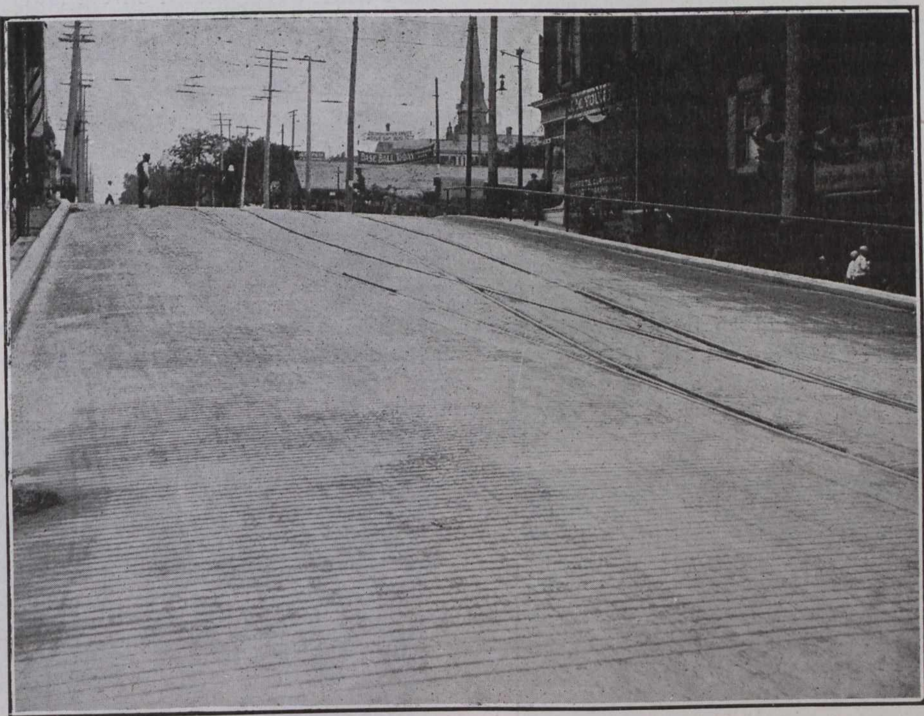
**By T. Harry Jones, M.Can.Soc.C.E., City Engineer.**

**Concrete Walks.**—Brantford, I believe, was the first city in Canada to undertake as a municipal work, by day labor, the construction of its concrete sidewalks. Since the first walk was laid, in 1890, by the present overseer of streets, Mr. Hugh Howie, there have been constructed some seventy miles of walks, none of which have required renewal, and only four miles of which were let by contract.

**Concrete Crossings.**—In connection with the walks, a great many concrete street crossings were put down, and some of these laid twenty years ago are still in good condition. The top surface, which was 1½ inches thick, was composed of 1 part of cement to 1½ of sand.

**Private Concrete Driveways.**—Some private driveways were also constructed, one put down in 1900 and subjected to the heavy traffic in connection with a wholesale warehouse, being in as good condition as when laid. This was 12 feet in width, 6 inches in thickness, the top coat of 1½ inches being mixed 1 to 1 and being corrugated every 6 inches.

**Concrete Bridge Floors.** — In 1908 the roadway of the concrete bridge, 85 feet long and 16 feet wide across the canal on Alfred Street, was laid with concrete. It was 6 inches in thickness, the top coat of 1½ inches being composed of 1 part of cement to 1½ of sand, with surface corrugations every 6 inches. This is in good condition and is wearing well. The floor of a steel bridge laid this year by the Hamilton Bridge Works Co., leading to the waterworks, was constructed by the city in concrete. It is 75 feet in length and 16 feet wide and is a one-course pavement, formed of a 1 to 5 mix with bank gravel, the thickness at the centre being 6½ inches, and 4½ inches at the sides. An expansion joint is left in the centre filled with a ¼ inch steel plate, with anchor bolts every three feet.



**Concrete Pavements on Market Street, Brantford, Ont.**

(Showing surface corrugations on an eight per cent. grade).

As regards permanent pavements, on our public streets, however, previous to 1908, the words of an old proverb were applicable, which spoke of a certain roadway, with a steep down-grade to an undesirable locality, as being paved with "good intentions."

**Concrete Foundations, Curbs and Gutters.**—In 1908 contracts were let on certain streets for bitulithic and westrumite pavements, including the concrete foundation, but since that year the top surface only of this class of pavement has been let by contract, the city doing the grading, concrete foundation and curb and gutter, resulting in the saving of about 25 cents per square yard on the 50,000 yards laid.

The thickness of the foundation is 5 inches on residential streets and 6 inches on business streets, the mix being 1 to 7 of pit gravel obtained in the city, it being very suitable for concrete work.

Instead of using broken stone spread over the surface of the concrete, as had been the custom of the paving companies, rammers with steel projections were used which gave the uneven surface necessary to bind the concrete with the top surface.

The cost has averaged about 12 cents per square yard for the grading, and 38 cents for the concrete foundations and 45 cents per lineal foot for the curb and gutter. The average depth of the curb face has been 6 inches, and the width of the gutter 15 inches.

**Concrete Street Pavements.**—Speaking generally, the sub-soil of the city is sand and gravel, and very suitable for this class of pavement.

After the sub-grade is shaped it is rolled with a 15-ton steam road-roller. On this the concrete is placed and thoroughly tamped, great care being taken to protect it from debris or from being walked upon by passers-by or the workmen on the pavement. The crown is shaped by a wooden template cut to the curve of the street, which on narrow pavements is worked from curb to curb, and on wider ones from the curb to a scantling 6 inches wide on top, 5 on bottom and 6 inches deep, placed in the centre of the street parallel with the curb.

This strip is afterwards removed, the sides broken in and filled with concrete, and the whole surface finished with a wooden float worked from a plank bridge extending from curb to curb. A drier of dry cement and sand mixed 1 to 2 is spread over the surface in finishing.

All the cement used was subjected in the city engineer's department to the standard tests prescribed by the Canadian Society of Civil Engineers, a Fairbanks testing machine being used for the purpose.

The crown of these pavements is now determined by the following formula by Ernest McCullough, published in *The Canadian Engineer* May 26th, 1909:

$$C = \frac{W\ (100-4p)}{6000}$$

C = crown in feet
W = distance between curbs in feet.
p = per cent. of longitudinal grade.

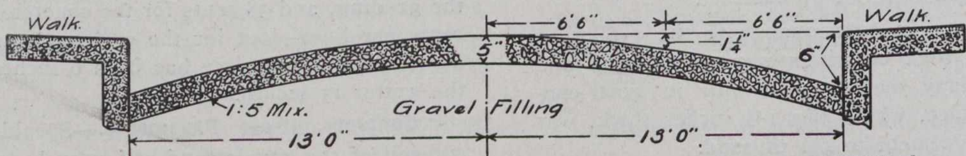
This works out a crown of 5 inches with a 26-foot pavement on a 1 per cent. grade.

The flat crown results in a more even distribution of the traffic over the surface of the street.

**Lorne Crescent Pavement.**—This is a one-course pavement laid in 1910, its length being 394 feet and its width 24 feet.

The depth of the concrete is 6 inches, being mixed in the proportion of 1 part of cement to 6 of pit gravel, the crown being 5 inches.

Transverse expansion joints, at right angles to the curbs were left about every 30 feet, some of the joints being filled with pitch, others with wood strips, and a few with neat cement. No contraction joints were left. No transverse cracks have appeared in the pavement, but most of the blocks have developed longitudinal cracks at the centre. The pavement, however, was laid late in the year and was caught by the frost. The cost was 80 cents per square yard, which includes in every case 5 per cent. for engineering.




**Plan Showing Section of Concrete Pavement on Chestnut Avenue, Brantford.**

**Chestnut Avenue Pavement.**—The length of this pavement is 535 feet and its width 26 feet. It is a one-course pavement and was laid in 1911. The grade of the street runs from less than 1 per cent. at the upper end to 5 per cent. at the lower end. The crown varies according to the grade, being about 5 inches at the upper end.

The depth of the pavement is 5 inches, the concrete being composed of 1 part of cement to 5 parts of crushed gravel and sand. Transverse joints, at right angles to, and extending from curb to curb were left every 33 feet. The joints were made by pine strips ¼ of an inch wide at the top and 1 inch at the bottom, extending the full depth of the concrete. A contraction joint was left in the centre of the pavement parallel with the curb for a distance of 110 feet of the upper part of the street. This was also filled with wooden strips similar to those used in the expansion joints. Although subjected to the heavy teaming from the gravel pit at the foot of this street, and also to the test of the last severe winter, no cracks have developed, even in the part of the pavement where no contraction joint was left.

**Laying Concrete Pavements at Brantford.**

It is our intention in future work to try a protecting plate at the contraction joints, as used in the Wayne County roads to prevent the wearing at this point. The cost of the pavement was 85 cents per square yard.

**Market Street Pavement.**—This pavement, laid this year, extends from Colborne Street to the new reinforced concrete Victoria bridge, its length being about 200 feet and its width from curb to curb 40 feet, the grade running from 8 per cent. at Colborne Street to 5 per cent. at the bridge. A single track of the street railway curves into double tracks at Colborne Street, the part between the tracks being paved with bricks.

This is a two-course pavement 6 inches in depth, the bottom course of 4½ inches being formed of 1 part of cement to 4 of gravel and broken stone. The top course of 1½ inches is composed of 1 part of cement to 1½ of clean sharp sand, and was put on immediately after the first course had been put in place.

Corrugations ½ inch in depth were left every 4 inches at right angles to the street and afford a sure foothold for horses.

This pavement, being at the intersection of the two main business streets of the city, is subjected to the heaviest traffic. No expansion of contraction joints were left. A slight transverse crack has appeared on the lower part of the pavement above the bridge.

**General Remarks.**—The sand, gravel and broken stone used in our concrete work is from our own pits, drawn in Brantford dump wagons. The road bed is rolled with a Brantford Waterous road roller, and the concrete mixed in a Brantford Goold, Shapley and Muir mixer. The cement is made by the Ontario Portland Cement Company of this city at their works at Blue Lake in this county, and Brantford labor alone in employed in the construction of these pavements.

It may be stated generally that the citizens are well pleased with the concrete pavements which have been laid.

**Concrete Pavement on Lorne Crescent, Brantford, Showing Expansion Joints.**

The cost is only about half that of the other kinds of permanent pavements, the cost of maintenance is less, they are low-crowned, less slippery and easily cleaned.

The white surface on residential streets, I consider attractive. If preferred, the surface can be colored.

It may be of interest to state that in addition to the cost of street intersections and exemptions on corner lots of half the total frontage (not exceeding 50 feet) that the city bears 40 per cent. of the cost of all pavements, and that the number of payments is extended over 10 or 15 years, according to the estimated life of the work.

# The Canadian Engineer

ESTABLISHED 1893.

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

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## CONTENTS OF THIS ISSUE.



## ROAD MAINTENANCE.

The maintenance and repair of roads after they are constructed is most important. There is little use in constructing new highways if they are not to be kept in the best of repair. The methods and experience of the New York State Commission of Highways is of interest in this connection, for they have at the present time upwards of 3,151 miles of State and county highways to be maintained. Many of these highways were constructed in the early years of road-building in the State, and of a material and character of construction that at that time was supposed to be the best. Just when it was thought that the problem of good roads had been solved, along came the automobile and its destructive accompaniment, as far as the highway surface is concerned.

The Commission state that after the use of various experimental materials they find that the more recently constructed macadam highways, with a bituminous binder, and those which have been resurfaced with similar top dressings, can be maintained under the patrol system at a minimum expense.

The cost of maintenance throughout the State appears to us abnormally large, the average cost per mile appropriated for 1912 being $926. About 1,000 miles of the 3,151 miles under maintenance, however, are being given a top course of fine stone or gravel and oil treatment.

The extension of the improvement of the highway system of the State has called into existence a class of traffic which was never contemplated in the original scheme. This is the use of traction engines in hauling heavily loaded cars and in the use of motor trucks. As a result, the roads, where regular freight lines of motor trucks have sprung into existence between large towns, and which were not built for such traffic, are being destroyed. The Commission suggest that the time has arrived when legislation should determine the economical limit of load per inch of tire.

## TEARING UP STREET PAVING.

With the introduction of street paving and community waterworks and other evidences of civilization into our cities and towns, the vexing question of alleged inefficiency in the matter of various civic departments overlapping, with a net cash loss to the ratepayers, became more and more evident; chief among these charges was the opening of recently paved streets for the laying of gas and water mains. In a Western city this old and time-worn question has cropped up, and one or two of the civic officials have striven to smooth out the ruffled tempers of the already overburdened taxpayers, and some of the points in their argument are worthy of consideration. They contend that the cost of installation of water and gas services into vacant lots prior to the erection of buildings is in excess of the paving repairs, and that the services and fittings lying in the ground are liable to deterioration and damage for their long burial, and they further contend that the holders of vacant property do not have the slightest idea as to what position they desire the services placed in.

In a city in Eastern Canada some months ago an appropriation was made to cover the cost of a new water main, and the plans were prepared, showing the line that the work was to follow, and a goodly portion of the pipe went up a residential street that was to be repaved, owing to the unsightly and unsafe condition of the asphalt owing to numerous openings and patchings. The pavement was stripped and a beautiful new coating of asphalt replaced, but the same was down only a few days when a deep trench was cut to allow of the placing of the water main. This was some weeks ago, but at the present time the trench is covered with the torn blocks, which are supposed to act as weights and compress the earth back into a sufficient degree of hardness to permit repairs. In the case of this water main, and in many other cases where this unnecessary and unbusinesslike work has been done, there have been considerable expanse of lawn offered as a desirable location for the pipes, but these apparently do not meet with favor, probably owing to there being no newly-laid pavement to rip up.

## TECHNICAL SCHOOLS.

As the remarks made by Mr. Walter Dixon, in his presidential address to the West of Scotland Iron and Steel Institute (to which reference was made in a recent issue of the London Times,) regarding the questionable benefits conferred upon manual workers by schools and technical colleges are based upon enquiries made in industrial districts throughout the British Isles among those who control many thousands of workpeople, they must be accepted as evidence that in the opinion of a proportion of employers most of the book-work beyond the rudiments of reading, writing, and arithmetic is superfluous for manual laborers; and they must be taken as indicating that the additional educational facilities scarcely afford real aid even to foremen, charge men, and other leaders in the workshops. In general terms this criticism may be said to accord with certain of the facts, but as an argument against those additional educational facilities it fails to convince, for the reason, recognized by Mr. Dixon, that the educational schemes in the Old Country, as applied to the industrial classes, have purposes beyond those appertaining to wage-earning, and in the main the United Kingdom is the healthier, the cleaner, and the happier for them. Consequently the "bread alone" principle cannot be accepted as a basis for criticism of a system of education for industrial localities. There is need, however, that great watchfulness should be exercised in regard to reading, writing, and arithmetic, for with the advance of mechanical appliances, instruments of precision, and manufacturing processes, the demand for proficiency in these subjects is daily increasing. If it can be shown that the teaching of additional subjects is detrimental to the acquisition of those cardinal elements of school work, the system stands condemned. The average employer, knowing humanity, however, will probably express the opinion that blame is due less to the teaching than to the learning.

## EDITORIAL COMMENT.

The current issue of the "Electrical Review," of London, England, has come to hand. With this issue our contemporary celebrates its fortieth anniversary. We extend our heartiest congratulations to the journal, with best wishes for its continued success.

## LETTERS TO THE EDITOR.

### LIGHT COMPRESSION MEMBERS.

Sir,—I have read with much interest the valuable discussion by the Western Society of Engineers on "Light Compression Members" printed in *The Canadian Engineer*. The variety of opinions is not only interesting, but valuable to all those who read your paper. Permit me to add, however, an opinion which seems to me to have been overlooked in the discussion.

One of the assumptions on which column design is based, whether long or short, is that, assuming a centrally applied load, the stress is uniformly distributed over the sectional area of the member, and that, assuming an eccentrally applied load, the stress is of a uniformly varying distribution. We know from experiment that the distribution of stress over the sectional area of a single piece of metal in simple tension is not uniformly distributed, but is greater at the edges of the section. Therefore, it would not be at all unreasonable to assume that the distribution of stress in compression would be higher at the edges than at the centre.

Looking at the matter in this way, one can easily see why the "built-up" member should fail by wrinkling of the plates between the rivets at a unit stress which we suppose to be much less than it really is.

The spacing of rivets in "built-up" compression members is based on the assumption that the plate between the rivets acts like a short column, and is limited in length, i.e., the distance between rivets along the axis of the column—by the ratio of $1/r$, which, coupled with the assumption of a uniform distribution of stress, goes to make up the present theory of rivet spacing in columns. A theory based on an assumption of higher stress at the edge of the section would lead to a shorter allowable rivet pitch per given thickness of cover-plate, and hence a much safer design; a state of affairs which we will probably reach sometime in the light of further experimental evidence.

Yours very truly,

I. F. MORRISON,

University of Alberta, Edmonton South, Nov. 23, 1912.

Sir,—I have read with interest Mr. I. F. Morrison's comment on the discussion of "Light Compression Members" by the Western Society of Engineers, which was recently published in *The Canadian Engineer*.

The effect of possible inequality of stress distribution over the cross section, apart from that due to eccentricity, imperfect materials or poor workmanship, is no doubt considerable, as Mr. Morrison points out.

His assumption that the stress at the edges of a compression member will be greater than at the centre, however, does not appear to be well founded. The fact that this is true for a simple piece subjected to tension in a testing machine is no indication that the same thing will be true of an ordinary column. The method of fastening a tension piece in a testing machine is largely responsible for the inequality of stress distribution, the grips applying the load to the edges of the piece instead of uniformly over the cross-section.

Our assumption of uniform stress per unit of area is based on the application of the load to all parts of the cross-section in equal measure. If the load is applied at a point on the cross-section, manifestly all fibres cannot be stressed equally. The elasticity of the material of itself, apart from the effect of slag threads, seams and longitudinal cleavage planes, precludes the transference of the load so as to give a uniform stress. The fibres close to the point of application of the load will be heavily stressed while those remote from it will bear a lighter stress. It would thus appear that with a central load on a column, considered as applied practically at a point, the outer edges would be stressed less than the portion of the cross-section directly under, or near, the point. For loads applied at other points than the centre of gravity of the column, the stress would vary in a similar manner, being most intense at the point of application of the load and least intense at the point most remote from it.

Yours very truly,

C. R. YOUNG,

Consulting Structural Engineer.

318 Continental Life Building, Toronto, Nov. 30, 1912.

## THE FREEZING TEST OF STONE.

The Mines Branch, Department of Mines of Canada, is making a complete reconnaissance of Canadian stone resources, and Vol. 1, covering the southern part of the Province of Ontario, has just been issued by the Department. Professor W. A. Parks prepared this report. Most of the stones were tested, and in this work the following observations were made:—

The freezing test which was applied to the samples of stone is described in the report as follows:—

A 2-in. cube was carefully prepared and dried in the air-bath at a temperature of 110° C. for 24 hours, after which it was allowed to cool in a desiccator and was then weighed. The cube was then saturated with water under reduced pressure for 36 hours, after which it was exposed to 40 alternate freezings and thawings. The specimen was again dried in the air-bath, and crushed in precisely the same manner as the unfrozen samples of the same stone.

The freezing test in this form is not considered by Mr. Parks to be entirely satisfactory, as the soaking in water is likely to make the stone contain very much more water than it would contain when ordinarily exposed to the weather, and, therefore, the conditions of the freezing test are not closely parallel to natural conditions. On the other hand, to make a freezing test on stone when containing only a normal amount of water was regarded as impracticable because its moisture would be so low as to require a very great number of freezings and thawings to give appreciable results. In default of something better the above described method was adopted. It is thought to give results of only very approximate value; i.e., the figures obtained from the freezing test should not be interpreted directly as a gauge of the weather-resisting or freezing-resisting power of the stone.

The following remarks on the general results of this freezing test are given:—

In the case of granites, gneisses, crystalline limestones, and marbles, there was a uniform loss of strength, but in the case of the limestones and sandstones, while the majority of the specimens lost in strength, there were some which increased to an appreciable degree. As there could not well be an instrumental error to account for the high result of the frozen specimens, new cubes were made of the stones in question and the crushing strength of the unfrozen sample again determined with the greatest nicety possible. In every instance a result nearly identical with the original test was obtained, so that we are forced to conclude that, in some cases, stone actually increases in strength by being subjected to the operations described.

It is not to be inferred that the freezing and thawing has produced this result; the explanation more likely lies in the heating and drying. An increase in strength after freezing has been recorded by various authors, but it has generally been attributed to lack of care in preparing the material. Buckley evidently considered such results anomalous, for he explains them as due to imperfect cubes or to the manner of operating the testing machines. Merrill gives a table in which five stones out of fifteen increase in strength, but he does not offer any explanation of the apparent anomaly.

Mr. Parks explains the phenomenon as being due to the formation of fine fragments in the interior of the stone as a result of solution and the disintegration due to freezing and thawing, followed by a subsequent recementation of the fine particles. He has actually observed this cementation as follows:—

At the time the old lithographic quarries near Marmora, Ont., were in operation, the fine dust obtained in working the stone was barreled with the intention of using it as a polishing material. Several of these barrels were left in the mill, and by the simple process of becoming damp and drying out, protected from both sun and rain, the contents have been converted into a solid mass rivaling the stone itself in hardness.

Two specimens of almost identical appearance, one of which gained in strength under freezing test, while the other lost materially, were reduced to powder, wetted, raised to a temperature of 100°, again wetted and allowed to soak for a few hours. On being raised to a temperature of 110° C., the pellet obtained from the stone which gained in strength showed a very much greater coherence than that from the other.

Elsewhere in the report, in giving the detailed description of the Marmora quarries, the author says:—

It is an interesting fact that the shavings from the planers if wetted and allowed to stand, set to a cement of considerable strength.

The relation of this observed cementing of the stone powder to the result of the freezing tests is summarized by the author as follows, with an observation also on the effect upon strength of wetting the stone:—

If it should be definitely established that the operations of drying, freezing and thawing, and again drying, tend to raise the crushing strength of certain stones, it follows that the recorded loss of strength does not really represent the loss due to freezing, but that loss less an increase due to the resetting of the disrupted particles.

In this connection may be mentioned the fact that most of the sedimentary stones lose appreciably in strength on being wetted; this loss of strength is due to the softening of the cementing material, which holds the grains together. On again drying, the stone assumes its original hardness and coherence.

## RAILROADS AND VANCOUVER.

It was stated in the city this week that the Grand Trunk Pacific was in the market for canneries, something along the same line as the principals of the Canadian Northern.

The Canadian Pacific Railway has big works on its hands. It will erect a large office building in Victoria for its own accommodation. In Vancouver, it is stated that the Canadian Pacific Railway is calling in on its wharfage. Mr. R. V. Winch has about 100 feet of Canadian Pacific Railway wharf frontage, while the Union Steamship Company has another section immediately east of that. Notice has been given Mr. Winch that the Canadian Pacific Railway will want the piece he occupies, and it is thought it is only a matter of time before the Canadian Pacific Railway will want all it holds. The railway company now occupies wharves equal to the frontage of nine city blocks, and this does not take into account a jetty several hundred feet long.

## AN AERIAL TROLLEY CAR.

**By L. McCully Edholm.**

Although suspended cars have been used successfully in Germany for a number of years, many new features have been devised in the aerial trolley system at Burbank, California.

The car is torpedo shaped with a framework of steel covered with aluminum. It is fifty feet long, seats fifty-six persons, and has carried capacity load with ease.

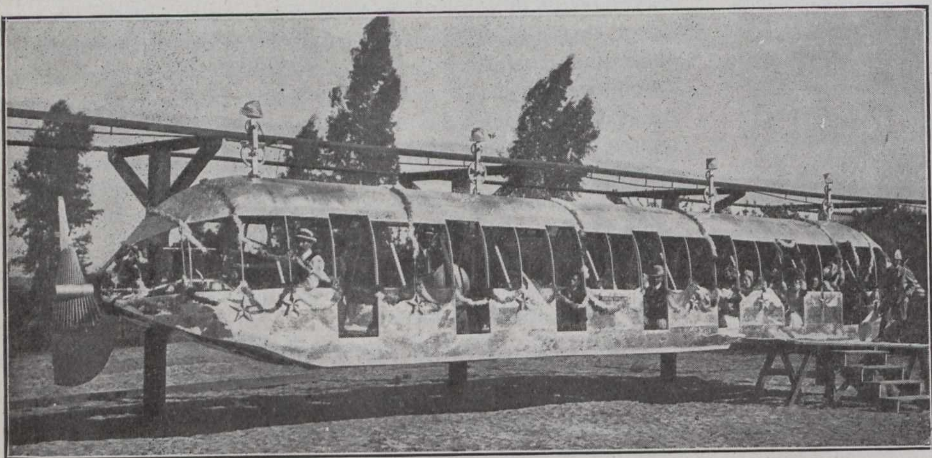


**Fig. 1.—View of Aerial Trolley Car Ready for Operation, at Burbank, Cal.**

The chief difference between this and other aerial cars is that it is driven by a six-foot propeller of unusual construction, having two fan-shaped blades of sheet metal, on ribs of steel tubing.

To serve in case of accident to the propeller and engine on the back of the car, a second propeller and motor will be placed on the front. This can also be used to double the power, if desired, or to hold back on down grades by reversing its motion.

This unique propeller is far more efficient than the kind used on aeroplanes because of its large surface. It is operated by a four-cylinder 25-h.p. gas engine, such as is used in automobiles. The propeller is capable of one thousand revolutions per minute and on a long stretch of track it is claimed that the car can easily make one hundred miles an hour.

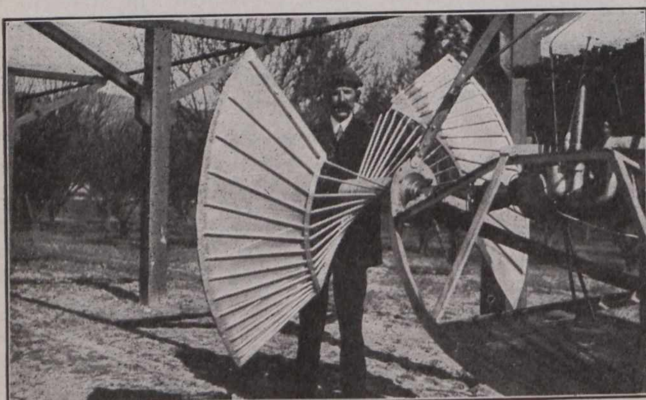


**Fig. 2.—View of Fan-shaped Propeller.**

The track in use at present is six hundred feet long and it built on the estate of the inventor, Mr. J. W. Fawkes. These tracks are supported on posts, some of steel and some of wood, with cross beams to correspond. This is in order to test both kinds.

The rails used are steel T-beams shree and a half inches broad, and three-eighths of an inch thick, and scientifically trussed to prevent sagging. The car is held securely to the rail by means of four sets of grooved wheels firmly clamped both above and below the rail, so that there is no danger of it jumping the track.

Another interesting point is the tilting planes to lighten the car by air pressure when it is in motion, and also an apparatus to lower and raise the cars at the stations.

It is claimed that this trolley line is much more economical to install, costing approximately \$2,000 per mile and \$1,500 for each car. It has many advantages over the old systems, as it can be built over hills and across rough country as easily as on the level stretches, the height of the track being regulated by the length of the pole. In fact, part of the Burbank system crosses a ravine by means of poles of various heights.

Mr. Fawkes is now considering the building of a double-track line between Los Angeles and one of the suburban towns. For commercial purposes his idea is to have a five-track system, the lower tracks for local transportation, while the upper one is for a "flyer."

This system will do away with all street congestion and collisions, so common under the present conditions, as all grade crossings are to be eliminated and the cars will be suspended at a height of twelve feet or more above the street.

Mr. Fawkes has proven his success as an inventor by a number of electrical devices which have won him a comfortable fortune.

## A NEW STEEL SCREW STEAMER.

A successful launch took place from the Neptune Works of Swan, Hunter & Wigham Richardson, Limited, on Thursday, the 7th ult. The vessel launched is a fine steel screw steamer which is being constructed to the order of the Cork Steam Ship Co., Limited, of Cork, and is the 24th steamer built and engined for that company at the Neptune Works.

The vessel is 285 ft. in length by 38 ft. beam, and is designed to carry over 2,700 tons deadweight on 19½ ft. mean draft. She is being built to attain the highest class in the classification of Lloyds registry.

The propelling machinery is also being constructed at the Neptune Works, and consists of a set of triple expansion engines supplied with steam by two boilers, and will propel the vessel at a speed of 11 knots per hour.

The steamer will be amply provided with the latest and most improved loading and discharging gear, including seven steam cranes, steam winch, etc., for her service in the line carried by the Cork Steam Ship Company between Liverpool, Manchester and Dutch and Belgium Ports.

As the vessel left the ways she was named the "Vanellus," the christening ceremony being gracefully performed by Miss M. E. Pease, of Middleton Lodge, Middleton Tyas, niece of Mr. Joseph Pike, the chairman of the Cork Steam Ship Company, Limited.

Amongst those present were Miss Pease and Miss Dorothy Pease, Mrs. Finch, Mrs. F. Christie, Mr. J. D. Christie, Mr. G. F. Tweedy, Mr. G. B. Richardson, Mr. Rendall, Captain Hore, of Liverpool, marine superintendent to the Cork S.S. Co., and Mr. J. A. Flockhart, of Liverpool, their superintendent engineer.

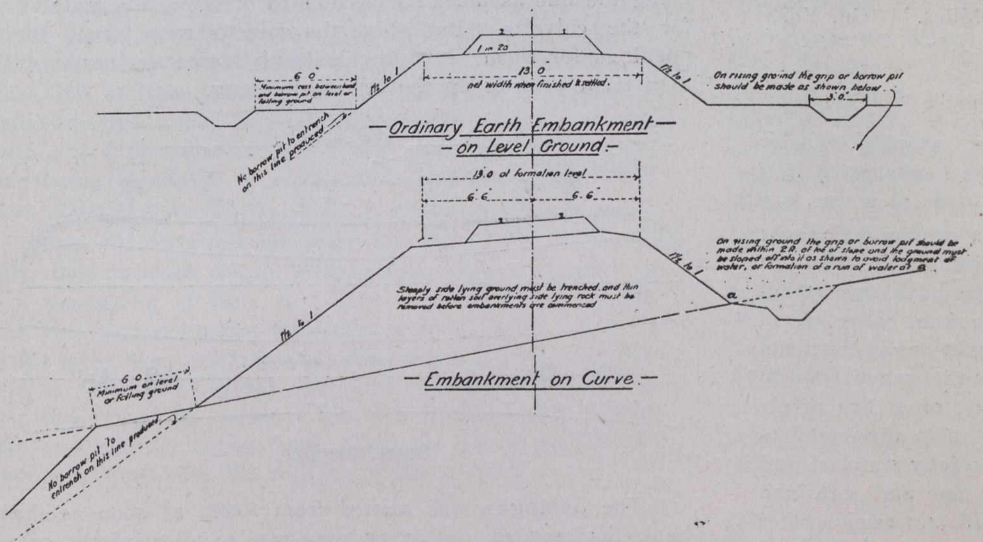
## THE CONSTRUCTION OF A WEST AFRICAN RAILWAY.

The placing of the construction of the Accra-Akwapim Railway, in West Africa, in the hands of a contractor was an entirely new departure on the part of the Colonial Government. Previously all the railway construction in both the Gold Coast Colony and the adjacent colonies had been carried out by their respective governments departmentally, and a departure from that practice was looked upon as an experiment. Mr. William Martin Murphy, of Dublin, Ireland, was the successful tenderer, the official notification of which fact was sent him under date November 3rd, 1908.

Exactly one month afterwards the first party of engineers and foremen overseers sailed from Liverpool, arriving at Accra on the 20th December.

The construction of the work was described in a paper by Mr. G. M. Harriss, read before the Institution of Civil Engineers, of Ireland, recently. The following details are abstracted from that paper:

Amongst the West African natives are men gifted with intelligence of a high order, and in Accra are to be found craftsmen of nearly every kind, who, with a little direction, are capable of turning out excellent work.




**Sections Showing Types of Construction.**

The ordinary laborers take to pick and shovel work well. They will not, however, under any circumstances, use wheelbarrows; everything is carried on their heads.

Female labor is available, and was largely used for carrying of all kinds, including the water for the concrete, the concrete when mixed, and the earth from the cuttings and for the banks. The women are very satisfactory, and are, as a rule, more industrious than the men. They will not, however, go far from the towns or villages.

The earth is carried in baskets holding about 55 lbs. when heaped up; the usual average working quantity would be between 30 and 40 lbs. Native-made baskets can be procured readily; they are made from a strong vegetable fibre plaited, but they are neither so strong nor so well liked by the natives themselves as specially imported English baskets. These are of a wicker-work construction, and last much longer than the native baskets. Both the water and the mixed concrete are carried in ordinary galvanized iron buckets.

One or two head-women go with each gang of twenty or more. They usually give a hand in lifting the loaded baskets on to the carriers' heads. The boys do the pick and shovel work, fill the baskets, make the concrete, and fill the buckets. If ahead of their work they will often help the carriers to get their loads up. A head boy or a second head boy will not, however, give any such assistance in the same way as a head woman will. If there is no other assistance at hand the carriers help one another, and will stoop down with their loads on their heads to assist each other.

Most of the stone-breaking for the concrete was done by female labor. The women are particularly fond of this work, though not very expert at it. They are, however, more satisfactory at the stone-breaking than boys, as they like the work and are more industrious.

The women like working, and are keen on making money; but they are independent of this class of labor. There is no poverty in the country; neither men, women nor children need go hungry. The ordinary rates for women is 25 cents per day, and for boys from 30 cents to 36 cents. Skilled native labor is dear—good carpenters get up to $1.20, blacksmiths and fitters more than this. The ordinary laborers come from various tribes, speaking different languages. Nearly all speak and understand a kind of English, only to be learned on the coast.

The ordinary hours of work were from 6 a.m. to 11 a.m., and from 1 p.m. to 5.30 p.m. Saturday was a half-holiday, work ceasing at 1 o'clock. This made a 54 hours' week.

The first sod of the railway was cut on January 7th, 1909. The railway runs due north for a distance of thirty-nine miles into the Akwapim district, where the cocoa plantations commence.

The site of the railway terminus is situated a mile and a half from the coast, in the hollow of a valley about fifteen feet above sea-level. A small branch line was constructed from an existing line, about two miles in length, already laid down for conveying stone for the harbor works. This put the new terminus in rail communication with the beach and breakwater, which was a first necessity, the available space at the beach being so limited that nothing could be stacked there, and all had to be cleared every day.

The country a few miles from the coast is densely covered with thick bush, which must have presented tremendous difficulties to the railway surveyor.

In the flying surveys through the bush some surveyors gain a great deal of information, and save a good deal of clearing, by the use of aneroid barometers, with assistants at either side, each assistant being furnished with a speaking trumpet, through which the barometer readings are transmitted to the surveyor—he taking the bearings judging direction from the sound.

For the finished survey a rough clearing was made along the centre-line with pegs at every chain (66 feet), and, where possible, the apex of each curve was marked by a concrete block, about 18 inches square and 2 feet 6 inches long, standing 18 inches above the ground.

These blocks were numbered, and so permanently marked the most important points for after reference.

The original survey, as well as the plans and specifications were prepared by the joint consulting engineers to the government, Messrs. R. Elliott-Cooper and Frederick Shelford, of London.

It may here be mentioned that the actual construction of the line was governed by the fact that the standard weight for transport is limited to what the natives can carry on their heads, on account of the tsetse fly which abounds inland and makes the use of beasts of burden impossible. The transport of tip wagons and the horses to work them, and the transport of locomotives before the rails are laid is therefore impossible. This causes an important departure from the ordinary practice, almost universal everywhere in railway work, of so setting out the line that the material taken from the cuttings bears a reasonable proportion to that required for the banks. The banks are in this case formed by digging trenches or "borrow" pits at both sides. These are kept well clear of the finished toes. The earth from the borrow pits goes to make the banks. The material from the cuttings is rarely or never used in banks, and goes to spoil.

Under these conditions the making of a bank costs per cubic yard about half that for a cutting, and of course in the cuttings there is always the danger of meeting rock, in which case the cost will be multiplied by five or six. These facts influence the building of the railway and show their mark on the finished work. The engineer in search of a cheap line avoids all the cuttings he can, and does not care how far they under-proportion the banks. The following are the figures for the first twenty miles section of this railway:—

| | Miles. | Cu. Yds. |
|---|---|---|
| "Formation" (level with the ground).. | 4.67 | — |
| Cutting ............................ | 3.11 | 28,070 |
| Bank ............................ | 12.25 | 222,098 |

It will be seen that the cuttings only provide some 12 per cent. of the material required for the banks, even if it were used in them. As a matter of fact none of it was.

It is provided that the banks have a camber below the ballast. It is very important that this camber be made in the first instance and maintained while the banks are standing for settlement; it prevents the water from collecting in pools or small lakes, which eventually break out in a stream down the slopes, and these streams in the heavy tropical rains become small rivers, cutting gullets, often five or six feet deep, in a short time. During the rains these gullets give great trouble. They have to be carefully watched and stopped, especially when the banks are new and soft, and uncovered by vegetation. This camber will not remain after ballasting, as practically all the first ballast will go down to formation level, and below it, when the traffic starts.

After twelve months' maintenance, with a reasonable train service over the first twenty miles section, the writer found from his own experience that three times the original ballast provided for in the contract was added. In some cases, such as in cuttings, and where the formation was hard, there would not be so much, but in some of the banks, where the earth was taken from the borrow pits, it was of a soft and spongy nature, and up to four times the original quantity of ballast was required in places.

The buildings at the Accra terminus are of a substantial concrete construction, and include a fine main station building and a building containing the manager's office and the general offices. There are also a large engine shed and repair shops, fitted with a 25 h.p. oil engine and a good supply of machine tools, and a well-equipped smithy, in addition to separate buildings for a general goods store and railway supply store. All these are of concrete. There is also a carriage shed, 250 feet long, of steel and iron, with two lines of rails. In addition, there are large bungalows for the first-class officers, smaller bungalows for the European foremen, and quarters for the native staff—all being included in the contract.

The rain-water from the roofs of the station buildings is led by stone-ware pipes to the principal underground tank shown in the illustrations.

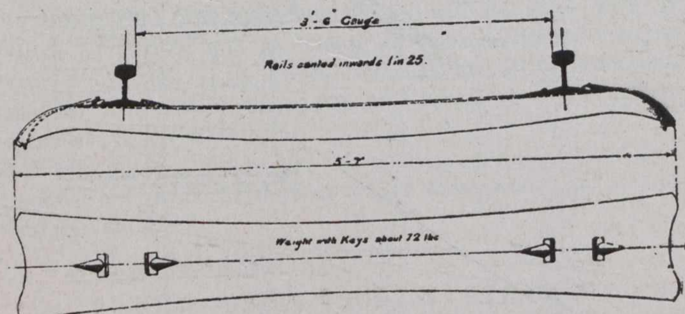
All the bungalows are provided with large cast-iron water tanks.

This is necessary, as the fresh water supply for the Europeans and the better class natives is that gathered from the roofs of their bungalows and houses, when it rains, and stored in tanks.

By the middle of February, 1909, laborers in gangs of from 100 to 200 boys were working at the clearing and earthworks, and gradually these were increased until there were gangs on different sections over the entire line. A white man, who was responsible to the engineers, looked after one and sometimes two of these gangs. As to the engineers, the line was divided into two sections, each under a district engineer responsible to the chief engineer.

At the same time that the clearing and earthworks were going on large gangs were working at the Accra terminus and the station buildings.

In the year 1909 the wet season was not a very severe one, and good progress was made at both the clearing and earthworks. When culverts were necessary, gaps or openings were left in the banks, and, as far as possible, the culverts were afterwards put in, in advance of the track-laying, using the line as much as possible to bring up the material for the culverts. But where the culverts were large, the openings for them were provided with temporary crossings to prevent holding up the linking-in gang.




**Steel Sleeper.**

The linking-in was started from Accra as soon as the banks had settled, but at an easy rate to allow of the culverts being completed, and avoid over-running them.

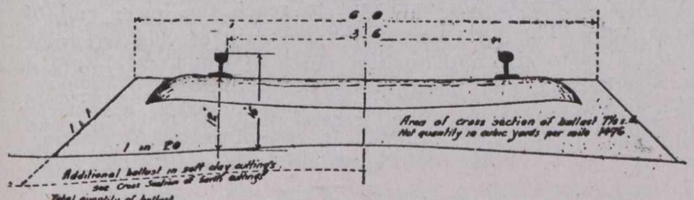
It was not until early in December, 1909, that much pressure was put on this work; but throughout that month the linking-in was done at the rate of a mile a day. This appears to be about the amount for efficient and economical progress, when rail head gets much beyond ten miles from the stacked material, except under very favorable circumstances, such as where there is flat and open country and a reasonable supply of water available for the locomotives, when, perhaps, another quarter mile might be added.

When the line is practically all carried on banks with stiff gradients and many curves, such as exist on the Accra-Akwapin line, a mile forward is a very good day's work. The trouble is not so much to get the actual linging-in done as to get the material to the plate-layers.

The gauge is 3 ft. 6 in., the weight of rails is 45 lbs. per yard, and the steel sleepers weigh 72 lbs. The latter are rather too heavy for one boy to carry, though there are numbers of them who do carry them with ease. The rails are 30 feet long, and eleven sleepers go to the length—distance centre to centre of sleepers 2 feet 9⅝ inches for 30 feet rail, and 2 feet 2 inches at the joints. Ballast is not easily got along the line, and is only to be found in a few places where pits have been made, and these average up to 5 miles apart. On that account the track was first laid direct on the formation level. Light engines were used to bring up the rails and sleepers, and these were brought along the track as fast as it was linked-in by the plate-laying gang. In this way the distance the rails had to be carried by the boys was kept as short as possible. The sleepers were usually thrown off, to be picked up and carried well ahead, when they were carefully laid on the formation square to the centre line and the correct distance apart. From ten to fourteen boys take a rail from the loaded truck, hold it above their heads, and carry it direct to its place, laying it on the sleepers to the satisfaction of the plate-layers. The plate-layers with their bars cant the rail, getting it under the clips of the sleepers. Considerable practice is necessary to do this quickly, and only well-trained gangs are of any use at the work. The bank at each side of the material train is reserved for the rail-carriers—the sleeper-carriers must go on the outside, either at the bottom of the bank or as best they can. As soon as a pair of rails are in place and fished up by the plate-layers the material train moves forward. The keying-up is usually left over for a more convenient time.

When three or four miles of linking-in had been done that work was stopped, and the ballast, which had been previously got ready at the ballast-pits, where separate gangs were engaged, was loaded and distributed over the length, and the first lift party, usually gangs of 100 to 200 boys, put in the ballast with a first lift from 8 inches to 10 inches. The remainder of the ballast was put in later in three or more lifts of from 3 inches to 4 inches each. A permanent gang was then left to maintain the line—the number varying from 4 to 6 to the mile; one native plate-layer with second man being in charge of a three-mile section, with a European plate-layer in charge of six or more gangs.

From the terminus the main line runs level for half a mile, then through a soft rock cutting, with a gradient of 1 in 100 falling 11 feet, to where the harbor line crosses and from that point the formation is level up to 2 miles 2 chains over open country and flats of grass land. These flats in places are marshy, the average height of the bank over them is about 3 feet. The flats continue for another mile at a slightly higher level, when the line is merely formation or level with the surface of the ground.




**Standard Section of Ballast.**

From 3 miles 0 chains the level rises in easy gradients up to 7 miles 63 chains. The country then gets more uneven, and is more or less covered with bush, but is still fairly open. At this point, which is the site of the first intermediate station—Dome—the level is about 79 feet above the flats. The line then rises with a gradient of 1 in 80 up to 8 miles 42 chains, then with an easy gradient down for 30 chains. It again rises to 9 miles 48 chains, when there is a depression, which the line crosses on a bank 7 feet high, with a gradient of 1 in 80—the line at this point being 55 feet above Dome station, or a total of 134 feet above the flats. It was between this point, 9 miles 48 chains, and the harbor line crossing that the most trouble with floods was afterwards experienced. From that point there is a stiff pull —1 in 80—up to 11 miles 14 chains to the top of a range of hills which runs parallel to the coast line. These hills must be crossed in getting from the coast to the interior. At the top there is a deep cutting mostly rock. This cutting is at a level of 216 feet above Accra terminus, and is the highest point on the line.

There is a long gradient of 1 in 80 down again to Ensaki Swamp at 13 miles 0 chains, then a rise to 15 miles, the site of the second station—Amasama—which is at the top of a second lower range of hills. After passing 11 miles the cooler sea breezes are lost, and the heat is much more intense—Ensaki being particularly hot and close in the middle of the day.

From Amasama the country is of a more undulating nature—thick and close bush continues in N'Sawam, and immediately after N'Sawam the forest is reached.

At the end of December the rails were laid for the first 27 miles, and in May practically the whole of this length was ballasted and packed, and was in good running order as far as N'Sawam.

The wet season of 1910, which started on June 6th, was, however, the most severe remembered, no less than 18 inches of rain fell between June 6th and 18th. This quantity very frequently represents the total rain-fall at Accra for a year. The whole of the Achimotah valley, through which the line runs, was one great running river. The banks were carried away at 5 miles, 5 miles 27 chains, and 5 miles 47 chains, and in many other places they were totally submerged.

In the wet season of the year 1908 this valley was quite dry. In 1909 very little water ran through it. These great floods were quite unexpected, and did tremendous damage to the line, making it quite impossible to get any material up, so that all progress was stopped for a time. As soon as it was possible every effort was made to repair the damage. Where the banks were carried away timber sleepers were built up in the form of cribs to support the lines, and openings were left. The cribs were so arranged that the concrete foundations, abutments, and wing walls for permanent openings could be put in without interruption to the traffic. Rail girders, consisting each of nine rails packed together, were used to carry the line over the cribs.

Early in August, 1910, through communication was again established, and on the 27th of August the line was publicly declared open for traffic as far as N'Sawam.

The original contract provided for a line to Mangoosi, and the earthworks were completed and the rails laid to that point, but the ballasting was stopped at a point one and a quarter miles short of Mangoosi, as it was then practically decided that an extension would be made to the town of Komfrodua, about fourteen miles further on: under those altered conditions the original site for the Mangoosi station was not suitable, and a new site on the opposite side of the hill upon which the town stands was selected.

Pending a final decision as to the extension, this line remains unfinished for the last mile and a quarter from the point where the route to the proposed new station site would commence.

In the meantime, the end of the line, as far as regular passenger and goods traffic is concerned, is at present at Pakro, which is thirty-four miles from Accra, or six miles beyond N'Sawam, and the contractor, under agreement with the Gold Coast government, is working the line over this length.

It is difficult, if not practically impossible, in the first survey, in tropical countries to reasonably estimate the effect of heavy rain-falls, especially where, as at Accra, the natives can give no reliable information of any kind on the point, and no previous records are to be found, and observation of old watercourses and flood-water marks are also impossible, owing to the luxuriance of the tropical growth which conceals all evidence of previous floods.

In consequence of these June floods it was found necessary to increase the openings under the line either by additional openings or by substituting culverts of greater width for those originally constructed.

In addition to the flood-water openings, the banks were raised over several miles of the line, principally through the Achimotah Valley, but also near twenty-three miles and over the Pom-Pom swamp, which is above N'Sawam.

The whole of the above work, including the addition of the bridges and the raising of the banks, was done without interruption of the daily traffic.

It will be readily understood that the successful carrying out of such an undertaking as the building of a railway in West Africa largely depended upon the perfect organization at home, as the mail boats take seventeen days in the passage from England, and the cargo boats five weeks. One large ship, containing a supply of coal for the engines, was wrecked on the coast, and the work would have been much hampered if there had not been a reserve supply on hand. Another cargo ship, containing some materials for the railway, was lost with all hands and never heard of. Everything that may be conceivably wanted has to be sent with a margin to spare, and well in advance of requirements. Great precision and a highly-organized system directed from home is an absolute necessity to prevent the work from coming periodically to a standstill. Everything required for railway track and station building construction, and for housing provisioning, and furnishing for the staff had to be anticipated and sent out in advance, so as to be available when required.

Bungalows for tne officers and quarters for the men and a fully-equipped hospital building were sent out in sections ready for erection.

The rolling stock for the construction consisted of two 6-wheeled locomotives (duplicates) with outside cylinders, 12-inch diameter, 18-inch stroke, 6 wheels coupled 3 feet 1 inch diameter, gauge 3 feet 6 inches, fire-box of best selected copper with brass tubes, 84 in number, 2-inch diameter, with 2 special hot water injectors, side tanks, holding 470 gallons of water; wheel base 8 feet 6 inches; weight, loaded, about 24 tons.

One with 9-inch cylinders, 15-inch stroke, 4 wheels coupled, 30½ inches diameter, gauge 3 feet 6 inches, fireboxes of copper with brass tubes, 50 in number, 2 inches diameter, 2 sirlus type injectors, saddle tank, holding 300 gallons of water, wheel base 5 feet, weight, loaded, 12½ tons.

The government provided the permanent rolling stock. This includes licomotives, weight 50 tons, covered-in carriages, with both first- and second-class, fitted with lavatories, also brake-vans for the guards. For the passenger traffic a very comfortable corridor train can be made up with this rolling stock.

For the goods traffic both open and closed trucks are provided. These are of steel construction. Hand-brakes are fitted on each carriage and truck. These can be operated from one of the platforms at the end of the carriages, and in the case of the trucks, both open and closed, either the hand-brakes or the couplings can be attended to when standing on a small platform which is hung on buckets at a height of about 12 inches above the rail.

Only European engine drivers and guards are allowed with the regular goods and passenger traffic. Mostly native drivers attended to the ballast and material trains while the line was being constructed and before it was opened to public traffic.

A five-chain curve was put in at the junction of the main line and the harbor branch, so arranged as to complete a third side of a triangle. This provides a means for turning an engine or the whole train if desired.

All the engines take water at Accra, which is taken from the well. When water is scarce the well is kept continually pumped to get the best supply, and the large underground tank is kept filled. Both are drawn from when the demand is heavy; when not heavy the underground tank is filled up.

During the dry season of 1911 there was always enough fresh water from this source for the railway requirements, and frequently there was some to spare for the harbor works where they were at times very badly off, and were obliged to get fresh water brought from N'Sawam by rail.

There is a good supply of fresh water at N'Sawam, which is on the Densu River, and also a fair supply at Ensake Swamp, 13 miles. At these two places there are tanks fitted for watering the engines.

The joint consulting engineers for the line are Messrs. R. Elliott Cooper and Frederick Shelford, of London. The resident engineer is Mr. Douglas Grey. Mr. Arthur J. Salter represents Mr. Muphy on the Gold Coast, and Mr. T. E. Etlinger is his chief engineer.

## REPORT ON HAMILTON SEWAGE DISPOSAL WORKS.

A report was made recently on the sedimentation tank. which is located in the north-east corner of the city of Hamilton, by Dr. John Amyot, Provincial Bacteriologist. Dr. Amyot visited the plant in the early part of November, and on November 23rd made his report to Dr. McCullough, Secretary of the Provincial Board of Health. The following is the text of the report:—

As a sedimentation basin, which was intended for a septic tank, it is too small for the purpose. It was reported to me that the sludge had never been removed from it, thus its capacity is much reduced over what was first intended. There are no means provided for handling the sludge if they desired to handle it.

According to the engineer, the hydraulic head provided for the carrying of the effluent from this tank to the sprinkler filters is not sufficient to reach the lower end of these beds. The beds themselves are built of very irregular material as to size and quality, much of which is crumbled by weathering, and possibly by the action of the sewage sprinkled upon them. The greater bulk of it is in good condition if it were properly sorted and could be made use of.

There is no foundation to the beds; the slag has been thrown right on the clay, thus making one of the most serious mistakes in its construction. Such beds, in order to work efficiently, must have a straight-away, unimpeded flow of drainage.

On account of the diminished sedimentation and the presence of iron waste in the sewage, heavy deposit of hydrate of iron and clay has taken place over practically the whole surface of the beds, thus sludging them completely and preventing them being put to the use they ought to be. If the sedimentation tank had been efficient, most of the iron would have precipitated in the tanks and not gone on to the beds and destroyed them.

I also found a lack of appreciation of the principles of sewage disposal in reference to these beds, and would in consequence advise as strongly as possible that a sanitary engineer accustomed to this particular type of sewage plant be employed by the city of Hamilton before any alterations are made.

Much of the plant can be used over again but special advice should be received in reference to this.

## DEVELOPMENT OF POWER IN EASTERN CANADA

The latest factor in the power field is the Eastern Canada Power Company, it being through the instrumentality of that company, apparently, that Mr. McGibbon is putting forward the following scheme. The formation of this company was announced fully a year ago, it being stated that a wonderful scheme of power development was contemplated by the concern. Sir Max Aitken was said to be the organizer of the company, and it was stated that the amount of power to be produced was very large. The story attracted considerable interest at the time, especially as there then seemed a probability of keen rivalry between the Montreal Light, Heat and Power Company and the Canadian Light and Power Company, each of which companies possessed hydraulic developments thirty miles from the city in the vicinity of Cedar Rapids. About the same time, also, Mr. D. Lorne McGibbon had succeeded in getting control of the Cedar Rapids power. Just where the Eastern Canada Power Company was going to get its enormous power from was somewhat of a mystery.

In the course of the following year Mr. McGibbon's plans for developing the Cedar Rapids Power were matured, and it began to be rumored that he was selling out control to certain other interests. The story was at first denied, but its truth was ascertained later. It was admitted that some of the principal interests in the Montreal Light, Heat and Power Company and the Shawinigan Water and Power Company were the purchasers. This meant that the Montreal, Light, Heat and Power Company was now in control of practically all the sources of hydraulic power located within commercial distance of Montreal.

A recent dispatch from Ottawa is to the effect that Mr. McGibbon now appears in a larger power scheme. It is proposed to build an enormous dam in the vicinity of Coteau, Cedar, Split Rock and Cascade Rapids for the purpose of developing an hydraulic power with an estimated capacity of 1,000,000 h.p. The dam will connect up a number of islands in the vicinity mentioned, and will have a total length of, perhaps, fourteen miles. The rapids will thus be dammed up to a level with Lake St. Francis, thus obliterating them and flooding a portion of the Soulanges Canal. The proposal is from the Eastern Canada Power Company, and behind it are Mr. McGibbon, and with him Sir Max Aitken. The proposal has already been brought before the government at Ottawa, and, so it is believed, has made progress with the powers there.

The other big power scheme is the Long Sault Development Company, which is backed by the Aluminum Company of America. This, also, is before the government at Ottawa, but whether it is in any way opposed to the Eastern Canada Power scheme or not is impossible to say at this moment. It may be remembered that the Long Sault scheme was brought up at Ottawa during the regime of the Liberal Government and met much opposition from the Conservatives, and, on the recommendation of the conservation commission, was not adopted. For some time past the Long Sault Scheme has been showing new life once more. It has been written much about and discussed, and there is no doubt that another attempt will be made at Ottawa.

The Long Sault scheme is not quite so ambitious in some respects as the Eastern Canada Power Company. Instead of a development of 1,000,000 horse-power, one of but 600,000 to 800,000 horse-power is claimed, and the engineering problem, it is stated, would not be anything so vast or complicated. On the other hand, however, the consent of both the United States government and the Canadian government would have to be obtained. These governments both refused consent in the past. Subsequently, the governments have been changed in both countries, and the new governments may feel more kindly disposed to the proposals.

Canadians must feel that the leasing of these powers in the St. Lawrence River is one of the most serious matters dealt with by parliament in many decades. They are the last big, commercially available powers in Canada, and their absorption by private interests can only mean that the advantages of ownership will be absorbed by the owners, whether these be the private interests or the country at large. The Hon. Clifford Sifton, as head of the conservation Commission, made the statement that "leases of these powers for limited periods" was the proper method, and in his suggestion there is much to commend.

## INTERNATIONAL PAPER COMPANY AND CANADA

The report of the International Paper Company for the year ended December 31st, 1912, will likely show the largest net earnings in any year since 1905, the directors anticipating that it will total about $6,000,000. Discussing the decline in this company's stock, it was suggested in New York last week that if a reduction were made in the paper tariff, the plants of the company in the United States might be transferred to Canada with very little expense.

The company is producing at the rate of about 1,750 tons of paper a day. The production varies from 1,746 to 1,777 tons. Of this, 80 per cent. is news print. The remainder of the output consists of tag paper, box paper and supplement paper. It is selling its product at $2.25 per 100 pounds and finds the market favorable, so that its entire output is sold. Beginning next year, International Paper will begin supplying news print on several new contracts, of which the New York Sun is the largest. The Sun contract calls for 40 tons of news print per day. The Sun is now receiving its paper from the Great Northern Paper Company and is paying less than it will have to pay on the new contract at the first of the year.

International Paper is spending considerable money in improving its property and has expended a large amount of money for this purpose during the last three years, and now has a profit and loss surplus of approximately $9,000,000. One of International Paper's greatest assets is its ownership of timber lands in Maine and Canada. The policy of the company is not to use its own wood where it can buy in the open market at a reasonable price. Directors of International Paper believe that the timber lands should be held as a final reserve, and should not be used until the price for wood pulp timber in the open market advances too much.

The International Paper Company was incorporated in 1898 in New York for the manufacture and sale of pulp and paper, and was a consolidation of nineteen paper producing companies. Among the concerns it controls are the Miramichi Lumber Company, incorporated in 1905 in Maine. It has rights to cut timber on about 415,000 acres of Crown land limits in New Brunswick. It also controls the St. Maurice Lumber Company, incorporated in 1891 in New York. This company owns cutting up and wood preparing mills at Batiscan, Three Rivers and Pentecost, Quebec, with water powers and rights to cut timber on more than 2,000,000 acres of Crown land limits in Quebec.

The International has authorized common stock of $20,000,000; 6 per cent. cumulative stock, $25,000,000; and a bonded debt of $16,473,000, exclusive of $1,189,000 bonds of controlled companies.

## TELEPHONE TRAIN DESPATCHING. †

By Mr. Hatton. *

How many are there in speaking of the transportation of the country's products, or in travelling by train, ever give a thought to the principle of train operation, or the problem of train reverse movements; in other words, the indispensable train order system?

It is not necessary for me to enter into that subject to-night, suffice it to say, that the system dates back to 1851, when Superintendent Minot, of what is now part of the Erie Railroad, issued the first train order, after vainly trying to run trains without it. The system has undergone many changes since that time, having been the subject of discussion by some of the brightest minds in the country at conventions and elsewhere, until the present almost perfect system has been evolved. From the first, the telegraph, which at that time was also only in its infancy, was the instrument of transmission of the train order. A few years later the telephone was invented, and, while it was the subject of much wonder and admiration, and likely to revolutionize methods of communication, it was not looked upon seriously by railroad men as a competitor to the telegraph, in so far as train operation was concerned. People evidently had no idea at that time of the vistas of usefulness that would later be opened up to it along that and other lines. The question of using it in place of the telegraph did, however, come in for discussion at different times, and it was actually put into use in a small way for the handling of trains as early as 1883. A few interurban electric lines adopted it some years afterwards, but it was not until 1907 that the steam railways experimented with it to any extent. Probably the first real experiment was made by the New York Central Railway in October of that year, when a telephone despatching circuit was installed between Albany and Fonda, New York, a distance of forty-six miles, followed by the Chicago, Burlington and Quincy Railway in December of the same year, with forty-five mile circuit on one of their lines running into Chicago. The trial in each case was so successful that other lines became interested, and these circuits were inspected by a great many of their representatives during the following year. In every case I believe a favorable impression was made, and those who came prepared to scoff put in a report recommending it, which resulted in the installation of a number of additional circuits on other lines, including the Canadian Pacific. The extension has since been so rapid that to-day of 87,700 miles of road on seventeen American railways over 38,000 miles are operated by telephone. I have not the figures for Canadian lines, except the Canadian Pacific, but this line has kept pace with its American neighbors by installing telephone despatching circuits on 4,858 miles of track, or on over 40 per cent. of its entire mileage, the circuit extending, with but two short breaks, from the Atlantic to the Pacific and on several of the most important branches. Before attempting to explain the reason for this remarkable growth I will give a brief description of the equipment.

The best results being obtainable from a metallic circuit, a pair of heavy copper wires is used for the line, these being transposed at frequent intervals to eliminate interference through induction from other wires as much as possible. By this means and with the use of good telephone apparatus, etc., a very clear transmission has been secured. It is not affected by wet and foggy weather, as is the telegraph, nor is the circuit as liable to interruption from other causes. The average circuit is from 110 to 140 miles long, but that is not the limit by any means, for in one or two instances of 250-mile circuits the result is almost as satisfactory as with the shorter ones. The number of offices on each varies, of course, but often runs as high as 25 and 30. These can be cut in singly or collectively. The apparatus consists of a signalling device and the necessary telephone equipment, the latter being very similar to the ordinary telephone, the despatcher using breast transmitter and head-band receiver, which gives him the free use of both hands, and is always accessible to call from any station. The station telephone is much the same, except that in some cases an arm with adjustable transmitter and receiver attached are used. There are several varieties of signalling devices, but all work practically on the same principle, the equipment in each case consisting of what is called a master selector in the despatcher's office, whose action is semi-automatic, and a sub-selector with bell attached, in each of the stations. In the case of one of these devices the master selector consists of a number of units, that is, a separate arrangement for every office, the whole enclosed in a small cabinet, and placed in a convenient position on the despatcher's table. Each of these has a different combination, and to each is attached a small key. By giving this key a quarter turn it continues mechanically until the contact point is reached, when the circuit is completed and the bell is rung in the office having a similar combination. From five to six of these operations can be made in a minute, which, of course, means that many offices can be called in that space of time. This constitutes one of the many advantages the telephone possesses, for, in addition to the ease with which the calling is done, the responses are usually more prompt than with the telegraph, as many of our agents and operators having duties, such as checking baggage, etc., taking them from the immediate vicinity of the office, may not hear the telegraph at once, while their attention is immediately arrested by the telephone bell. It is also possible to work with one office at the same time that other offices are being called without the transmission being in any way interfered with. These features are appreciated by all despatchers, meaning a great saving of time, labor, and sometimes temper. A great amount of time is also saved in the repetition of orders, for with the telegraph a distinct operation is necessary in transmitting each character, while with the telephone the order may be repeated as fast as the operator can talk. By reason of the quickness of transmission the despatcher is also able to keep his train sheet up in better shape than ever before and with much less actual effort. There is not the same necessity for condensing or restricting information in connection with train movement, etc., which might be of great value if given, but with the telegraph is omitted, because of the time it takes to spell out letter by letter every word of such information. The despatcher is also able to speak direct with conductors and engineers if necessary, thereby securing more accurate knowledge of details than was ever possible with the telegraph. In order that train crews may get in touch with despatcher in case of a delay between stations a portable set is furnished every passenger and freight train, making telephone connection possible at any point on the line by simply hooking a jointed pole with flexible cord, which is also carried on the train, on to the proper wires and connecting it with the portable set.

By talking with agents and operators, the trick despatcher saves many messages a day that would otherwise be necessary regarding cars, etc. In fact, in a hundred ways the telephone not only saves time, but labor.

It is not easy to figure out just what these several advantages mean in dollars and cents, but it is variously

* Superintendent Car Service, Canadian Pacific Railway, Winnipeg.

† Paper read before Western Canada Railway Club, October 14th, 1912.

estimated that the capacity of the despatcher is increased from 25 to 50 per cent. It is also only reasonable to conclude that on account of the contact between despatcher, operator and trainmen being of a more personal character results in a closer co-operation and a more efficient service.

Now, with regard to the most important point of all, the question of safety, the telephone again has the advantage. In the first place, the despatcher in sending an order by telegraph does so without a written copy for reference, and has no record until the first operator repeats it. With the telephone he copies the order at the same time he is sending it to the different offices, so that the repetition can be checked directly against his own copy and an error on the part of the operator immediately detected. Numbers of trains and engines names of stations and other essential words in order are spelled out by letter as well as pronounced, so that a mistake is almost impossible.

In conclusion, I venture to say that, while great advancement has been made in the selective and telephone apparatus and installations in the short space of five years, still further improvement is in store, and the time is not far distant when the telephone will have almost entirely supplanted the telegraph for the despatching of trains. It is also coming into use quite extensively for the transmission of local messages and in this respect also will run the telegraph a hard race.

In speaking thus, I am not oblivious of the telegraph's wonderful achievements in the past, nor blind to its future possibilities, but I am convinced that for the purposes I have described the telephone has triumphed over it.

## VANCOUVER'S PROPOSED HARBOR COMMISSON

As noted previously in *The Canadian Engineer*, at the next session of the federal parliament a bill is to be introduced by Mr. H. H. Stevens, M.P., to provide for placing the port of Vancouver under a commission of three, two members to be appointed by the government for terms of five years, and the other by the city council, for a term of three years. The commission, if the bill passes, will be empowered to improve, operate, maintain and govern Vancouver harbor.

The proposed port limits will include Burrard Inlet with the North Arm and Port Moody, False Creek and English Bay; in fact, all tidal waters to a line drawn from Port Atkinson to Point Grey. The commission is to be the pilotage authority.

The commission may acquire, expropriate, lease and dispose of lands deemed necessary for development, improvement, maintenance and protection of the harbor; may acquire movable property, plant, vessels, machinery, etc. It can acquire property for wet or dry docks, warehouses, elevators and railways in connection with the harbor, and all tidal lands within the harbor limits shall be under its jurisdiction. Further, the commission may construct and operate tracks and harbor lines and may make agreements with railroads, affording all companies whose lines reach the harbor equal facilities for traffic. Laws governing the harbor not contrary to laws existing or the jurisdiction of the corporation may be enacted, fairways, special anchorages, etc., regulated, and the navigation of the harbor will be generally managed by the commission. The harbor master will be appointed by the commission.

Rates will be levied at discretion upon all goods landed or shipped in the harbor, moved by rail on the harbor tracks, excepting military supplies. Powers will be given the commission to borrow such moneys as are necessary to carry on its work, and debentures may be issued to cover such loans. The governor-in-council may advance funds necessary to complete the harbor works. Salvage disputes will be heard by the commission and all wreckage or flotsam dealt with.

Upon certain conditions the commission may seize vessels or goods, the detention being effected upon order of any judge or magistrate having power of two justices of the peace. Judicial powers will be given the commissioners to cover infringements of the Canada Shipping Act within the harbor limits. The government may waive duties on all merchandise required for the port commission work.

## HARBOR IMPROVEMENTS AT NEW WESTMINSTER

New Westminster is seemingly entering the most active building period of its career. A statement which is creating great interest in New Westminster, Port Mann and every part of the Fraser River is that Messrs. Mackenzie and Mann have rejected the agreement between Vancouver and the Canadian Northern Railway.

It is stated that the clauses which Messrs. Mackenzie will not accept are those binding them to make Vancouver their home port, to enter the city by a tunnel and to purchase additional property in the city for their hotel site. If this report ultimately proves to be correct, it will only be in accordance with the steady conviction of a great many that the Canadian Northern Railway would never go to a vast expenditure to make Burrard Inlet their shipping point when they already owned a port capable of magnificent development at Port Mann.

New Westminster's harbor developments may also have had some influence on the Canadian Northern Railway's decision. These are taking concrete shape, and the expenditure of the $500,000 worth of bonds that have been sold for this work will begin very shortly. Mr. Powell, the engineer in charge is calling for tenders for 3,000 linear feet of cedar pile quay wall and 1,000,000 yards of back filling with rock rivetted slope. This is for the widening of Front Street to 192 feet, and the construction of a straight municipal quay of over a mile in length.

## COSTS ON THE PANAMA CANAL.

The annual report of Col. Gorthals, chief engineer of the Panama Canal, gives some interesting unit costs on the work during the past year.

Excavation in the prism by steam shovels was cheapest in the Central division, averaging $0.5101; in the Atlantic division a lower cost is shown than during the previous year—$0.5952 against $0.6010—while in the Pacific division it is higher—$0.7527 against $0.6960. There was a total of 1,443,570 cu. yd. of masonry laid in the locks and spillway during the year. The unit costs for the masonry were: Gatun Locks, $7.7552; Gatum spillway, $7.0988; Pedro Miguel Locks, $6.4640; Miraflores Locks, $4.7675. The labor costs for the year per cubic yard of plain concrete at the various locks and spillways show lowest at Miraflores, $0.8394; next, Gatun Locks, $1.3840; Pedro Miguel Locks, $1.4733; and Gatun spillway, $1.5425.

The cost of concrete piling at Gatun was $0.0679 less during the year than in 1911, while the cost in place was $0.7088 less. The total amount driven was 83,670 lin. ft., at a cost of $1.5719 per lin. ft.; in addition, 51,450 lin. ft. of wooden piles were driven, at a cost of $0.6516 per lin. ft. On this basis had wooden piling only been used for the south approach pier a saving of $77,000 would have resulted.

## APPLICATION OF CONCRETE TO UNDERGROUND WORK.

Concrete has been used for many years in building underground dams, bulkheads, etc., some notable examples of which can be seen at the Chapin mine at Iron Mountain, Mich. Mr. H. T. Mercer, in a paper presented to the Houghton meeting of the Lake Superior Mining Institute, describes some of the applications of concrete in mining work. He states that the principal uses of concrete in mines are in connection with shaft support. Good examples of concrete shaft collars can be seen at many of the mines, and although the details vary somewhat, a description of one or two will perhaps suffice to illustrate this form of construction.

At the Trimountain mine it was decided to replace the old timber collars with concrete, and work was begun at No. 2 shaft, where the overburden was 80 ft. deep, consisting for the most part of sand, with more or less clay and some boulders. To guard against any possible "running" of the sand, and to make the operation of the shaft during construction easier, as well as to reinforce the concrete, it was decided to replace the timber with steel I-beam sets, and then concrete between and around the steel sets. The sets would provide a support in case it became necessary to put in lagging to hold back the sand before the concrete was placed. A foundation was first prepared at the ledge by placing heavy steel beam box girders across the shaft from foot to hanging under the dividers and under the south end plate. At the north end there was a natural rock ledge or shelf. Starting from the foundation thus formed the steel sets were built up, two or three at a time, and concreted in. The work proceeded as follows:

First, the old timber on the ends and foot wall was taken out for as great a height as was deemed safe, then two or three of the steel sets were placed and bolted up, after which the forms were erected, and the concrete poured. Then another space would be opened up and the operation repeated, and so on until the surface was reached. Fortunately the old hanging-wall plates did not have to be removed, as there was sufficient clearance to permit the new concrete lining being carried inside of them. Care was taken to leave no timber or blocking under the foot-wall side of the concrete lining which might by rotting permit settling. The sand was carefully tamped along the foot wall as the concrete was finished. One skip road and the ladder way were built first, hoisting going on meanwhile in the other compartment. The skip was then changed over to the completed road, and the other road was built up. The steel sets were 2 ft. 4 ins. apart in the lower half of the collar, and 3 ft. apart in the upper half, centre to centre. The concrete between the sets was reinforced with ¾-inch rods, as shown by Fig. 1, which also shows the construction of the steel sets and the position of the concrete.

The materials used for the concrete were: Portland cement, coarse amygdaloid stamp sand and crushed trap rock. They were mixed by hand in the proportion 1:3:5, in the shaft house just back of the shaft and lowered by a

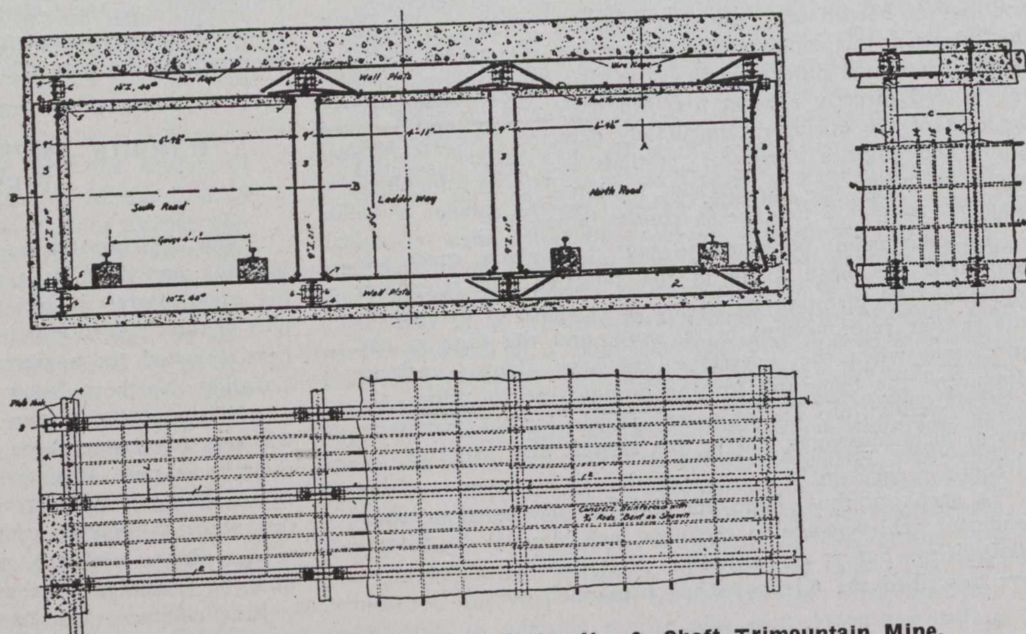



**Fig. 1.—Details for Steel-Concrete Collar No. 2. Shaft Trimountain Mine, Plan and Elevation.**

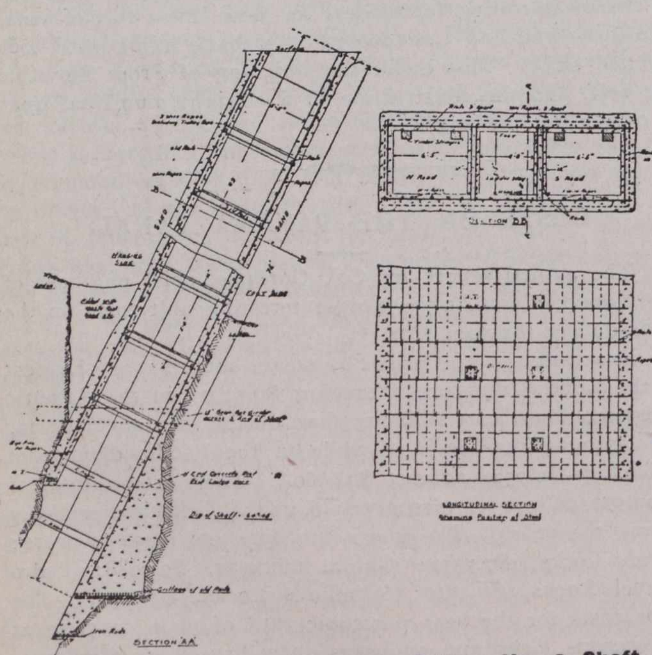


**Fig. 2.—Reinforced Concrete Collar, No. 3 Shaft, Trimountain Mine.**

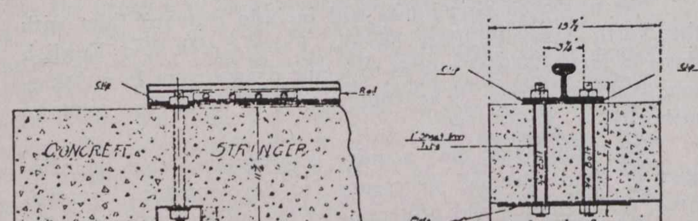



**Fig. 3.—Details for Concrete Stringers, Showing Old Method of Fastening Rails.**

bucket and trolley, the trolley rope being concreted in on the hanging side as the work progressed. As no difficulty was experienced at No. 2 shaft with the sand running in, or otherwise, it was decided to build the Nos. 3 and 4 collars of reinforced concrete only, leaving out the steel sets. Fig. 2 shows the construction of the No. 3 collar, which was started in June, 1910, and finished in August, 1910. The materials for the concrete were the same and work was carried on in the same manner as at No. 2, except that there were no steel sets. The collar at No. 4 shaft was similar to the one at No. 3, except that the dividers were made 12 by 48 ins. instead of 12 by 12 ins. The overburden at No. 4 shaft was 128 ft. deep on the pitch of the shaft (71°), that at Nos. 3 and 2 being 60 and 80 ft. respectively; but in order to secure a suitable foundation, the No. 3 and No. 4 collars were started some distance below the ledge in the solid rock. The length of No. 3 collar was 93 ft. and of No. 4 was 158 ft.

| Cost per ft. | Labor. | Supplies. | Total. |
|---|---|---|---|
| No. 2 shaft | $47.47 | $43.70 | $91.17 |
| No. 3 shaft | 16.77 | 16.66 | 23.43 |
| No. 4 shaft | 15.04 | 7.25 | 22.29 |

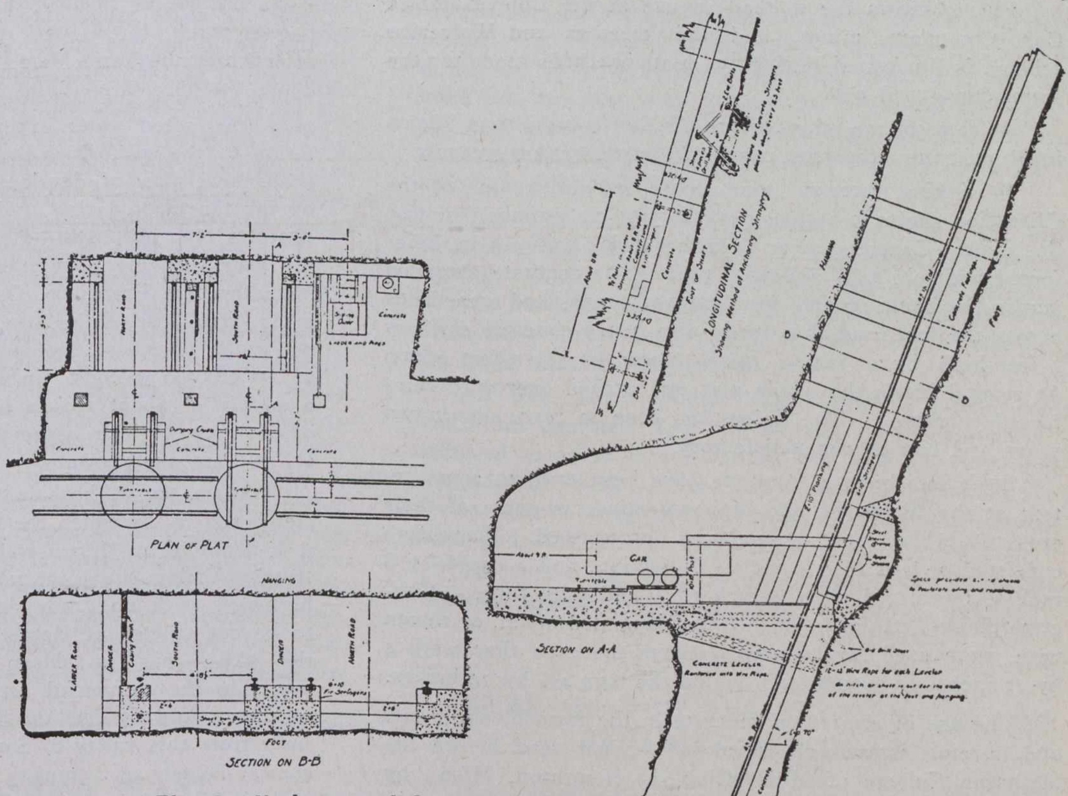



**Fig. 4.—Underground Concrete Construction, Champion Mine.**

**Comparative Statement of Cost of Concrete Shaft Collars.**

| Labor. | No. 2 shaft. | No. 3 shaft. | No. 4 shaft. |
|---|---|---|---|
| Length, to foundation | 80 ft. | 93 ft. | 158 ft. |
| Shaftmen | $2,019.10 | $1,028.85 | $1,994.70 |
| Masons | 528.51 | ...... | ...... |
| Surface labor | 301.80 | 295.50 | 192.45 |
| Blacksmith labor | 360.41 | 67.55 | 40.50 |
| Machinist labor | 311.76 | 41.82 | 27.85 |
| Carpenter labor | 144.97 | 42.73 | 54.69 |
| Electrician labor | 10.84 | 8.82 | 8.96 |
| Teaming labor | 120.56 | 74.46 | 56.64 |
| | $3,797.95 | $1,559.73 | $2,375.79 |
| **Supplies.** | | | |
| Structural steel | $2,180.56 | ...... | $ 136.00 |
| Cement, 1,252 sacks No. 2 | 588.83 | ...... | ...... |
| Cement, 1,238 sacks No. 3 | ...... | $ 470.80 | ...... |
| Cement, 2,169 sacks No. 4 | ...... | ...... | 810.09 |
| Stamp sand, 11 cars No. 2 | 159.50 | ...... | ...... |
| Stamp sand, 3¼ cars No. 3 | ...... | 45.70 | ...... |
| Stamp sand, 8⅓ cars No. 4 | ...... | ...... | 123.25 |
| Fine rock, 3 cars | 90.00 | ...... | ...... |
| Sundry supplies | 261.75 | 102.55 | 75.91 |
| Freight | 215.33 | ...... | ...... |
| | $3,495.97 | $ 619.05 | $1,145.25 |
| Total cost of shaft collars | $7,293.92 | $2,178.78 | $3,521.04 |

No. 2 shaft collar commenced February, 1907, completed August, 1907.

No. 3 shaft collar commenced June, 1910, completed August, 1910.

No. 4 shaft collar commenced March, 1911, completed August, 1911.

Fig. 4 shows a station or plat in one of the Champion Copper Company's shafts, and indicates the manner in which the levelers are reinforced. This illustration also shows the method used for concrete stringers. At first an all concrete

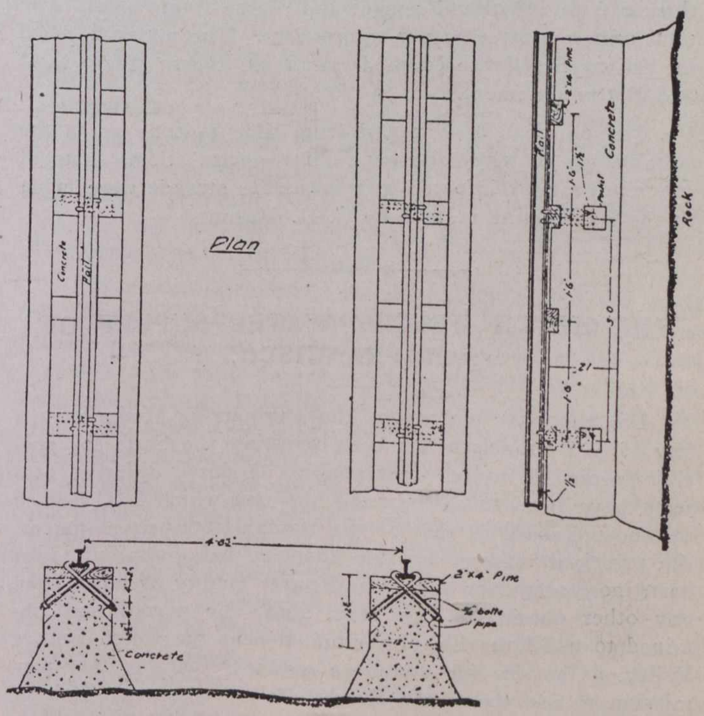



**Fig. 5.—Concrete Stringers, Mohawk Method.**

stringer was built after the manner in use at the Ahmeek mine as designed by W. J. Uren, to which the rail was bolted by means of bolts and clips as shown in Fig. 3, but because of the hard rigid roadbed thus formed the wear and tear on skip and rails was very great, and the bolts and clips were continually working loose. The scheme was therefore abandoned in favor of a combination wood and concrete stringer.

Fig. 4 shows the method in use at the Copper Range Con. Company's mines, and the Mohawk and Wolverine scheme is illustrated in Fig. 5. Both methods made a very satisfactory road bed.

At some of the mines where the foot is subject to "heaving" concrete stringers cannot be used advantageously.

In sinking through some loose ground at one of the Champion shafts it became necessary to close-timber, or line the shaft. Concrete 12 to 18 inches thick was put in, reinforced with old rails and wire rope. The concrete extended across the hanging and down on both ends, and sometimes across the foot, and there were also heavy concrete dividers 4 feet high by 10 inches thick, placed 10 or 12 feet apart. At several levels the whole plat was arched over with reinforced concrete. The lining has been in place about two years and has proven satisfactory.

Drift sets built of concrete have been tried to some extent at the Wolverine and Mohawk mines in some of their crosscuts where loose ground was encountered. These sets consisted of legs 6 by 6 inches in section, and a cap 6 by 8 inches, reinforced with ½-inch rods and wire rope. Concrete planks, reinforced with Kahn expanded metal, or woven wire, were used for lagging. Above the caps they were 4 by 14 inches in section and behind the legs 2½ by 14 inches.

The use of reinforced concrete in the form of shaft sets and lagging is well described in a paper read before the Michigan College of Mines Club, at Houghton, Mich., by E. R. Jones.

Concrete floors for shaft houses are being tried at several places and are proving satisfactory in many respects, although subjected to the hardest usage. The floors built at the Champion Copper Company's shaft houses were made 6 inches thick of 1:3:5 concrete, with a top finish 1-inch thick of 1 to 2 Portland cement and coarse stamp sand. The total cost was 13 cents per square foot. The materials used for the concrete were crushed trap rock, coarse stamp sand and Portland cement.

Question has been raised from time to time as to the suitableness of wire rope for reinforcement. Some tests of concrete beams reinforced with wire rope strands were made at the Baltic mine in 1910 by C. G. Mason.

## THE HETCH HETCHY WATER SUPPLY OF SAN FRANCISCO.

For the past ten years, the engineering force of the city of San Francisco has been scouring the State for possible means of future water supply. A dozen different projects have been examined, and the one which has seemed the most feasible is that of the Hetch Hetchy development, the principal reasons for this adoption being that of lower cost, more abundant supply and purer quality of water than any other obtainable. In May, 1908, the permit was obtained to use Lake Eleanor, situated near the Hetch Hetchy Valley, as a site for a storage reservoir, with further permission to use the Hetch Hetchy Valley when the limit of storage of Lake Eleanor had been reached. This latter permit was later called in question by the Department of the Interior, as two objections had been raised to its granting. The one was, that prior rights to the waters were being jeopardized, and the other that the natural beauty of a great scenic national park would be destroyed.

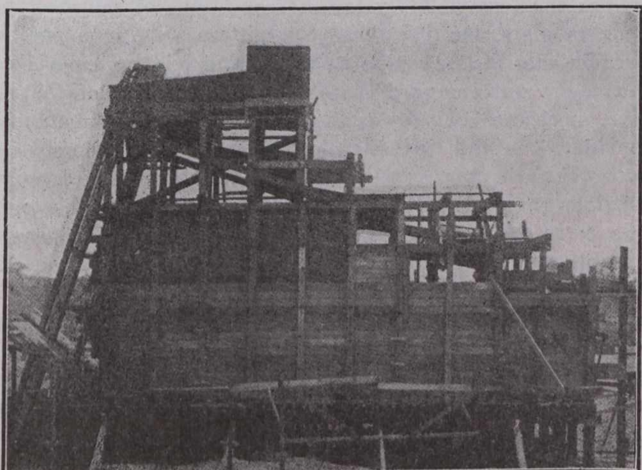
The first proposition, to bring these waters to San Francisco, outlined by C. E. Grunsky, engineer of the city of San Francisco, was to bring the water from Lake Eleanor and the Hetch Hetchy down across the San Joaquin Valley to Altamont. At this point he proposed to pump these waters over the coast range into San Francisco. The power for this pumping was to be gotten from power generated in the drop of the water from the Sierra Nevada side of the valley. During the last season, however, Mr. John R. Freeman, the noted water expert, has been called into consultation by the authorities in San Francisco to outline a comprehensive plan of development. Mr. Freeman's report is by far the most daring and all-comprehensive of municipal projects ever proposed. He has carefully estimated that by the year 2000 the population in the cities around the Bay, including San Francisco, Oakand, Berkeley, Richmond, Alameda, San Jose, Palo Alto, Redwood City and San Mateo will total 3,632,000, and will require a daily water supply of 441,000,000 gallons. In addition, it is proposed to obtain a supply of about 100,000,000 gallons a day for irrigating 95,000 acres. The general features of Mr. Freeman's scheme are as follows:—

A dam 300 ft. high is to be erected at the dam site of Hetch Hetchy by which the floor of the valley will be flooded to a depth of 270 ft.; a wagon road is to be built to Hetch Hetchy Valley equal in point of construction to the State highways with no grade exceeding 8 ft.; a scenic road is to be constructed at Hetch Hetchy Valley on both sides of the lake— this, as shown in the illustration, will make available the wonderful attractions of a region now inaccessible. And finally, the Hetch Hetchy aqueduct is to be built from this valley to San Francisco. This aqueduct will consist largely of a tunnel 10 ft. in diameter, for the most part deeply below the surface of the ground. This tunnel extends to the easterly edge of the San Joaquin Valley. Thence continuing westward across the valley, the suggested aqueduct will consist of one steel pipe 7 ft. 6 in. in diameter, and ultimately of two steel pipes side by side of similar proportions, about 45 miles in length. On the westerly side of the San Joaquin Valley the steel portion is to end about 8 miles westerly from the San Joaquin River. From this point the aqueduct proceeds westerly for the most part in the form of tunnels about 12 to 13 ft. in diameter to a point near the village of Irvington, at which point the terminal chamber and gate-house will be built, and branch aqueducts lead off as desired to Oakland, San Jose, San Francisco and other communities. From this point the aqueduct would proceed in the form of a steel pipe submerged across the Dumbarton Narrows near the head of the Bay, or it could be carried on dry ground around its head to a suitable point in San Mateo County, whence it could discharge by gravity at an elevation of 320 ft. through a new tunnel into Crystal Springs Reservoir or could feed branch lines leading to neighboring communities and to a main aqueduct line leading directly to San Francisco. The proposed aqueduct between Hetch Hetchy and the Irvington gate-house would be designed to deliver by force of gravity without pumping a quantity somewhat in excess of 400,000,000 gallons daily, equivalent to 620 ft. per second. All the tunnels will from the first be built to their full size and smoothly lined with concrete. During the early year, with only the single pipe line across the San Joaquin Valley, the delivery of the aqueduct would be in excess of 200,000,000 gallons daily, possibly 240,000,000. The branch line to supply the San Francisco peninsula will have a capacity of about 100,000,000. It is proposed to utilize the water until the population requires it for domestic use in the reclamation of arid land in and about the Bay region.

That portion of the tunnel, as shown in the illustration, which is about 12 miles in length and lays down stream from Hetch Hetchy, is to be delayed in construction for some years. Eventually, however, the construction of this tunnel will afford the development of 75,000 horse-power. At the point on the illustration marked "Power House No. 1" is seen a drop of 1,425 feet into Moccasin Creek, where 70,500 horse-power is developed. In addition to this it is proposed to construct a canal 8 ft. in diameter from the Hetch Hetchy Reservoir to the reservoir site in Cherry Valley, passing beneath the Lake Eleanor Reservoir site, with intake shafts at Cherry Creek and Lake Eleanor for the purpose of diverting their waters into the Hetch Hetchy reservoir. Only temporary dams are to be constructed at these two latter points, reserving for future demands a more permanent and substantial form of construction. The drop, as shown on the profile of this tunnel work, allows an additional development of power to the extent of 12,500 horse-power. Hence, in all, there is a total possible power development of 157,500. The entire project as proposed for immediate construction is estimated to cost $38,500,000. Mr. Freeman makes note of the fact that standing water tends to purify, and hence the purest supply of water is to be expected from this high Sierra construction. Indeed, he has stated in public before the Commonwealth Club, of San Francisco, that in comparing the softness of this supply to the softness of supply that might be developed from the Sacramento rivers, the saving in soap alone to the community about the Bay would eventually pay the interest on a $3,000,000 investment. To insure sanitary perfection and non-corrosion of the steel material in the pipe line, the pipe conduit is to be lined with concrete throughout its entire length.

## A GRAVEL WASHING PLANT.

The gravel washing plant of the T. R. Nickson Company, which is shown in the illustration, is located within the business district of Vancouver, B.C., on the water front. Unwashed gravel is brought to the plant on barges, is washed and sized here, and delivered by teams as required in various parts of the city.



**A Gravel Washing Plant at Vancouver, B.C.**

As all towing is paid for by the yard, it is cheaper to bring in the raw material on barges than the sized, as in the former case, the fines fill the voids between the larger stones, allowing the unsized gravel to occupy about 20 per cent. less space and it is on this account that the plant is located within the city.

Gravel is unloaded from the barges by means of a grab bucket delivering into a receiving hopper at the plant. This hopper feeds an elevator, 56 feet centres, and equipped with 18 x 9 x 12-inch continuous buckets. The discharge from this elevator passes into a double chute feeding two rows of 54 inch Gilbert washing screens. These screens are all of the improved type, being provided with removable inner wearing skirts; these skirts increase the capacity of the screens and practically double the service of the outer screen plates. The typical arrangement of the screens in each row is adhered to, each screen successively separating the larger sizes into the bins and passing the fines and the water to the next screen. The last screens each deliver to a single discharge settling tank for separating the sand from the clay and loam in the water.

The first screens reject all the stone over two inches back to a jaw crusher below. This crusher delivers to a crusher elevator, 40 feet centres, with 9 x 9 x 9-inch continuous buckets, discharging to a small revolving screen. From here, the stone is passed to three bins, which supply the trade with crushed gravel.

All bins are equipped with swinging cut-off valves, which are operated from the wagons. These valves are balanced so as to be self-closing and they are consequently very easy to operate. They are entirely of cast iron, giving a very simple, rugged construction that can not get out of order and that can not choke up or spill.

This plant was designed and equipped by the Stephens-Adamson Manufacturing Company, of Aurora, Illinois.

## CAUSE OF THE DESTRUCTION OF THE CANADIAN TAMARACK.

The almost total destruction of the tamarack, or larch, which took place throughout Eastern Canada almost thirty years ago, was caused by an insect, the Larch Sawfly. It appeared again about eight years ago, and in its spread westward it is repeating its former devastation on the younger tamaracks.

To all who are interested in our forests the appearance of a comprehensive account of this insect entitled "The Large Larch Sawfly, with an account of its Parasites, other Natural Enemies and Means of Control," by the Dominion entomologist, Dr. C. Gordon Hewitt, will be welcome. This has been published by the Dominion Department of Agriculture as Entomological Bulletin No. 5 and Bulletin No. 10 of the Second Series of the Experimental Farms Bulletins, and may be had free, on application to the Publications Branch, Department of Agriculture, Ottawa.

Dr. Hewitt has studied the life-history, habits and means of control of this injurious sawfly, both in England and North America. In England, it was found that the natural enemies, especially parasitic insects, effectively gained control of outbreaks of the insect. Other natural enemies were mice and birds and a system of bird encouragement was started on a large scale. The devastating spread of the sawfly in North America was due to the comparative absence of the natural means of control. Several important species of parasites new to science were discovered and have been studied and described. To increase the number of natural enemies of the sawfly, attempts are being made to introduce and establish in Canada parasites which were discovered in England and which appeared to control the pest there. An account of these interesting experiments and of the methods devised to encourage the birds and other means of control are described in this bulletin which consists of forty-two pages and contains twenty-six figures, including a colored plate. The publication of this bulletin is indicative of the attention which the Division of Entomology is now devoting to the insect pests of our forests which are responsible for incalculable loss each year.

## COAST TO COAST.

**Fort William, Ont.**—David Johnson, a young clerk, was electrocuted in the show window of a men's furnishing store by an ordinary tungsten lamp when he was endeavoring to replace the broken light. It was only a 110-volt line. He died instantly.

**Strathcona, Alta.**—Extension lectures have been arranged in seven towns of Southern Alberta by the Department of Extension of the University of Alberta. These towns are Red Deer, High River, Macleod, Pincher Creek, Lethbridge, Taber and Medicine Hat.

**Kaifers, B.C.**—The entire top of a section of Jackass Mountain, opposite this place, on the line of the C.P.R., col- lapsed a few days ago, hurling into the Fraser River hun- dreds of thousands of cubic yards of rock, ruining a 249- foot tunnel of the C.P.R. The slide made a noise that was heard for miles. No lives were lost.

**Toronto, Ont.**—The employees of the Consumers' Gas Company, this city, are to be afforded the opportunities and benefits of a course of training along the lines of salesman- ship and general education. This company recently joined the membership of the National Commercial Gas Associa- tion and in this connection the employees are entitled to in- struction from the correspondence department of the parent offices.

**Moose Jaw, Sask.**—City Engineer Antonisen, after an in- spection of the mines and property of the Consumers' Coal Company, has stated that a supply of coal for economical power purposes may be secured from the areas of coal south of this city. His plan includes the erection of a power plant at the mines and the construction of a high-voltage trans- mission line into a municipal step-down station. It is re- ported that there are ten million tons of coal easy of access in this region.

**Provinces of Ontario and Quebec.**—A deputation of five representing the Ontario Government, occupied seats on the floor of the Legislative Assembly, November 27th, to confer with the government regarding certain suggestions that have been made for the celebration of the peace century between Canada and the United States. The members of this depu- tation were Hon. Jas. Duff, Minister of Agriculture; the Hon. Mr. Reaume, Minister of Public Works; Mr. John G. Kent and Dr. J. O. Orr. They were entertained by the Speaker, Hon. Mr. Delage.

**Hamilton, Ont.**—City Engineer A. Macallum has sub- mitted to the works committee a plan for a cross-city flood sewer. He said the cost of sewer to cover 75 per cent. of the district would be $360,000, and to cover 95 per cent. $596,679. Controller Allan suggested that if the sewer pro- ject were in shape they could submit a by-law to the people to raise money at the same time as the Hydro-Electric Com- mission was to be elected, in May. The city engineer also submitted plans for improving the sewage disposal works in the east end, and was instructed to submit them to an expert.

**Ottawa, Ont.**—The Board of Railway Commissioners of Canada have issued specifications dealing with the erection of highway crossing signals. They are as follows: The signal must be placed upon a post of suitable structural material. If the post is made of wood, it must be of sound timber not less than 8 x 8 inches and 18 feet long, and shall be firmly set in the ground to a depth of four feet. If it is made of iron or steel, it shall be not less than 4 inches in diameter, shall extend at least twelve feet above the ground, and shall be firmly bolted to a concrete or other foundation constructed below the frost line. A bell which shall emit a clear, loud volume of sound under all weather conditions must be used. A sign shall be placed upon the same post as the bell, with the word "danger" upon it in letters not less than 6 inches in length, to be illuminated, so as to be plainly visible after sunset. There may be added to the post, if so desired, the railway crossing sign provided for by Section 243 of the Railway Act.

**Regina, Sask.**—The proposal to divert water from the South Saskatchewan River to supply the needs of Regina, Moose Jaw and many of the towns to the southern part of the province has been taken up by the Federal Government. It will be remembered that during the latter part of last year and the early part of this the Provincial Government had T. Aird Murray, consulting engineer, of Toronto, go into the question fully and it is understood his report was favorable to the furtherance of the scheme. The Federal Government has three parties of men at the Elbow and Tu- gaske to take levels at the river bend, about thirty miles west of Elbow, and to secure other information relative to the matter. H. E. M. Kensitt, the inspector of the water powers branch, Department of the Interior, has been in charge of the work. It is understood that all the preliminary work has been completed, and it is expected that an official statement concerning the matter will be given out within the near future. To carry out the proposed scheme would require the laying of a pipe line about 140 to 170 miles in length, according to a statement made by Mr. Kensitt, and the cost would be between $5,000,000 and $7,000,000.

**Ottawa, Ont.**—Judge Gunn's report on the recent water- works investigation was received by the city council on De- cember 2nd. It places the blame for the typhoid epidemic on the waterworks coimmittee, board of health, City Engineer Ker, and Medical Health Officer Sherreff. The waterworks committees from 1908 to 1912 are censured for failure to give their duties the consideration warranted by their importance. The board of health is held responsible through failure to undertake earlier investigation of the polluted water situa- tion. Judge Gunn says: "I place on the committees of 1910-11 the responsibility for the conditions of the steel and concrete piers, because these committees were in a position to exact that the new pipe be tested and laid by experienced workmen, and I regard that testing and laying of the new pipe, steel and concrete as the most important element to be considered in this investigation. Because of the many new duties thrown upon him by the Public Health Act, I do not consider that the present medical health officer will, to his own or to the satisfaction of the citizens, find that office ac- ceptible, and a grave injustice was, in my opinion, done Dr. Sherreff when he was placed by his friends and supporters in a position that was in every way a difficult and most try- ing one. I unhesitatingly acquit of any irregularity or at- tempt other than lawful means to secure his appointment. The appointments to the board of health should not be made for the purpose of giving municipal office to an ex-alderman or prominent citizen who has no other qualifications. I would recommend that in order that the new council might have a free hand in the reorganizing of the department, these gentlemen, (present members with terms still to run) throw up the seals of office."

## PACIFIC COAST COLLIERIES.

The Pacific Coast Collieries, Limited, has been formed with capital of $3,500,000 bonds, $1,500,000 6 per cent. pre- ferred stock, and $3,500,000 common stock, which has taken over the Pacific Coast Coal Mines, Limited.

## LARGE PIPE FITTINGS.

Three special fittings of large size have just been made for the Crane Falls Power and Irrigation Company, of Caldwell, Idaho.

The three cast-iron bell-end fittings have a combined weight of 19,150 pounds, the larger one in the figure weighing 10,850 pounds, the smaller one 4,200 pounds, and the third 4,100 pounds.

View of Large Fitting.

The dimensions are, respectively: 5 feet with three 24-inch flanged outlets. 4 feet 4½ inches with two 24-inch flanged outlets, and 3 feet 10 inches with two 18-inch flanged outlets.

These are all discharge fittings for pumps and were ordered through the Portland branch of Crane Co. by Smith, Kerry & Chase, engineers for the power and irrigation company. The fittings connect at the bell-end to wood pipe and at the flanged ends to spiral steel pipe penstocks. The largest fitting will work under a static head of 159 feet, the next in size under a head of 89 feet, and the smallest under a head of 54 feet.

## PERSONAL.

E. L. COUSINS, B.A.Sc., harbor engineer for the Toronto Harbor Commission, delivered an address to the Toronto branch of the Canadian Society of Civil Engineers on Thursday evening, November 28th, on the new plans for Toronto harbor. The meeting was very well attended, about one hundred and fifty being present.

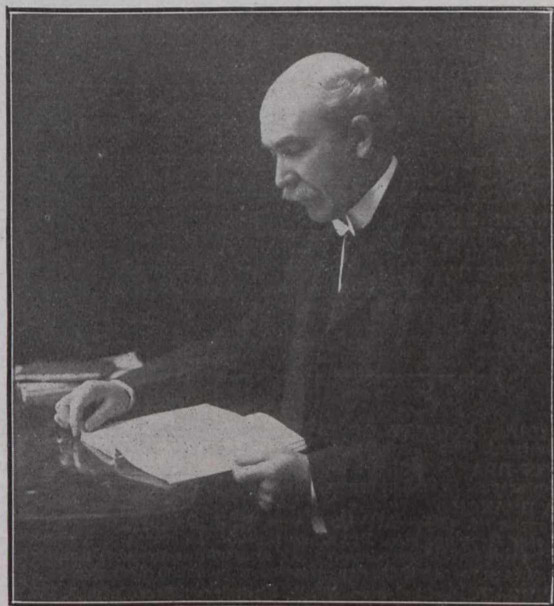
ARTHUR H. BLANCHARD, M. Can. Soc. C.E., professor of highway engineering in Columbia University, on November 25th delivered an address entitled "The Art and Science of Highway Engineering" at the celebration of Founders' Day at the Clarkson School of Technology.

STANLEY M. OBORN, who is in the main drainage department of the Department of Works, Toronto, has been elected an Assoc. M. Can. Soc. C.E. Mr. Oborn has had a varied experience in municipal engineering in England, and has been in Canada about six months.

JOSEPH OWEN, of London, England, has been appointed assistant to Mr. John Wilson, city engineer, of Fort William Ont.

JAMES WALKER, Assoc. M. Inst. C.E., M.I. Mech. E., we are informed, is about to join the staff of Messrs. Boving & Company, Limited, water power engineers, of 9½ Union Court, E.C., and will also join the board of directors. After a long and extensive experience with the contracting firm of Messrs. S. Pearson & Son, of Westminster, he was engaged by Messrs. J. G. White & Company, Limited, of 9 Cloak Lane, E.C., with whom he has been for the last nine years, acting as construction superintendent on large works abroad, and latterly as engineer in charge of construction in the head office in London. With his wide experience in hydro-electric undertakings and civil engineering work in general, he will undoubtedly be a great acquisition to the firm in its already large and rapidly increasing business. It will also interest our readers to learn that Mr. Reginald K. Morcom has also consented to act on the board of Messrs. Boving & Company.

VIRGIL G. BOGUE, a New York engineer, has been retained in a consulting capacity by the Canadian Pacific Railway in connection with double-tracking of the main line between Vancouver and Calgary.



Hon. Robert Rogers, Minister of Public Works.

## MEETINGS.

Mr. C. C. Cariss, of E. Leonard & Sons, lectured on the "Clayton, Logarithic Analysis of Cylinder Performance" before a large audience at London, Ont. Mr. Cariss showed how improved performance could be obtained from steam and other heat engines by improved methods of indicator diagram analysis.

## OBITUARY.

JAMES M. SHANLEY, one of the best known civil engineers in Canada, died on November 28th, at Montreal. The deceased was born in Illinois 55 years ago, but came to Canada at an early age. He was educated at Galt Collegiate Institute and Toronto University. After graduating he started practising in Montreal. One of the first pieces of work done by the late Mr. Shanley was in connection with the Beauharnois Junction Railway, now a part of the New York Central's road into Montreal. He is survived by Mrs.

Shanley, who is a daughter of Mr. Robert Conroy, of Aylmer, three sons and three daughters.

C. W. LEONARD, of the firm of E. Leonard and Sons, of London, Canada, passed away on November 22. Mr. Leonard was born in 1852 and at the time of his death was just 60 years old. He was educated in the London public schools, and at Upper Canada College. After completing his course at the latter institution he entered the employment of his father, the late Senator Elijah Leonard. Later on he was admitted to partnership, and after the death of his father, Mr. Leonard and his brother carried on the business under the name of E. Leonard & Sons. Mr. Leonard's death, which was due to heart failure, was very sudden, as he had been at work in the office the night before until nearly 6 o'clock, as usual. He is survived by his widow and one daughter, Mrs. Dr. Fitzgerald, of California.

## COMING MEETINGS.

CANADIAN SOCIETY OF ENGINEERS.—Mechanical Section Meeting will be held in the rooms of the Society, 413 Dorchester Street West, Montreal, December 5th, 1912. Chairman, H. H. Vaughan.

NATIONAL ASSOCIATION OF CEMENT USERS.—December 12th to 18th. Annual Convention, Pittsburgh, Pa. President R. L. Humphrey, Harrison Building, Philadelphia, Pa.

UNION OF MANITOBA MUNICIPALITIES.—Programme for Ninth Annual Convention to be held in Convention Hall of the Industrial Bureau, Winnipeg, Nov. 26, 27, 28, 1912. Secretary, Reeve Cardale, Oak River, Man.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

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

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. Secretary, E. L. Power, 150 Nassau St., New York.

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

## ENGINEERING SOCIETIES.

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

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

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

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

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

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

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

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

## MUNICIPAL ASSOCIATIONS

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

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

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

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

## CANADIAN TECHNICAL SOCIETIES

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

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

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

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.