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The Canadian Engineer

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WINNIPEG-SHOAL LAKE AQUEDUCT CONSTRUCTION

PROGRESS ON THE $13,500,000 UNDERTAKING OF THE GREATER WINNIPEG WATER DISTRICT—COMPLETION OF 102.4-MILE RAILWAY—FALCON RIVER DIVERSION DYKE AND CHANNEL—REVIEW OF 1914 WORK AND FORECAST OF 1915 ACTIVITIES.

IN 1913 the Greater Winnipeg Water District was formed to construct a waterworks system to bring a supply of water for domestic, commercial and sanitary purposes to Greater Winnipeg from Shoal Lake. The District comprises the city of Winnipeg and its more important suburbs. It has a population of 238,000 and an area of 91.67 square miles. It is governed by a body consisting of the mayor and board of control of the city of Winnipeg and two members appointed by each of the municipalities constituting the corporation. It is managed by three commissioners appointed by this body. Mr. S. H. Reynolds is chairman of the commission and Mayor Waugh of Winnipeg is chairman of the District. In 1913 Mr. James H. Fuertes, New York City, was appointed consulting engineer to the District, and Mr. W. G. Chace, chief engineer.

Mr. Thos. R. Deacon was at that time mayor of Winnipeg, and it was largely through his diligent and persistent efforts that the scheme was launched. Winnipeg's chief problem for many years had been that of water supply, and a number of investigations had been carried on to secure more desirable and adequate sources. The Shoal Lake supply was reported upon by Messrs. Rudolph Hering, Frederic P. Stearns and James H. Fuertes in 1913 and the project was approved by vote on October 1st of that year, after which the above commission was appointed and work commenced. The reader is referred to a summary of the report of the board of consulting engineers, appearing in *The Canadian Engineer* for September 11th, 1913, and to an article descriptive of the design and engineering features of the proposed aqueduct in the issue for October 23rd, 1913.

In brief, the work may be said to include 104.2 miles of railway track for construction purposes, a diversion dyke and channel, an intake, 35 miles of cut-and-cover aqueduct from the intake to the site of a future reservoir southeast of Transcona, 9.8 miles of 60-inch steel pipe from the reservoir site to the Red River, a tunnel beneath the river, and 2.3 miles of 48-inch cast-iron pipe from the river to the McPhillips St. reservoir. Advantage is taken of a gross fall of 294 ft. between Shoal Lake and Winnipeg to bring the water in by gravity. The estimated cost of the undertaking is $13,500,000 and the daily supply to the District will amount to 85,000,000 Imperial gallons.

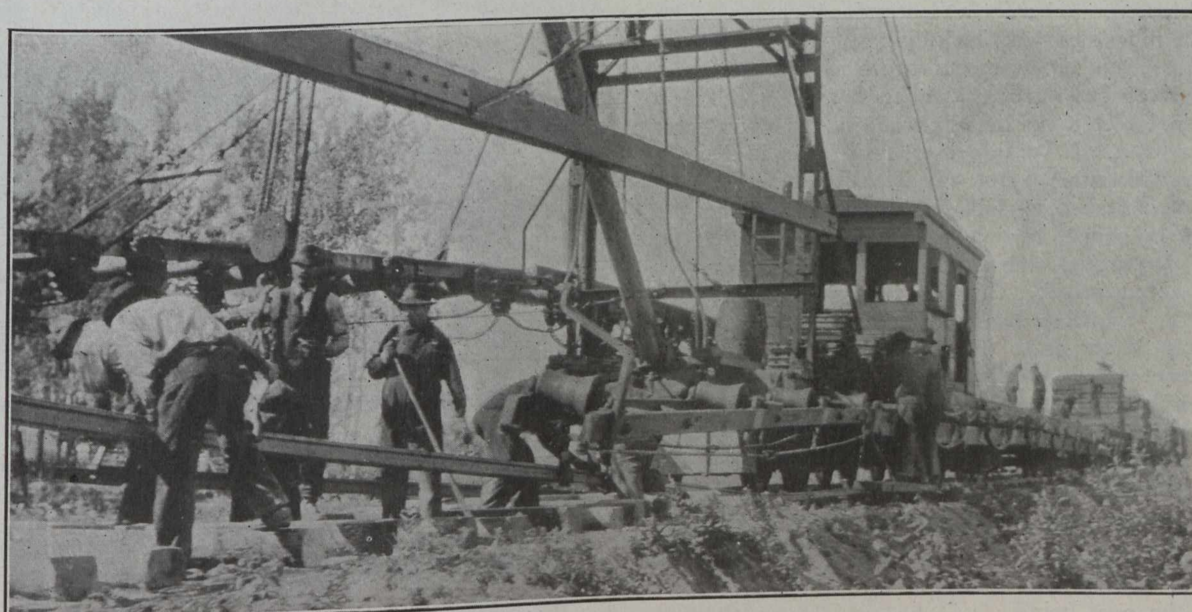


Fig. 1.—Track-laying on Aqueduct Railway, Greater Winnipeg Water District.

Activities in 1913 included the organization of the designing office and of field survey parties. Location work was completed in February, 1914. It included about 380 square miles of topography, 362 miles of transit lines, 1,317 miles of levels, 95 miles of precise levels, 11,544 ft. of soundings at Indian Bay and 3,897 ft. of test borings along the line with 7,445 ft. at Indian Bay. An interesting description of a portion of this work, including wash borings at the intake site and Falcon River crossing, appears in an article in *The Canadian Engineer* for June 4th, 1914. Mr. D. L. McLean, of the District's field staff, there presents valuable data concerning cost of equipment and operation, etc., under extreme weather conditions.

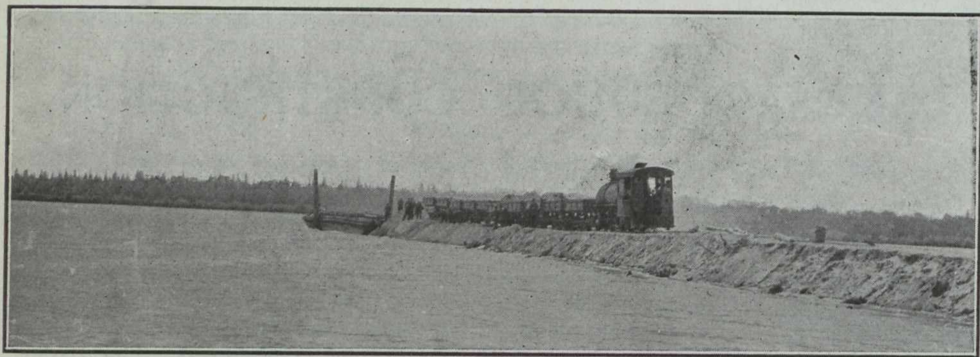


Fig. 2.—Falcon River Diversion Dyke.

In view of the fact that the route of the aqueduct is through undeveloped country, a railroad along the right-of-way had to be constructed for the transport of machinery and supplies. This road is of permanent construction with 60-pound rails and standard gauge. The total of 102.4 miles of track, including spurs and sidings, has been laid. The minimum curvature is 4 degrees and the maximum grade 6 inches per hundred feet. Track laying was completed by the contractors, the Northern Construction Co., of Winnipeg, Mr. A. C. McKenzie president, on December 17th, 1914. About ten miles of the railway remains to be ballasted this spring, and the road will be in shape for aqueduct construction at an early date. It parallels the centre line of the latter at a distance of about 110 ft., thus providing space between for contractors' working tracks. The railway is costing approximately $1,200,000. The operation of it, for supplying the contractors with necessary materials, will be carried out by the Water District. Mr. J. A. Nelson has been appointed railway superintendent. Fig. 1 is a view of the track-laying machine in operation in connection with its construction.

Another feature of 1914 activities was the clearing of the aqueduct right-of-way. This was done under contract by E. J. Bawlf & Co., Winnipeg, the cost being about $79,350. The work included the clearing of approximately 2,586 acres of land. It involved the removal of large quantities of wood and timber, for much of which there is a ready market. Other preliminary work included the construction of roads, residences, a telephone line from Winnipeg to Indian Bay, and similar works. The telephone line was built by the District to connect all the camps with the head office.

A more important feature of the attending problems of construction is the diversion dyke and channel at Falcon River, designed to prevent the inflow of muskeg colored Falcon River water to the vicinity of the intake. These works divert it into Snowshoe Bay.

The dyke has been constructed by Tomlinson & Fleming. It is 7,500 ft. long and contains about 220,000 cubic yards of material. Fig. 2 illustrates the method of constructing it, the material being deposited between the scow and the end of the dump, and the cars, as they are emptied, being run out on the scow to provide room for those remaining to be unloaded. As shown in the illustration, dinky engines were used to haul 4-yard side-dump cars. Fig. 3 illustrates the method of loading the cars in the gravel pit.

Dredging operations for the Falcon River Diversion channel are still in progress. There is a total yardage connected therewith of about 37,000 cubic yards. Mr. C. G. Anderson is doing the work under contract awarded on January 15th last.

This season's work will include the construction of about 20 per cent. of the total mileage of the aqueduct itself. It is nearly 86 miles long, and will be constructed of concrete, reinforced where under pressure or in cases of river crossings, etc. There will be depressed sections at five river crossings. The J. H. Tremblay Co. have a contract for a portion of the work valued at $945,945; Thos. Pelly & Sons have another valued at $1,301,485, and the Northern Construction Co. and the Carter-Halls-Aldinger Co. have three contracts between them valued at $1,265,680, $1,132,010 and $1,484,520 respectively.

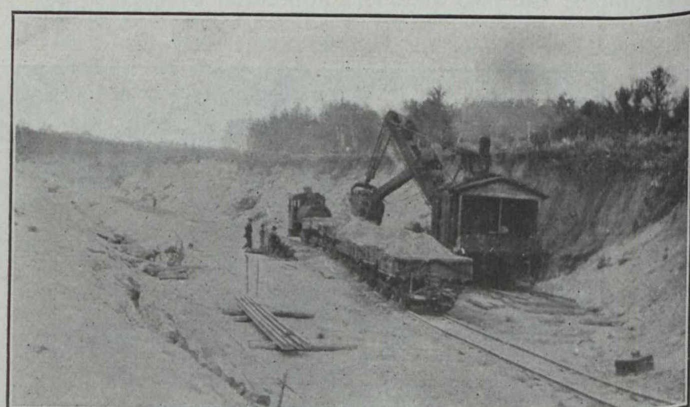


Fig. 3.—Gravel Pit—Falcon River Diversion.

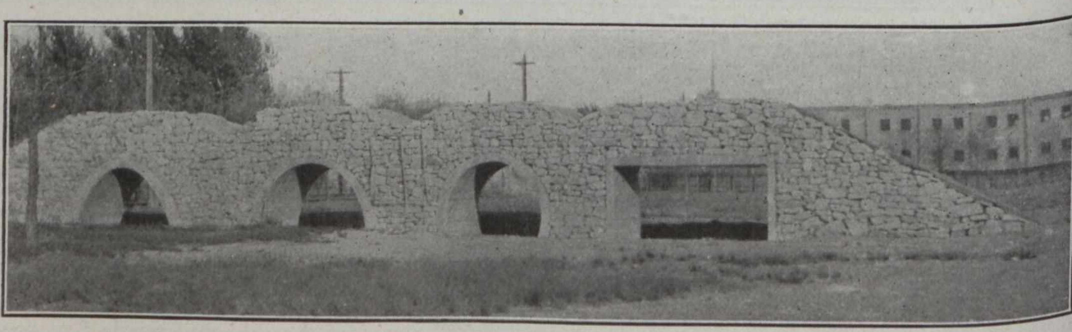


Fig. 4.—Test Sections for Aqueduct.

The operation of the sand and gravel pits for concrete aggregate will be carried out by the Water District, which will also supply the cement. Tests have recently been made of the sand and gravel from the various pits, chiefly the McCorkell pit, which will provide much of the aggregate. Other pits, including the Gauthier and the Webster, have been practically abandoned while others are being investigated. It is planned to put the material through a screening and crushing plant and to re-mix it before delivery to the contractors.

The reader is referred to previous articles, mentioned above, for details concerning the sections adopted for various portions of the concrete aqueduct; the location of meters, weirs, blow-offs, and the gradients adopted along the line. Fig. 4 shows four test sections, the standard sections used being the arch for gravity flow portions and the circular for portions under pressure.

It is estimated that the 1915 operations will involve an expenditure of about $1,700,000. There are many smaller contracts, such as the erection of an engine shed at Deacon (the first station of the railway, out of Winnipeg), the supply of equipment for screening and crushing plants, additions to rolling stock for the railway, etc., to be included in this year's undertakings. Contracts, totalling $135,907, were let late in January to a number of Canadian firms for varied plant and equipment, including locomotives, excavators, rock crushers, screens, boilers, engines, pumps, and railway cars. In February, a contract was awarded to the Progress Construction Company, Winnipeg, for the construction of a 3-stall engine house at Deacon. In March, Mr. F. Windels, of St. Boniface, Man., got a contract for the construction of a large number of camp buildings.

It is estimated that the construction will cover a period of about four seasons. When completed, the system will be self-supporting, the annual cost of maintenance of the aqueduct and the total expense connected with its operation being estimated in the Board of Consulting Engineers' report at $40,000.

ANNUAL CONSUMPTION OF PORTLAND CEMENT IN CANADA.

The following figures relating to Canada's consumption during recent years of Portland cement were prepared by the Department of Mines:—

	Canadian.		Imported.		Total.
Calendar year.	Barrels.	Per cent.	Barrels.	Per cent.	Barrels.
1910	4,753,975	93	349,310	7	5,103,285
1911	5,692,915	90	661,916	10	6,354,831
1912	7,132,732	83.3	1,434,413	16.7	8,567,145
1913	8,658,805	97.1	254,093	2.9	8,912,988
1914	7,172,480	98.7	98,022	1.3	7,270,502

In the last five years the coal used in metallurgical coke manufacture has averaged around 65,577,000 tons, yielding 43,983,000 tons of coke, valued at $111,736,000. Of this total, 14,767,000 tons were used in by-product coke ovens, yielding, besides the coke, 54,491,000 cubic feet of gas, 94,306,000 gallons of tar, and $9,190,000 worth of ammonia.

The chief function of a locomotive head lamp is to warn persons on the track ahead that a train is approaching. A lamp having a centre-beam intensity of 500 candle-power can be seen 25 miles away by a person of average height, therefore it will give 25 minutes' warning of the approach of a train running at 60 miles an hour on a straight track, with nothing to obscure the light.

OBSERVATIONS OF SOME EUROPEAN WATER PURIFICATION AND SEWAGE DISPOSAL PLANTS.

NUMEROUS descriptions have been presented in recent years by American engineers of European practice in water purification, in sewage disposal and in laboratory control. As a rule they are the result of observations made during a summer trip, and they generally relate to a few of the most prominent or latest developments—a few only of the many there are to see, in peaceful times, in the different countries. The summer of 1914, especially the latter part of it, was fraught by many difficulties in this respect and current literature does not record much new information relative to further investigations. The few visiting engineers who did succeed in following to any considerable degree their summer schedule, however, have described some rather unique developments. One of these is Edward Bartow, whose observations contained in a paper read recently before the Illinois Section of the American Waterworks Association. The writer enumerates many difficulties encountered owing to the war, but the following observations will be found interesting:

Hamburg was the first city visited. The water supply is taken partly from the Elbe River and partly from wells. The waterworks are located on the river above the city, but, the Elbe being a tidal water, at times the sewage-polluted waters of the river reach the intake. It is customary only during the ebb tide to pump the water into the large settling basins. Altona, which adjoins Hamburg down the river, obtains its water supply from a point below the sewers of both cities. Reversing the practice of Hamburg, Altona pumps water into its purification works only during the flood tide. The Elbe River through Hamburg and Altona is therefore like a large tank disposing of the sewage which is passed into it. The only treatment Hamburg sewage receives is screening through revolving screens composed of aluminum bars about one foot long, placed about one centimeter (a little less than one-half inch) apart. The flow of the water in the river averages 1,200 cubic meters per second. The dry-weather flow of the sewage is 3 to 4 cubic meters per second, and the wet-weather flow 20 cubic meters per second, so that there is ample dilution to prevent any nuisance, and to allow the water to be satisfactorily purified for drinking purposes. At the water purification plant alum is used as a coagulant prior to sedimentation. It is thought that Hamburg has the only purification plant on the continent where a coagulant is allowed. The water, after passing through large sedimentation basins, is filtered through slow sand filters. These filters are uncovered, and in winter are covered with ice. Owing to the fact that there is a prejudice against the use of water taken from the river, the water department is endeavoring to develop a ground water supply. A number of wells have been sunk, and considerable water obtained, but the Hamburg authorities are handicapped by the fact that there is not sufficient area in Hamburg for proper development of ground waters. Hamburg is unable to extend its well system into Prussia, and, for the disposal of its sewage, has purchased from Prussia an island in the lower Elbe. The situation is similar to one in this country, where New York City cannot go outside of New York State to Connecticut or New Jersey for its water supply. The ground water obtained by Hamburg contains so much iron that iron removal plants have been constructed.

While the sewage from the city of Hamburg itself is easily disposed of by the dilution method, several of the smaller cities under the direction of the Hamburg authorities are located so far from the river that another means of purification is necessary. At Bergedorf, a city of 15,000 inhabitants, located about ten miles from Hamburg, no water whatever is available for sewage dilution. Purification is accomplished by Imhoff tanks and sprinkling filters, followed by fish ponds. This is a modification of a system of purification introduced at Strasburg, under the direction of Professor Hofer, of Munich, where satisfactory results with a dilution of two or three parts of pure water are claimed. At Bergedorf with no dilution it has been possible to satisfactorily purify the effluent from the sprinkling filters. The purification is accomplished with the assistance of water plants which apparently remove the toxic properties of the sewage, and make the water suitable for fish culture. Fish placed in the ponds in the spring grow rapidly during the summer. The flesh is good, especially if the fish are transferred to pure water for one or two weeks before they are eaten.

At Berlin the Laboratory for Water Hygiene, located at Berlin-Dahlem, was especially interesting. In 1901 the Royal Research and Testing Station for Water and Sewage Purification was established. At the end of twelve years the organization had grown so much that a new building costing $125,000 was constructed.

This laboratory has control of the water supplies and sewage disposal plants in the province of Prussia. It also does commercial work for other German provinces and for foreign countries. Work of investigation is often done in co-operation with officers in cities and villages, and joint articles are frequently published by members of the staff and the city officials. At the present time the staff numbers forty workers. The scientific publications from the laboratory are of great value. The new building contains library space which will accommodate 30,000 volumes. In July, 1914, one hundred and one journals were regularly received. An attempt was being made to have available for the use of the laboratory staff all literature in all languages, concerning water. In April and October instruction is given to waterworks men in methods of water supply and sewage disposal. Regular lectures are given, and the men are taken on trips to interesting plants in the neighborhood of Berlin. Professor Dr. Thum, of the laboratory, very kindly outlined several trips which would be most advantageous to take in the limited time which could be devoted to this section.

The water supply of Berlin is obtained partly from lakes and partly from wells. In Berlin, as in Hamburg, there is a prejudice against water from surface sources, and the authorities are endeavoring to replace the lake supplies by ground water supplies. At Mugglesee, about one-third of the slow sand filters originally used to filter lake water have been given over to the removal of iron from ground water supplies obtained from wells near the lake. The water is pumped from the wells to elevated distributors, from which it trickles over many series of wooden gratings, during which process the iron becomes completely oxidized.

A new plant at Wuhlheide obtains ground water from eighty driven wells. It had been in operation only five days at the time of this visit. The water from the wells is pumped to the upper part of a high building and sprayed through special nozzles over beds of coarse gravel. The water having been thoroughly aerated and the iron oxidized, it is passed through pressure filters. The plant had been in operation only a few days, but from the experiments from which the plant was designed, it is expected that good results in iron removal will be obtained.

The Prussian authorities are very particular to protect the streams from pollution by sewage. This is especially necessary because of the small flow and the sluggish character of the streams. Berlin proper owns large irrigation fields to which the sewage is pumped; 43,000 acres in all are owned; 21,000 are in use. It is rumored that Berlin is giving up sewage irrigation. Berlin proper is not doing so. The suburbs have, however, found it necessary to adopt biological processes of purification because of the lack of suitable land for irrigation fields. The sewage from twelve districts in Berlin is pumped to various sewage fields. The fields at Gross Beeren are the largest in extent, and are typical of all the fields. The sewage passes through a pressure pipe line. An indicator tower shows the rate of flow. The heavy material is removed by open tanks. From the tanks it flows by gravity through open channels to the fields. The land in the fields is rented to the peasants, who are willing to pay twice as much for lands inside these irrigation fields as for land outside. On some of the fields several crops are harvested each year. The vegetables raised were especially noteworthy, most of the vegetables used in Berlin being obtained from the sewage farms. One other crop is especially noteworthy, Italian rye grass, which may be harvested six times during the season. It grows to the height of a meter a month.

Tanks or sprinkling filters are in use at Wilmersdorf, one of the larger suburbs, and in other parts of Greater Berlin.

Especial attention was called to the Reinsch screens in use at Eberswalde. These are revolving screens having numerous holes about 1/16 inch by ½ inch. The screens are cleaned by revolving brushes. The sludge obtained is sold to the farmers who allow it to ripen for use as a fertilizer. Very complete purification is obtained at Eberswalde. The sewage, after screening, is passed into septic tanks and through sprinkling filters with a unique system of distribution. The sewage passes to a trough along the side of the filter beds. From this trough it is syphoned to a travelling cylindrical distributor containing numerous buckets. When these buckets are filled the weight causes the traveler to move. A check at the end of the bed reverses the flow and the direction of the traveler. It then passes through contact beds and is finally discharged into a canal.

At Cöpenick, another Berlin suburb, the sewage is mixed with finely ground lignite or brown coal, and a small amount of alum to serve as a coagulant. A very complete mixing is obtained by means of perforated baffles. The mixing is much more satisfactory than when the bafflles were solid. The thoroughly mixed sewage and lignite pass to large sedimentation basins. Much of the suspended matter settles near the inlet. Very little baffling is needed, and an effluent satisfactory to the government authorities is obtained. Three sedimentation basins are provided. While one is in use as a sedimentation basin, in the second the sludge is being dried, and in the third the dried sludge is being removed. The dried sludge is burned for fuel, alone in the furnaces under the low pressure boilers, and mixed with one to two parts of coal under the high pressure boilers, which supply power to the electric light plant of the city. It is stated that more satisfactory drying of the sludge takes place when it is piled to a height of several feet, than when spread out in a thin sheet, probably due to the pressure exerted on the lower porous layers.

At Dresden the water supply is obtained from wells. Serious difficulties have been experienced because of the manganese content of the Dresden water supply. Service pipes become filled with a black precipitate, and the water cannot always be used for the laundry. Two manganese removal plants are in operation. One consists of gravity filters built in the original reservoir. The water passes through coarse sand on which manganese removing algae have been developed. These filters are washed by reversing the current, and are probably the nearest approach to the mechanical gravity filters in use in the United States. The second plant consists of pressure filters. One-half are filled with manganese permutit and half with gravel on which a manganese removing organism has been allowed to develop. Both processes are satisfactory, but owing to the economy of the sand and manganese removing organism this process seems to be better than the manganese permutit. A very satisfactory account of the experiments performed at Dresden is given by Tillmans.

Reinsch screens have been recently adopted at Dresden for sewage treatment. The dry weather flow is taken care of by one screen. The storm water sometimes requires four to be put in operation. Without further treatment the sewage is allowed to flow into the Elbe. There is sufficient diluting water to render the sewage innocuous.

No photographs could be obtained of a sewage disposal plant at Coethen, as the plant was visited during a heavy rain storm and photography was out of the question. This plant has been designed by Baumeister Benzel with Dr. Dunbar of the Hamburg Hygienic Laboratory as consultant. By settling ninety-two per cent. of the suspended matter is removed, and the sludge is withdrawn before it has time to putrefy. In the bottom are sixteen transverse divisions, each sloping to a trough to which the sediment settles. When this sediment is to be removed, a sliding door separates the trough from the upper part of the tank. The opening of a gate on the side of the tank allows the greater part of the sludge to flow out, the balance is drawn out by means of a hoe. The gate is closed, the trough filled with water and the sliding door opened without any disturbance of the liquid above. The effluent from the tank passes to sprinkling filters which are well constructed with an outside concrete retaining wall of a special design. In the centre is a specially designed piece of concrete so arranged that the underdrains can be flushed out with hose whenever desired. Green algae were growing in the effluent drains, showing a very satisfactory purification. Owing to the fact that the plant is new, and that it takes care of both sanitary sewage and storm water, and that comparatively few sanitary connections have been made, the plant should receive a more extended trial before the design is unreservedly recommended.

At Magdeburg the Puech-Chabal filters of the Magdeburg water system were visited. Magdeburg has the only large plant of this kind. The authorities are apparently satisfied with it for they are doubling its size. At Magdeburg they use not only the prefilters, but also the so-called rapid filters and final sand filters. It may be necessary to take such precautions with the water from the Elbe, but the installation is certainly very expensive and the cost of filtration must be high.

At Munich the sewage without any purification whatever is allowed to flow into the swift flowing Isar River. Sewage purification is unnecessary because the water below the city is not used for drinking purposes and is too cold for bathing. The engineer stated that within sixty miles all traces of sewage had disappeared.

Owing to the war the London waterworks were under an armed guard, and it would have been necessary to obtain special permission to visit the plant. Under those circumstances it seemed unwise to ask the authorities for the special favor.

An interesting plant visited in England was the water softening plant of the Woolcombers, Limited, at Bradford, where 50,000 gallons per day of water having a hardness equivalent to thirty grains per gallon were softened to zero by lime, soda and permutit. Permutit alone was not satisfactory and the combined soda ash, lime, permutit plant was installed. The water is first treated with lime and soda, passed through a settling tank, then over calcium permutit to remove the suspended matter and excess of alkalinity. A permutit filter gives the final product of zero hardness. The process is said by the chemist and superintendent to be very satisfactory. Two pounds of soap per grain per gallon per 1,000 gallons is the saving made. This is a saving of 60 pounds per thousand gallons.

The largest municipal permutit water softening plant is located at Hooten, near Liverpool. This plant was built to furnish a water guaranteed to have less than ten grains per gallon of hardness. The original water contains about thirty grains per gallon. Two-thirds of the water is reduced to a hardness of zero, and is then mixed with one-third its volume of the original water. Owing to lack of time, the plant was not visited, but, in an interview Mr. Bettle, the superintendent, stated that the process was satisfactory, and that, if it were necessary to enlarge the plant, the same process would be used.

An interesting feature in sewage purification, aëration, was observed at Manchester. The preliminary experiments have been described in the 1914 Annual Report of the Rivers Department of the Corporation of Manchester. This process in brief consists in blowing compressed air through sewage until what is known as activated sludge is developed. This sludge, added to sewage and stirred by air, has the property of purifying the sewage very rapidly. For example, with a tank containing 1,300 cubic feet in which are 300 cubic feet of activated sludge, 1,000 cubic feet of sewage can be treated every six hours, or 4,000 cubic feet of sewage can be treated daily. This allows four hours for treatment, two hours for settling, emptying and filling. It is claimed that by this process a sewage effluent can be obtained which is in better condition than an effluent which has passed through Imhoff tanks and sprinkling filters. If the claims of the process are borne out by further experience, it is expected that considerable sums will be saved in the construction of sewage purification works.

To show the stress under which waterworks men are working, it need only be stated that in one place six rifles were leaning against the wall of the office, and the superintendent stated that the three plants of his company were watched by armed guards night and day. The men in charge of the various plants visited were very cordial, and, even after war broke out, when many of the assistants had volunteered and extra work devolved on those left, most courteous attention was extended.

The 15th annual summer session of the College of Engineering of the University of Wisconsin will be held at Madison during the six weeks, beginning June 21st. Special courses will be given in electrical, steam and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shopwork and surveying. All courses given in the University summer session are open to engineering students.

SHEARING RESISTANCE OF REINFORCED CONCRETE BEAMS.

MANY readers of this journal are no doubt familiar with the investigations of the Committee on Concrete and Reinforced Concrete of the Canadian Society of Civil Engineers. In our issue for January 22nd, 1914, there appeared a draft of standard general specifications presented by the Committee for discussion by the membership at the annual meeting that year, and recommended for adoption. Between that occasion and the 1915 annual meeting tests were carried out by Messrs. E. Brown, H. M. MacKay and C. M. Morssen relative to the shearing stress in beams, and other factors embodied in clause 28 of the then proposed specifications. It will be remembered that the specifications in their revised state as submitted at the recent annual meeting were adopted by the Society, clause 28 being identical therein with the corresponding clause in the draft (see *The Canadian Engineer*, January 22nd, 1914, page 200), with the excepted revision that the spacing of the shear stirrups shall not exceed 60% of the depth of the beam.

The experiments were conducted along four distinct lines, to determine the behavior of beams reinforced with:—

(*a*) Straight rods only on the tension side.

(*b*) A combination of straight and bent rods, the latter assisting in carrying the tension due to shearing.

(*c*) Straight rods as in (*a*), assisted by vertical stirrups of different spacing.

(*d*) A combination of straight and bent rods as in (*b*), assisted by vertical stirrups of different spacing.

The sixty-four beams tested were rectangular, 8 in. wide, 12 in. deep outside, 11 ft. long, supported on 10-ft. centres, and loaded equally at the third points, a condition giving uniform bending over the central third, and a constant shear combined with a variable bending moment over the outer thirds. Fig. 1 shows the amount and disposition of the reinforcement in the 4 sets of beams. A mixture of 1:2:4 limestone concrete was used. The materials were supplied by the Atlas Construction Co., and the endeavor was to place the steel, mix and pour the concrete, etc., in a manner representative in all respects of average conditions.

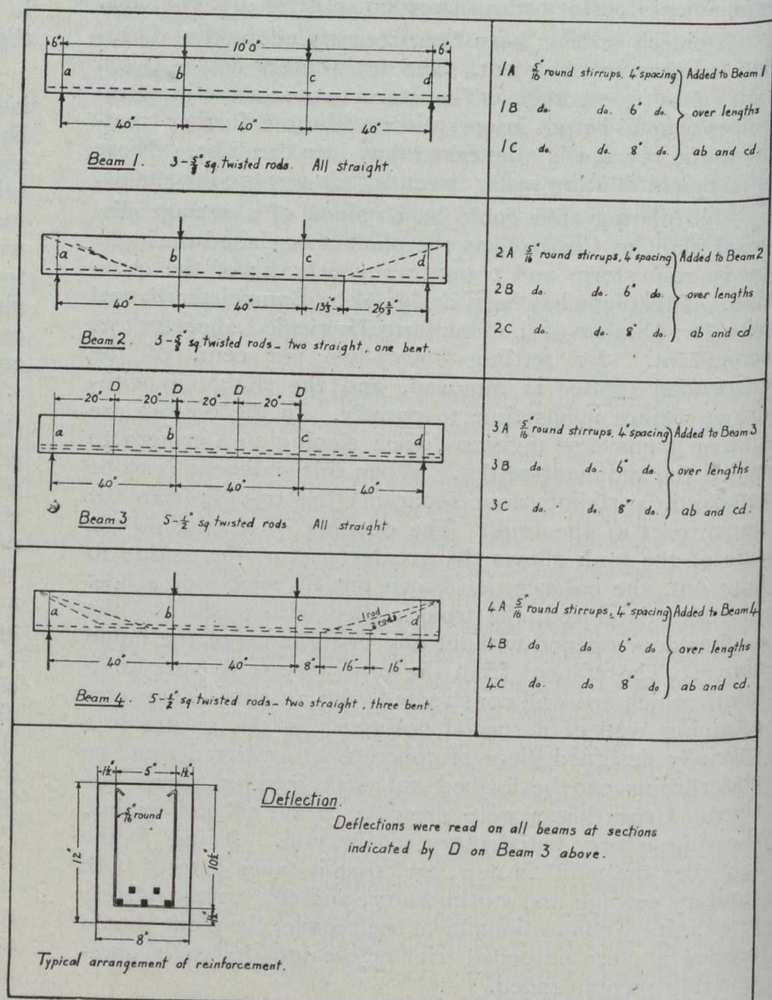
An analytical comparison and discussion of ultimate strength and manner of failure of the deflections of the various beams formed the basis of a paper presented to the Society at its general meeting in Montreal on April 22nd. The following notes and conclusions are taken therefrom:—

When shearing failure occurred it was generally at a section rather nearer to the end support than to the load point, although the section most severely loaded is that close to the load point, where the bending moment is nearly at its maximum value, and the shearing force is the same as at any other section between the load point and the support. The beams did not fail in shear between the load point and the sections where the steel was turned up diagonally. Probably the fact that the curve assumed by the beam is much flatter in the neighborhood of the load points, than in the neighborhood of the end supports, has some connection with this result. The distortions in the concrete are much greater towards the end sections than towards the load points, and this probably influences the position of the shearing failures, when these develop.

General Conclusions.—1. The use of stirrups with tension reinforcement only, tends to eliminate shear failures, and increases the ultimate strength of beams.

2. Shear failure may also be eliminated by bending up some of the tension reinforcement in a diagonal direction. In the tests described, the bending up of 60% of the rods was sufficient, and the bending up of 33⅓% of the rods was insufficient, to eliminate shear failure.

3. The bending up of rods in a diagonal direction greatly increases the ultimate strength, and the addition of stirrups to the beams having such diagonal rods, affects the manner of failure rather than the load at failure.



4. When 60% of the tension reinforcement was bent up diagonally, the addition of stirrups, whether of 4 in., 6 in., or 8 in. spacing, had little significant effect, either on the load at failure, or on the manner of failure.

Summary.—1. For eight beams having tension reinforcement only, the specification gives a minimum factor of safety of 4.0, and an average factor of safety of 4.9.

2. For four beams having 33⅓% of the tension reinforcement bent up as shown in Fig. 1, but having no stirrups, the specification gives a minimum factor of safety of 3.9, and an average factor of safety of 4.2.

3. For four beams having 60% of the tension reinforcement bent up as shown in Fig. 1, but having no stirrups, the specification gives a minimum factor of safety of more than 4.2, and an average factor of safety

of more than 4.8. The upper limit is unknown since no beams failed by shear.

4. Of twenty-four beams having stirrups, but having no tension reinforcement bent up, eight satisfied the specification as to the quantity of metal in the stirrups. Excluding one which proved defective when broken up, none of these failed by shear. Of the remaining sixteen beams in which the quantity of metal in the stirrups was less than that called for by the specification, ten failed by shear.

5. In the case of beams having 33⅓% of the tension reinforcement bent up as shown in Fig. 1, the addition of stirrups eliminated shear failures, which occurred in every case when stirrups were not provided, but on the average the ultimate strength was not improved.

6. In the case of beams having 60% of the tension reinforcement bent up as shown in Fig. 1, no shear failures occurred, with or without stirrups. The ultimate strength was affected but slightly by the addition of stirrups.

Comments on the Clause of the Specification.—In view of the fact that the bending up of 33⅓% of the tension reinforcement is as effective in raising the ultimate load for the beam as the addition of many stirrups, the question may be asked as to why the specification fixes a limit for v at 3% of the ultimate strength of the concrete in the case of beams having some tension reinforcement bent up, and sets it at 6% of the ultimate strength for beams having stirrups combined with tension reinforcement. The engineer is not concerned particularly about the manner of failure, provided the beam carries the load. It must be remembered, however, that while these experiments are of value in indicating the relative effects of various elements in a beam, and the magnitude of those effects, the question is not entirely one of making a clause agree with laboratory tests, but rather of correlating these tests with conditions of practice. Unless bars of special shapes are used, the shearing reinforcement must be provided by the bending up of the tension reinforcement as opportunity offers, and by the use of stirrups inclined or normal to the length of the beam. In practice, the reverse bending moment calls for the provision of tension reinforcement on opposite sides of the neutral plane of the beam at the centre and at the ends, and it is convenient to accomplish the transfer of steel from one side to the other by bending it diagonally. The percentage of rods which will be so transferred, and their effectiveness as diagonal reinforcement, depend greatly on the number of rods used to provide a given sectional area of steel. Three, five, or seven rods might be used to give equal sections; and of these, one, three, or five rods might be bent up diagonally, affording much advantage in the latter case from the point of view of efficiency of the material, if that phrase may be permitted. But the cost of bending and placing the larger number will be a most important economic factor, far outweighing considerations which ignore it, and it is unlikely that the possibilities of diagonal reinforcing will be fully attained in practice. Again, since the reverse moment at the supports of continuous beams extends for a considerable distance towards the centre of the span, the steel when spared from one side of the beam is soon required as tension reinforcement on the other side, so that a considerable length of beam adjacent to the supports is likely to be found without any diagonal reinforcement, and having longitudinal steel only on the tension and compression sides. The tests prove conclusively that beams having no diagonal bars or stirrups fail at much lower loads than they will carry when stirrups or diagonal bars are added. Stirrups are, therefore, likely to prove effective near the ends of a beam where the shearing is greatest. The size of rod used for stirrups will not be determined by considerations which ignore the conditions of practice, for the stirrups act not merely as a reinforcement against failure at a low load by shear, but as frames to which the main bending reinforcement can be wired. They must, therefore, have a certain degree of rigidity, so as to hold the bending reinforcement in the proper relative positions. The tests do not indicate any definite stirrup spacing as being decidedly more advantageous than others, but in the light of a close observation of the behavior of the sixty-four beams tested, and in recognition of other factors than those evident from the tests, we believe the clause of the specification to be fundamentally sound, and that its demands will prove effective without being irksome.

COAL RESOURCES.

The estimated coal reserve of the various portions of the British Empire is given in the following table:

	Anthracitic coals. Million tons.	Bituminous coals. Million tons.	Sub-bituminous coals, brown-coals and lignites. Million tons.	Totals. Million tons.
Canada	2,158	283,661	948,450	1,234,269
Great Britain and Ireland	11,359	178,176	.....	189,533
Australia	659	132,250	32,663	165,572
India	.....	76,399	2,602	79,001
South Africa	11,660	44,540	......	56,200
New Zealand	.....	911	2,475	3,386
Rhodesia	2	493	74	569
Newfoundland	.....	500	......	500
Southern Nigeria	.....	......	80	80
British N. Borneo	.....	75	......	75
	25,838	717,005	986,344	1,729,185

The Canadian estimate, while large, must be considered as tentative in character, since a large part of the country, particularly in the northwest, has not been examined in detail, and even in the better known fields the information available is not full, for in many of them mining operations, with the closer examinations they entail, have not been prosecuted for any great length of time. The present figures relating to distribution by provinces, are as follows:

Nova Scotia	9,718,968,000	metric tons
New Brunswick	151,000,000	"
Ontario	25,000,000	"
Manitoba	160,000,000	"
Saskatchewan	59,812,000,000	"
Alberta	1,072,627,400,000	"
British Columbia	76,034,942,000	"
Yukon	4,940,000,000	"
North West Territories	4,800,000,000	"
Arctic Islands	6,000,000,000	"
	1,234,269,310,000	"

These figures are from Mr. D. B. Dowling's report to the Department of Mines, Canada.

THE USE OF SLAG IN CONCRETE.

By Henry J. Scott.

THE use of slag in concrete has been open to a great deal of discussion, and many tests of blocks of this material have been made and the results published. While not detracting at all from the value of these results, from the practical standpoint something more is necessary than such tests made on blocks prepared even under working conditions and then left for testing purposes a certain length of time. Concrete, as we know, depends primarily for its strength on the adhesion of the binder, cement, to the minute facets of the sharp sand used, and to the rough surfaces of the broken stone or slag. It is, of course, for this reason that clean, sharp sand is used and that no loamy sand or gravel is suitable for the best concrete.

In the case of limestone, granite and some other natural products no change is likely to take place after the concrete has set. In the case of slag, however, the conditions are different.

In the cooling of slag from the molten state great internal strains are set up. The outside solidifies while the inside is in a molten state. The result is that a tap from a hammer will easily break up large blocks of this material. When this is broken and graded for concrete every piece of the broken material has the same characteristic in greater or less degree. This can be readily seen in a road macadamized with slag. A road so made is infinitely more dusty than one treated with granite or hard limestone and is not nearly so durable. Three causes are responsible for this state: (1) Action of traffic; (2) variations in temperature; (3) constant wetting and drying.

When slag is made into concrete for building purposes we can perhaps eliminate the last of these factors and to some extent the second in such places where the concrete is not exposed to the action of the weather, while of course the first is non-existent in that particular form. There is, however, an equivalent to the first in shocks due to vibrations that in turn are due to many causes, such as wind pressure on a structure, machinery, passing traffic, etc. These causes are very apt to produce cleavage and disintegration of the slag unit at any time. When it occurs, the strength of the concrete depends entirely on the surrounding cement, etc., and the cross-sectional area at a spot where such a piece of slag has become disintegrated is reduced by the cross-sectional area of that piece.

It is obvious from the foregoing remarks that a test block taken in the usual way and allowed to mature and then tested has no practical value. Indeed, actual practice is the only test for the conditions which militate against the slag units, which conditions are ever present and the failure of individual items may occur after years.

Natural stone not having the internal strains that occur in slag is not susceptible to change until its cleavage strain is reached and this point is a known factor.

There are many uses to which slag concrete can be adapted where the above conditions are at a minimum, but in all cases a higher coefficient of safety should be employed where it is proposed to use this material.

The variations in the quality of slag are very considerable and cannot be neglected.

NOTES ON CHILLED CAST-IRON.

In the Proceedings for 1914 of the American Society for Testing Materials Mr. E. B. Tilt describes a detailed examination of the variations in the properties of cast-iron according to its composition and the effect of chilling with a view to determining the most suitable material for car wheels. Wheels were tested by allowing weights to fall repeatedly from definite heights until a flange was broken off, and also by submitting them to a rapid temperature change. The nature of the defects to which the wheels are subject is discussed. Satisfactory metal can be obtained both from charcoal pig iron and from material prepared from coke pig iron, steel scrap, and ferro-manganese. The carbon content should not exceed 3.5 per cent. The metal was found to be brittle in proportion to the degree of chilling.

FUEL CONSUMPTION ON RAILWAYS.

The volume of fuel consumed by the locomotives operating on Canadian railways, and the cost thereof, have been computed by the Department of Railways and Canals, Canada, to be as follows since 1907:—

	Tons.	Cost.
1907	5,608,954	$15,137,504
1908	5,970,791	17,718,468
1909	6,832,108	17,544,449
1910	6,252,054	18,570,393
1911	6,800,648	20,182,193
1912	7,783,736	24,160,823
1913	9,263,984	28,426,355
1914	8,547,675	26,710,758

ELECTRIC RAILWAY MILEAGE IN CANADA.

The Department of Railways and Canals, Canada, publish the following returns showing the operative mileage in 1914 and in the five preceding years of electric railways in Canada:—

Length of tracks.	1909. Miles.	1910. Miles.	1911. Miles.	1912. Miles.	1913. Miles.	1914. Miles.
Length of first main track	988.97	1,049.07	1,223.73	1,308.17	1,356.63	1,560.82
Length of second main track	215.05	242.39	259.74	294.50	371.14	338.91
Total length of main track	1,204.02	1,291.46	1,483.47	1,602.67	1,727.77	1,899.73
Length of sidings and turnouts	83.62	91.39	103.54	120.84	141.86	152.71
Total, computed as single track	1,287.65	1,382.85	1,587.01	1,723.51	1,869.63	2,052.44

It will be observed that there was an addition to first main track of 204.19 miles as compared with 1913.

CARE OF COUNTRY ROADS.

A VERY useful set of instructions on the care of country roads is given by Hiram Donkin, C.E., Road Commissioner for the Province of Nova Scotia, in his recent report. They are all dependent on the fact that water is the one great foe to good roads of any kind except sand, and sand roads can scarcely be classed with good roads. Road men are advised to keep ruts and pitch holes filled in order to force the water to run quickly into the ditches, always with the same kind of material as that of which the road is composed. Keep weeds, grass and brush cut away from the sides to permit rapid drying and remove all other obstructions. Keep the ditches and culverts free from all obstructions, to permit the water to run away before it has time to soak into the foundation of the road and soften it. Keep loose stones, etc., off the surface.

In the following list he gives briefly the elementary principles of road-making, as applicable to the roads of Nova Scotia, and the systems under which they are maintained.

1. Every good road has two essential features: (*a*) a thoroughly dry foundation; (*b*) a smooth, hard, waterproof surface covering.

2. The foundation is the natural sub-soil, the "dirt road," which must be kept dry by good drainage.

3. The surface covering is generally a coating of gravel or broken stone, which should be put on the road in such a way that it will not, in wet weather, be churned up and mixed with the earth beneath. That is, it should form a distinct covering.

4. To accomplish this: (*a*) the gravel or broken stone should be clean; (*b*) the roads should be crowned or rounded in the centre so as to shed the water to the open drains; (*c*) ruts should not be allowed to form, as they prevent water from passing to the open drains; (*d*) the open drains should have a sufficient fall, and free outlet so that the water will not stand in them but will be carried away immediately; (*e*) tile under-drains should be laid wherever the open drains are not sufficient, or cannot be reasonably made sufficient, and where the ground has a moist or wet appearance with a tendency to absorb the gravel and rut readily. By this means the foundation is made dry.

5. Do not leave the gravel or stone just as it drops from the wagon, but spread it so that travel will at once pass over and consolidate it before the fall rains commence.

6. Keep the road metal raked or scraped into the wheel or horse tracks until consolidated.

7. Ditch road before putting on gravel or stone. Do not use soft worn-out earth and sods in the road bed under a coat of gravel or stone.

8. A fair crown for gravel roads on level ground is 1½ inches of rise to each foot of width from the side to the centre.

9. The road on hills should have a greater crown than on level ground, otherwise the water will follow the wheel tracks and create deep ruts instead of passing to the side drains. Two inches to the foot from the side to centre will be sufficient.

10. Repair old gravel roads which have a hard surface but too little crown, and which have high, square shoulders, by cutting off the shoulders, turning the material outward and placing new gravel or stone in the centre. Do not cover the old earth foundation with the mixture of earth, sod, and fine gravel of which the shoulders are composed. The shoulders can be most easily cut off by means of a grading machine.

11. A width of twenty-four feet between ditches will meet most conditions, with central ten feet gravelled or metalled with broken stone.

12. Wherever water stands on the roadway or by the roadside, or wherever the ground remains moist or is swampy in the spring and fall, better drainage is needed.

13. Look over the road after heavy rains and during spring freshets. The work of a few minutes in freeing drains from obstruction or diverting a current of water into a proper channel may become the work of days if neglected.

14. Surface water should be disposed of in small quantities; great accumulations are hard to handle and are destructive. Obtain outlets into natural water courses as often as possible.

15. Tile should be used where foundation cannot be properly drained with well made ditches.

16. Give culverts a good fall and free outlet so that water will not freeze in them.

17. In taking gravel from the pit, see that precautions are taken to draw only clean material. Do not let the face of the pit be scraped down, mixing clay and the turf with good gravel. All stone over 1½ in. diameter should be rejected.

18. Gravel which retains a perpendicular face in the pit in the spring, and shows no trace of slipping, is generally fit for use on the road without treatment. Dirty gravel should be screened.

19. When surfacing a road with gravel use carts with wide tires, 4 in. or over. Then, by commencing the work at the end nearest the pit and driving over all the gravelled surface with the loaded and empty carts, a good smooth surface will be the result, and not cut up in grooves, as is usually done. If the gravel is coarse and will not pack down readily, do not put it on in the spring. It will not get hard until the fall rains come; therefore, whenever a coarse gravel is used, do the work in the fall. The fall and spring rains will consolidate it and will produce a good hard road for the coming summer.

20. When an old worn-out road has been re-built and put in proper condition, it is true economy to give it constant attention, by using the drag or grader whenever needed. The cost per mile will be small and such attention will add greatly to the life of the road.

21. Another important matter is the proper care of the drains. This work is usually done in the spring, but while it is always in order to keep the drains open, the fall is the more important time to look after them. After the leaves have fallen and the grass is done growing, a little work then in clearing out these obstructions will allow the water to flow freely. In the fall and spring we have the greatest amount of rain, therefore the greatest need of good open ditches to allow this water to pass quickly away. If this is done, the frost of winter will do less damage to the roads.

22. Plan and lay out all of the work before calling out the men.

23. When preparing plans keep the work of succeeding years in view.

24. Call out for each day only such number of men and teams as can be properly directed.

25. In laying out the work, estimate on a full day's work from each man and see that it is performed. Specify the number of loads of gravel to constitute a day's work. Every wagon box should hold a quarter of a cord.

26. Make early arrangements for having on the road when required, and in good repair, all implements and tools to be used in the performance of labor.

27. Do all work with a view to permanency.

A study of the foregoing will point to three main faults commonly to be found in the roads. These are, bad drainage, poor gravel, and improper methods of placing the metal (gravel or broken stone) on the roads. It is doubtful if any of these evils can be fully remedied. To overcome bad drainage it is essential that there should be a constant system of repairs keeping the road well crowned, free from ruts, the gravel or broken stone raked into place, and the side drains and culverts open and without stoppages. The use of poor road metal (gravel or stone) is likely to continue until there is someone who, by experience, is able to select the best material available, and is provided with proper implements to screen and crush it when necessary. Nor can we ever provide the means necessary for putting metal on the roads in the right way without first preparing the road by the use of modern machinery, then properly spreading the metal and rolling it.

Improving Sand Roads.—A degree of moisture is necessary in the summer season in keeping sand roads or roads over sandy ground in their best condition. Drains are necessary, but they should not be deeper than will provide suitable drainage in spring and fall. Underdrains, if they are needed at all, should be shallow.

If sand is deep in dry summer weather, a portion of clay mixed with it helps to harden the road and make the sand less objectionable. This treatment is also valuable where a coating of gravel is to be used, as it tends to hold the gravel on the surface. In no case should a light coat of gravel be used on a bad sandy road, as it will soon become churned up with the sand, and the road will be as bad as before the gravel was put on.

One of the best and cheapest methods of maintaining a clay or gravel road is to use the road drag. It is one of the most important single factors in the betterment of our dirt roads. The principle on which it works depends upon the fact that clay which has been thoroughly mixed with water will cake into a hard compact mass on drying. The drag is used just after a rain when the ground is full of water and it works up about one-half inch of well puddled clay toward the centre of the road. The front log is shod with steel about 4 inches wide and ⅜ inch thick, and may project ½ inch below the wood at the ditch end of the steel and come flush up to the wood at the other end of the steel. This will cut away the grass and material of the berm or shoulder and carry it towards the centre. The back plank, not being shod, acts as a sort of packer to press down the puddled surface left by the front plank. The ruts are thus filled with wet packed material which is further packed by the wheels and immensely baked on drying into a hard compact mass. The length of chain which is regulated by hooking it backward and forward gives the required angle to carry in the material. Length of chain regulates the hold taken on the earth. To make the chain longer is equivalent to putting weight on the drag. If the drag is heavy, shorten the chain. To remove much dirt or cut small weeds, hitch the hook close to the ditch end of the drag as nearly on the end of the front slab as is safe. Drive very slowly when thus hitched.

Position of Driver on Drag.—In a soft spot stand on rear slab. On a hard spot stand on front slab and drive slowly. If the drag clogs with straw, weeds, sods or mud, step to a point as far as you can get from the low ditch end of the drag. To drop dirt in a low place step quickly from ditch end to other extreme. To fill a low place or mud hole nicely it is the severest test of skill of the drag. When the machine grader is used in setting up the road after each rain the drag should go over it several times to keep the wheel tracks filled in and the water pressed out. Unless the material placed upon the road bed by the grader is properly "dragged" or "rolled" the more mud will have to be contended with during the fall rains. Consequently the greater the depth of material so placed and not treated in the way indicated, the greater the injury to the road bed. Heavy teams cut it down to the hard surface and make it almost impassable.

Road Grader and Its Uses.—This is one of the greatest labor-saving machines for road construction and repair yet invented. The blade can be set at any desirable angle to bring earth up from the sides to the centre, and also to level the surface of the road and give it a smooth even crown. It will do this work better than it can possible be done by men with picks and shovels.

The value of the work done with the road machine depends entirely on the skill of the operator. An experienced man can do better work and at much less cost than one who is inexperienced. When operated by men who do not know the principles of road building, a vast amount of injury is done by the misuse of these machines, particularly in cases where long stretches of old gravel roads have been covered with grass and earth drawn in from the shoulders.

In shaping up an old worn-out road, first stake out the width desired, then dispose of away from the road bed all worthless material, such as sods, bushes and worn-out material. Then, with the road machine, commence outside at the ditch, and work in towards the centre. In this way the injurious habit of making deep cuts too near the centre of the road and then filling them up with soft earth brought in from the sides, will be avoided. The result will be a better, harder road bed, at much less cost.

If the ground is hard and stony, it is best to use a plow along where the ditches are to be made, before using the grader, being careful to take out all the stones and boulders which will interfere with the proper working of the road machine. This will make a better road and will not injure the machine, as it would if using it without first using the plow and taking out the boulders.

Stony Roads.—In a boulder soil the points of large and small stones project. Wheels strike these "round heads," wearing out the tires, axles and turning gear. The constant jolting increases the work of the horse as, besides the shock of wheels striking, there is always a little hill to pull over. Horses' shoes break also and their hoofs are injured.

Remedy: Pick off loose stones, throwing them beyond side ditches. Sight out, say, 300 paces along the centre of road with pickets. If there are bends, make them sweeping.

Mark on convenient trees, posts, etc., alongside road, the distance to picket line in Roman numerals; this will establish the middle of road year after year.

A good roadway 6 or 8 feet wide will be enough to help rigs and horses at first.

Drive in small plugs 3 feet or 4 feet on each side of picket line to mark edge line of work. Concentrate attention to taking stones out of this strip only.

Use a pick or a sledge of about 8 pounds weight. Strike the small stones first. One blow will likely loosen them enough to bar out. Use a stone or block to heel the pry upon.

When stone is out, throw or roll it across roadway completely clear of side ditch.

Time will only be lost trying to dig out big boulders. Explosives are cheaper.

Drill a one-inch hole, four to six inches deep, with a hand drill. Fill it with 60 per cent., or 40 per cent., dynamite, the latter costs less, but the former is stronger and surer.

Cut fuse 3 feet long, which allows a minute for getting to a safe distance. Insert end of fuse into detonator cap very carefully. Do not force fuse into end of cap, and be careful not to punch or strike end of cap. Pinch open end of cap tight on to fuse to prevent its falling off.

With a small stick, the size of a lead pencil, make a hole in the explosive of a couple of inches deep. Insert cap with fuse attached, then holding fuse, cover it with earth to prevent drawing out. Place a ten-pound stone on top of earth, light fuse and run away. Another method is to churn a hole with a bar beneath the flattest part of boulder. Place fuse cap in a cartridge so it won't come out, then carefully press cartridge into the hole with a small wooden rammer and cover with earth.

Keep explosives and caps apart. Only insert fuse and cap when all is ready.

Do not pick cap with knife or stick. Iron rammers must not be used; have a small stick instead. Frozen cartridges often miss fire. To thaw, place in a tin can which is surrounded with warm water, but not on stove. Never roast cartridges on a stove, or beside a camp fire, or directly exposed to heat that would burn leather boots.

In case of a "miss fire" never unload hole, but brush away earth and place new cartridge with fuse and cap in it. This will explode the first one when fired.

Employ an experienced man and, wherever economical, fire at noon, or after six. When the stone is taken out the hole should be filled with the best soil obtainable. Earth from road surface is much better than sod and mould.

Pack filling into holes with a wooden rammer.

Where reefs of solid rock are met with, drill with hand drill and shoot like a large boulder. Enough can often be broken off with sledge. The frost has no lifting effect on solid rock.

Side ditches obstructed by boulders or reefs of rock are useless. A continuous water channel must be blasted out.

In springtime the stones are heaved up and loosened, so this is the best season to take them out.

Gravel spread over stones is washed away by the rain and frost heaves the stones through the covering; therefore take out stones before gravelling.

Crown road surface 1½ inches per foot from centre to side. On hill roads crown two inches per foot to more quickly shed the water into side ditches.

Make outlets from side ditches as often as possible to get rid of water before it gains strength in sudden rain storms.

If a covering of stone is used, no stone should be larger than would pass a 2-inch ring, otherwise a rough, uneven surface will result.

EXTENSION OF SEWAGE DISPOSAL SYSTEM REQUIRED AT BERLIN, ONT.

The city of Berlin, Ont., has been advised by the Provincial Board of Health that it must take steps before November 10th next, to abate the nuisances which its overworked sewage disposal system has occasioned to those living in the vicinity. The present plant was completed in1906 and its design was based upon the report and recommendation of Dr. J. A. Amyot, submitted in 1902, at a time when the flow amounted to 414,000 gallons. The plant was designed for a capacity of 650,000 gallons, but the community had grown to such an extent in the 4-year interval between the presentation of the report and the construction of the plant that, when put into service, it was required to take care of a flow of 680,000 gallons. The present flow is estimated to be about 2,000,000 gallons, but since 1906 the only additions to the plant have been three acres of sewage beds, increasing the previous capacity by about 125,000 gallons. The expenditure to date on the plant has been about $110,000.

The recent requirement, submitted by Dr. J. W. S. McCullough, Chief Inspector of the Provincial Board of Health, comes just at a time when the city council had favorably considered the addition of a number of sewage beds this summer. There are 26 acres of sewage beds at present, and it is just a question whether this area should be sufficiently increased to adequately take care of the increased flow, or whether consideration should be given at this stage to other methods of sewage disposal. This is a point that requires immediate decision, in view of the necessary alterations or extensions this summer. A committee has been appointed to confer with the public health authorities in this regard, and to reach a definite conclusion before making further expenditures.

The plant, as recommended in 1902, was one of the most complete of its kind then in existence, and the Government contributed $4,000 toward the cost of its construction. It was not built, however, until 1906, at which stage the requirements equalled or exceeded the capacity of the plant. Since then inadequate provision has been made for the increasing amount of sewage created by the numerous large industries and the growth of the city. The result has been that the beds have been overworked, and raw sewage, it is alleged, has been permitted to empty into Schneider's Creek and pollute the stream. The Waterloo Township Board of Health entered complaint. Inspection was made by Mr. F. A. Dallyn, C.E., engineer to the Provincial Board of Health, who reported that the present system was inadequate, and suggested that some other method of disposing of sewage might well be considered, in view of the large area now devoted to sewage disposal, and the great addition of area that would be necessary if the present system were adhered to.

Broken stone, as an aggregate for concrete, should be nearly cubical in form, as thin, flat particles will not pack well. The shape of the fragments has an important effect on the proportion of voids in the mass.

In placing concrete in floor slabs, girders and beams, the work should, if possible, be carried along in a straight line from the section of the building which is being concreted. Unless adjoining masses of concrete of different depths, like adjacent girders and slabs, have the puddling or ramming operation carried down as thoroughly through one as the other, initial setting cracks are likely to form between the masses of different depths.

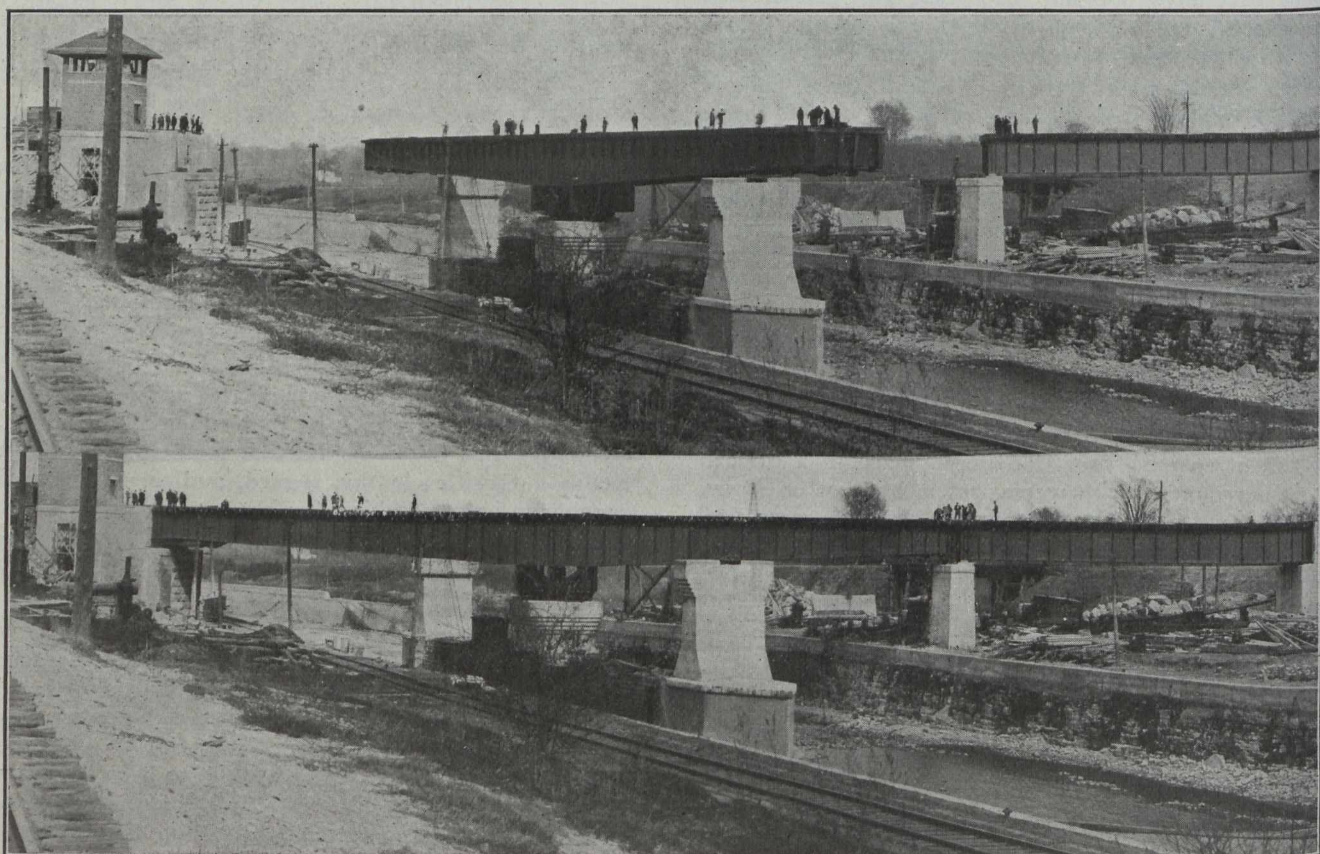
C.P.R. BRIDGE OVER LACHINE CANAL.

On April 16th a new electrically operated double-track swing bridge over the Lachine Canal was formally opened for traffic by the Canadian Pacific Railway Co. The accompanying photographs illustrate the new structure in its opened and closed positions, the bridge being operated from the tower shown at the left. There are a number of interesting features connected with the design and with the rapid construction of this bridge which the following paragraphs will briefly point out.

The bridge is a part of the double tracking system of the C.P.R. between Montreal and Brigham Junction, and replaces the only single-track structure which remained last fall on the route between these points, and the adjoining roadway which is a continuation of St. Patrick Street, Montreal. This latter bridge admits also of the running of a track along the south bank of the canal, if found necessary in future.

As stated, the new bridge accommodates two tracks. The design called for four deck plate girders with the result that while the old structure was being demolished and the new one erected it was possible to carry on operations without interference with the existing traffic. Two girders were erected on the upstream side of the old bridge, sufficient to carry the traffic while the downstream side was being altered. The other two girders were then erected and connected up. This method saved the building of a temporary structure across the canal.

The new bridge is operated by electricity, the power being carried by under-water cables under the canal to the



New C.P.R. Double-track Swing Bridge Over the Lachine Canal, as Seen in Open and Closed Positions.

which occasioned slight but numerous delays owing to convergent tracks at the bridge approaches. The old bridge was of lattice truss construction. The new design provided a deck plate girder bridge arranged so as to utilize the pivot pier of the old structure without decreasing the width of waterway for traffic on the canal over which it passes.

This plate girder swing span is stated to be the longest plate girder span of its kind in existence. It is 239 ft. 7 ins. in length. The girder depth is 13 ft. 6½ ins. at the centre pivot, diminishing to 8 ft. ½ in. at the ends, measured from back to back of flange angles. The weight of the swing span is about 615 tons, the four girders, each of which weighs 112 tons, being shipped in three pieces by the builders, the Dominion Bridge Co., and lowered into place by derricks. At the south end of the bridge a 90-ft. span, weighing about 143 tons, replaces an old 40-ft. deck plate girder span that accommodated centre pier, and there supplied through duplex 30 h.p. motors controlled from the operator's fireproof house on the north bank of the canal, where a special 30 h.p. motor is kept on hand for emergencies. From the time that the railway traffic is closed till the moment when the waterway is open for steamship traffic is a period of 70 seconds.

The structure is protected by the most modern interlocking machinery, so as to make it impossible for a train to approach the bridge before it is properly closed and safely locked. In addition, it is impossible for the operator to open the bridge for canal traffic until all railway traffic is stopped at a safe distance from the bridge—all of these operations being carried out from the signal tower, which commands a view up and down the canal even when trains are passing over the bridge.

The structure is also provided with a system of lights for the protection of shipping on the canal, and gives a much clearer view along the track than formerly, as there is no overhead lattice work projecting above the rail level.

An interesting feature of the undertaking is the speed with which the structure was erected. Work on the substructure was commenced on December 1st, 1914. It included the demolishment of the old single-track abutments, the building of a new double-track abutment, the widening of the earth embankment, the extension of two piers, one of which entailed considerable subaqueous work and bonding into the old stonework, and the extension of the old north abutment to accommodate the double track and also to act as the lower story for the operator's house. The bridge seats were ready to receive the steel girders on February 8th, and since that time the erection of steel and completion of masonry has been accomplished with such speed that the double tracking was ready for service last week.

The total cost of the new structure amounted to $233,000.

The bridge was designed and erected under the direction of Mr. P. B. Morley, Engineer of Bridges for the Canadian Pacific Railway Company. The extensions to the superstructure were carried out by the John S. Metcalf Company, and the steel work was manufactured and erected by the Dominion Bridge Company.

USE AND PRODUCTION OF CANADIAN MICA.

Mica finds a number of uses in the electrical industry on account of its dielectric strength, the ease with which it may be split into thin, flexible sheets, and in some cases on account of its transparency.

The following is a partial list of its uses in this industry, as given by Howells Fréchette, M.Sc., in a recent Department of Mines report on non-metallic minerals used in Canadian industries: Motor and dynamo winding—commutator ring and segment insulators; electric lights—discs for interior insulation of light sockets, covers for fuse boxes; telephones—long, narrow slips on which fuses are mounted; electric heaters—pieces on which the resistance wire is wound, forming the heating elements of toasters, sad irons, etc., etc., spark plugs —the insulation of some gasoline engine spark plugs is made of mica.

The mica is furnished to the consumers split to the necessary thinness and sometimes cut to shape. It must be free from electro-conductive inclusions and in perfect sheets.

For commutator insulation, amber mica is best, as it wears, under the action of brushes, at the same rate as the copper which composes the segments of the commutator. It must be free not only from electro-conductive inclusions, but also from quartz and garnet.

For electrical purposes micanite is being extensively used. It is made by cementing together very thin, small sheets of mica into large sheets. For this purpose much of the small mica is used, which otherwise would be discarded as useless or else ground to powder.

Finely ground mica, free from quartz and garnet, is mixed with a heavy grease for lubricating purposes.

Coarsely ground mica is used in the surfacing of certain prepared roofings. Cheapness is the main consideration in selecting this material. Any variety of mica may be used.

In addition to the above uses there are many others of lesser importance.

The price of mica is liable to great fluctuation, according to the demands of the market. The following prices are only approximate: Sheet mica, 1 inch by 1 inch, 7 cents; 5 inches by 8 inches, $2 per pound; ground white mica for wall paper manufacturing, $70 to $85 per ton; roofing mica, $5 per ton.

Amount of mica used in the manufacturing industries, as reported by the consumers:—

Location.	No. of firms reporting consumption.	Domestic. Tons.	Imported. Tons.
Maritime Provinces ..	6	215	175
Quebec	5	1,315	——
Ontario	41	37,205	27,986
Prairie Provinces	—	——	——
British Columbia	1	——	10
Canada (Total)	53	38,735	28,171

Amount of ground mica used in the manufacturing industries as reported by the consumers:—

Location.	No. of firms reporting consumption.	Domestic. Tons.	Imported. Tons.
Maritime Provinces ..	—	—	—
Quebec	2	10	50
Ontario	5	45¼	50
Prairie Provinces ...	—	—	—
British Columbia	—	—	—
Canada (Total)	7	55¼	100

THE HORSE-POWER OF A CANNON.

A matter of speculation likely to interest engineers is the enormous energy or horse-power developed in the breech of a big modern cannon discharging a projectile weighing, say, 1,850 lbs., at a velocity of 2,000 ft. per sec., when $W = 1{,}850$ lbs.; $V = 2{,}000$ ft.; and $g = 32.16$.

The formula $$E = \frac{WV^2}{2g}$$ gives 110,000,000 ft.-lb.

This amount of work, according to "Power," must be accomplished during the projectile's travel in the gun, probably not over 1/100 of a second. Therefore,

$$\frac{110{,}000{,}000 \times 100}{550} = 20{,}000{,}000 \text{ h.p.},$$

or in another way, the vertical distance a body would have to fall to attain a velocity of 2,000 ft. per sec. at a uniform rate of acceleration due to gravity would be about 60,000 ft. A projectile weighing 1,850 lbs., falling this distance would generate

$$1{,}850 \times 60{,}000 = 111{,}000{,}000 \text{ ft.-lb. of energy.}$$

The same amount of energy would be required to produce the same velocity at the muzzle of a cannon and represent in horse-power

$$111{,}000{,}000 \div 550 = 200{,}000 + \text{h.p.}$$

if done in one second; but the actual time is probably about as the length of the gun is to the velocity, or 20 to 2,000, or 1/100 of a second. The energy exerted for the shorter period must be 100 times greater, or equal to 20,000,000 h.p.

The average consumption of fuel in all the central stations of New York City is at the rate of 3.3 pounds per kilowatt-hour, inclusive of all standby and other losses. The average consumption of fuel by isolated plants is at the rate of not less than 10 pounds of coal per kilowatt-hour, or three times the average rate of central-station operation.

MOUNTAIN INCLINE AT HAMILTON, ONT.

THE Hamilton Mountain Park Company, Limited, of Hamilton, Canada, recently installed a new electric hoist, with interesting and novel features, to operate their incline railway which gives access to the large tract of land they have acquired at the top of the mountain and to the fertile country beyond. The "Mountain," as it is called, is really the Niagara escarpment, the steep bluffs behind Hamilton being a prolongation of the heights at Queenston, over which the Niagara River originally flowed, before cutting back the gorge to the present falls. The difference in elevation between the general level of the city and the plateau back of the bluffs is 325 feet, and as the roads leading up the bluffs are few and necessarily steep, the incline in question does a large business in transporting passengers, automobiles, teams, etc. The original steam hoist used for this purpose became inadequate to handle safely and quickly the rapidly increasing traffic, resulting in the installation of a modern system well equipped with numerous automatic safety devices. The contract for the complete equipment was taken by the Canadian General Electric Co., Limited.

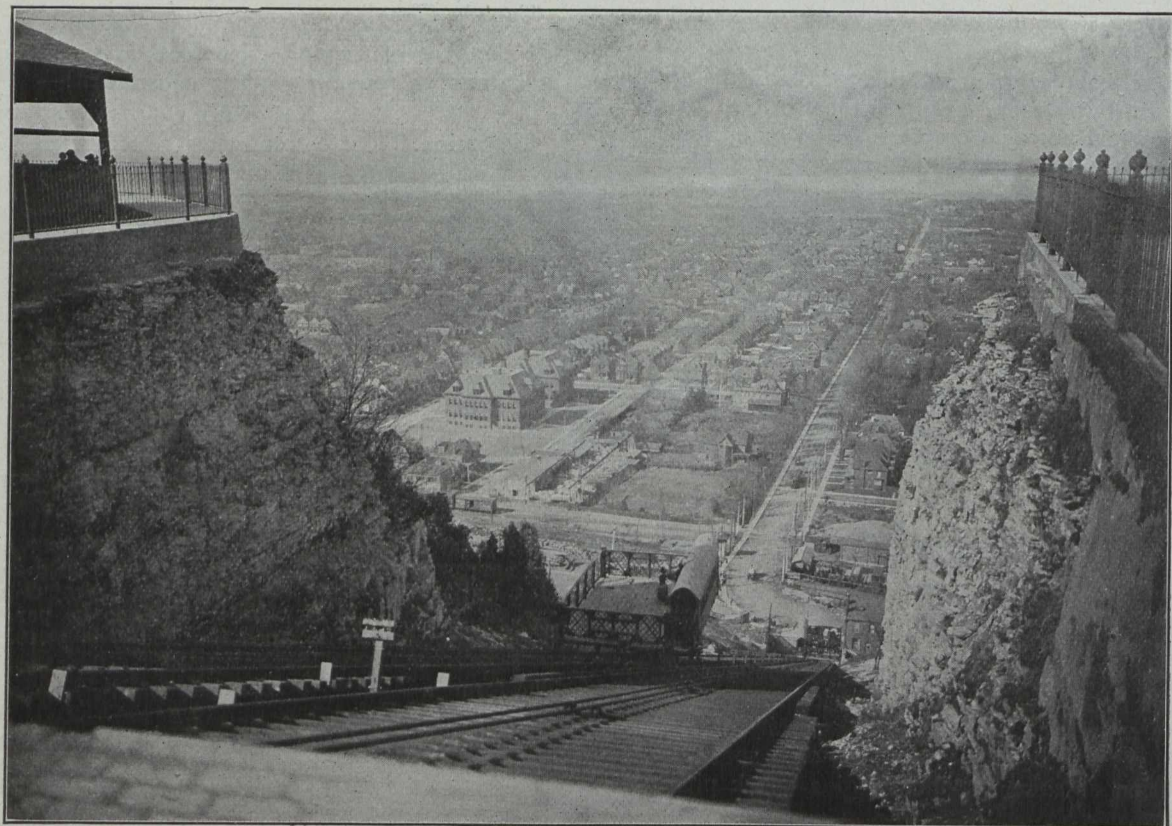


Fig. 1.—View of Incline Railway in Operation.

Electric Hoist.—A special double fixed-drum, double-geared electric incline hoist, built by the Lidgerwood Mfg. Co., New York, represented by Canadian Allis-Chalmers, Limited, operates two cars in balance on an incline 800 ft. long with a grade of 40.27%. Each car weighs 30,000 lbs. and runs on tracks having a gauge of 12 ft. 1½ in., the centre to centre of tracks being 20 ft. 3 in. The average load on the cars will be about 20,000 lbs., with a maximum load of 30,000 lbs., and the hoist arrangement is suitable for either hoisting the maximum load with empty car descending, or for lowering the maximum load with the empty car ascending.

The time required for making a single trip is 1½ minutes, and the rest period between trips 3 minutes. Attached to each car are two ropes of 1⅝-in. diam., each rope weighing 4.15 lbs. per ft. One of these ropes is used for hauling the car, and the other for the purpose of safety. The average rope speed during the run is 585 ft. per minute.

Incline Arrangement.—The hoist is located in a house 106 ft. from the knuckle between the incline and the level of the summit. The main rope from the right-hand car is wound over the top of the right-hand hoist drum. The main rope from the left-hand car is wound underneath the left-hand hoist drum. The safety rope from the right-hand car is led over suitable deflecting sheaves to the top of the left-hand drum, and that from the left-hand car is wound over suitable deflecting sheaves to the bottom of the right-hand drum. Each of these sheaves is 7 ft. in diam. to the bottom of the rope groove and weighs 3,500 lbs. There are 4 head sheaves and 4 deflecting sheaves. The former are arranged vertically so as to carry the hoist ropes and safety ropes in a direct line from the cars; the deflecting sheaves are placed horizontally at such an angle that the rope will be led in a direct line to either the top or bottom of the hoist drums, as, the case may be. Floating sheaves are also furnished to guide the ropes and are placed in the rope tunnels between the head sheaves and the hoist drums. The reason for reeving the safety ropes as outlined above is that in case of an accident to the left-hand side of the hoist the safety rope on the left-hand car would take care of it properly, being wound on the right-hand drum; the same thing would apply if the other drum of the hoist should become disabled; that is, the main ropes and the safety ropes from each car lead to opposite drums. Further advantage is gained by the fact that each drum is equipped with an independent double-acting brake, and in case either of the main ropes should break, the safety rope will hold the cars. Furthermore, the safety rope, if called upon to take the load, will be controlled by all the automatic brake features in exactly the same manner as when the load is being handled by the main ropes. In actual operation the length of the safety ropes will be slightly more than that of the main hoist ropes, thereby relieving the safety ropes of any hoist stresses other than those required to keep the ropes themselves in motion.

Operation and Safety Appliances.—The operator's cabin is fitted with one electric control and two hand-brake levers. The levers will not be used ordinarily as the hoist is equipped with solenoid brakes operating on the motor shaft. The hand-brakes, therefore, need only be used for the locking of the cars at the top and bottom positions or for cases of emergency. In starting a run, the operator releases the drum post brakes by the hand-levers, puts his foot on the small foot pedal located at bottom of master controller, and by moving the handle of the controller to either the right or the left, as the case may be, the cars will start and will automatically accelerate to the normal

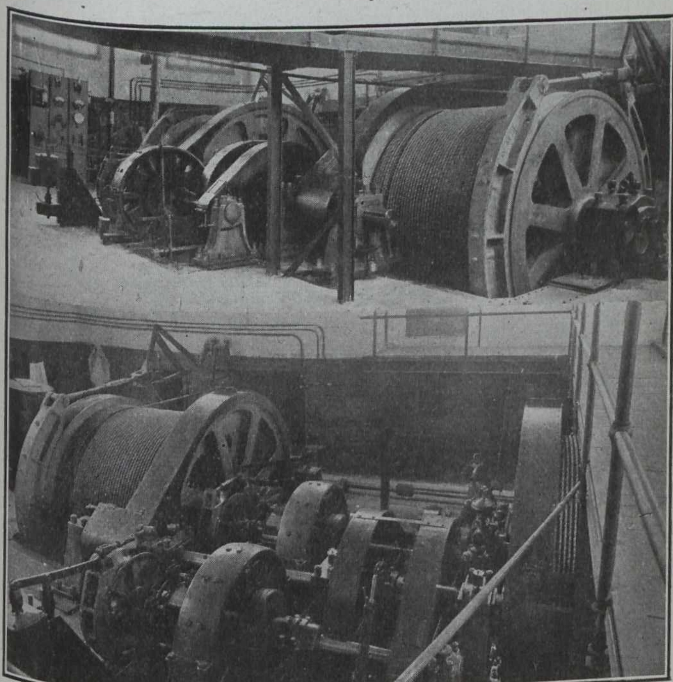


Fig. 2.—Interior of Power House. Top View Shows Geared Overwinding Safety Device on Drum Shaft and Solenoid Brake. Bottom View Shows Both Motors, Fly Ball, Speed Limit Device, Etc.

rope speed. At a predetermined point on the incline, the controller handle will be automatically turned to such a position that the speed will be cut down to 1/10 of the normal and finally be turned to the off position, thus setting the solenoid brakes and bringing the cars to rest. Should the operator become disabled during a run, he will of necessity remove his foot from the foot pedal, thereby cutting off the current, bringing the cars to rest. In order for the cars to move, the operator's foot must be on this pedal. In case the cars should stop short of their landing positions, due to the automatic overwinding mechanism, there are available two or three points on the controller so that the operator can bring them to their proper positions. Should the cars fail to stop, due to the fault of controller, an overwinding device is attached which will shut off the current and set the solenoid brakes. Should the speed of the cars exceed the normal by a predetermined amount an overspeeding device is so arranged that it will trip a weight of 570 lbs., which will set the drum post brakes. This overspeeding device or governor is of the fly ball type, and it will be caused to operate by an excessive speed, whether due to motor or a breakage of the hoist parts. The emergency weight may also be tripped manually from the cabin.

Shafts and Drums.—The drum shaft is a steel forging in two pieces, 12 in. in diam. Including the two sections, it is 32 ft. long and weighs 13,300 lbs. The intermediate shaft has been machined from a single steel forging and is 7 in. in diam. its entire length. It is 20 ft. long and weighs about 3,000 lbs.

There are two cast iron drums 96 in. in diam., 70-in. face and coil 800 ft. of 1⅝-in. rope, plus 3 holding coils at each end of one layer. These drums are made up in two sections, of barrel construction, and are bolted at one end to the post brake ring, and at the other end to the drum gear. The two sections composing each drum weigh each 8,350 lbs., which means a total weight of drum barrel for each drum of 16,700 lbs. Each of the drum gears is made of cast steel with cut involute teeth, and is of the double-arm wheel type, having eight arms reinforced by ribs forming an "H" section. The gear has 122 teeth of 1 D.P. and a face 12 in. in width, the pitch diameter being 122 in.

The intermediate gears are of cast steel with Herringbone teeth, cut. They have 113 teeth of 3 D.P. and a face 8 in. in width, being 56½ in. in pitch diameter. The intermediate pinions are of forged steel and have 22 teeth of 2 D.P., cut in the Herringbone type. They have a face of 8 in. in width and are 11 in. in pitch diameter.

Electrical Equipment.—Power is supplied in the form of 3-phase, 25-cycle, a.c., and for transforming this to d.c. a C.G.E. motor generator set has been installed of sufficient capacity to supply the average demand of the hoist, plus some surplus for charging the battery described below. The d.c. end of this machine is rated at 165 amp. continuously at 550 volts, the latter being the floating voltage of the battery. This generator is driven by a 2,200-volt induction motor. The generator end is designed with a special drooping characteristic by means of a reversed series field for the purpose of throwing load fluctuations on the battery. A small percentage of the load fluctuations falling on the machine will lower its voltage to such an extent that the battery must discharge and furnish the balance of the momentary demand. The regulation is, therefore, inherent in the design of the machine, and is entirely automatic.

The hoist is driven through two gear reductions, the total ratio of which is 29.84 to 1 by a General Electric 180-h.p., 500-volt, 475/585 r.p.m., d.c. motor, which is especially designed to stand such voltage variations as come from a storage battery when it is frequently charging and discharging. The motor is controlled by a magnetic contactor panel so that the motor may be controlled remotely from the operator. This system of control admits of the various protective devices to ensure against the cage operating at greater than a predetermined speed. To ensure a greater degree of continuity of service a reserve 180-h.p. motor and solenoid brake are provided. The machinery of the hoist is so constructed that in a very few moments one motor can be disconnected from the hoist and the other clutched in ready for service. The master controller is situated in the operator's cabin at the top of the incline.

Storage Battery.—The power plant has been supplemented by a storage battery built by the Electric Storage Battery Co., of Philadelphia. One of the objects of installing this was to reduce the maximum peaks due to the fluctuating load of the hoist, and thus reduce the power bills. Another object was to furnish current for operating the hoist if alternating current supply is interrupted.

The demand of the hoist motor when lifting a load of 7½ tons was estimated at 470 amp. for 10 sec. followed by a demand varying from 410 down to 230 amp. for a period of 80 sec., the voltage being approximately 550 volts. Under the conditions of maximum schedule it was estimated that the load period of 90 sec. would be followed by a 3-minute rest, thus providing for a trip of the hoist every 4½ min. For handling a 10-ton load, the maximum 10-second demand was estimated at 530 amp. followed by 80 sec. of load varying from 470 down to 310 amp. The hoist is designed to handle a 15-ton load occasionally, but this will not occur when the battery is handling the entire load with the power supply cut off. It is believed that hoisting a 7½-ton load every 4½ minutes will represent the average conditions during the hours of maximum traffic. The average load is 112 amp. on this basis.

The battery consists of 262 cells of the Tudor-box type. Each cell contains 11 plates, measuring approximately 11 in. x 10½ in., five of the plates being positive of the Tudor type and six of the plates being negative of the box type. The plates are supported in glass jars mounted on glass sand trays, the entire battery being installed on wooden racks. The capacity of this battery is 200 amp. for one hour on continuous discharge. For intermittent service extending over several hours the ampere-hour capacity will be somewhat greater and it is estimated that this battery will operate the hoist under the average load conditions cited above over 1¾ hours with the power supply entirely cut off; or if the schedule is reduced, so that the trips of the hoist are made less frequently, the hoist can probably be kept in operation for several hours.

Under normal conditions, with the motor generator supplying the average load, the battery does not become exhausted, but receives back sufficient charge during the period of rest between trips to make up for the discharge while the hoist is in operation. The battery, therefore, while relieving the motor-generator and power line of the severe load fluctuations is maintained at all times practically full and ready to supply the entire demand in case of interruption to the power supply.

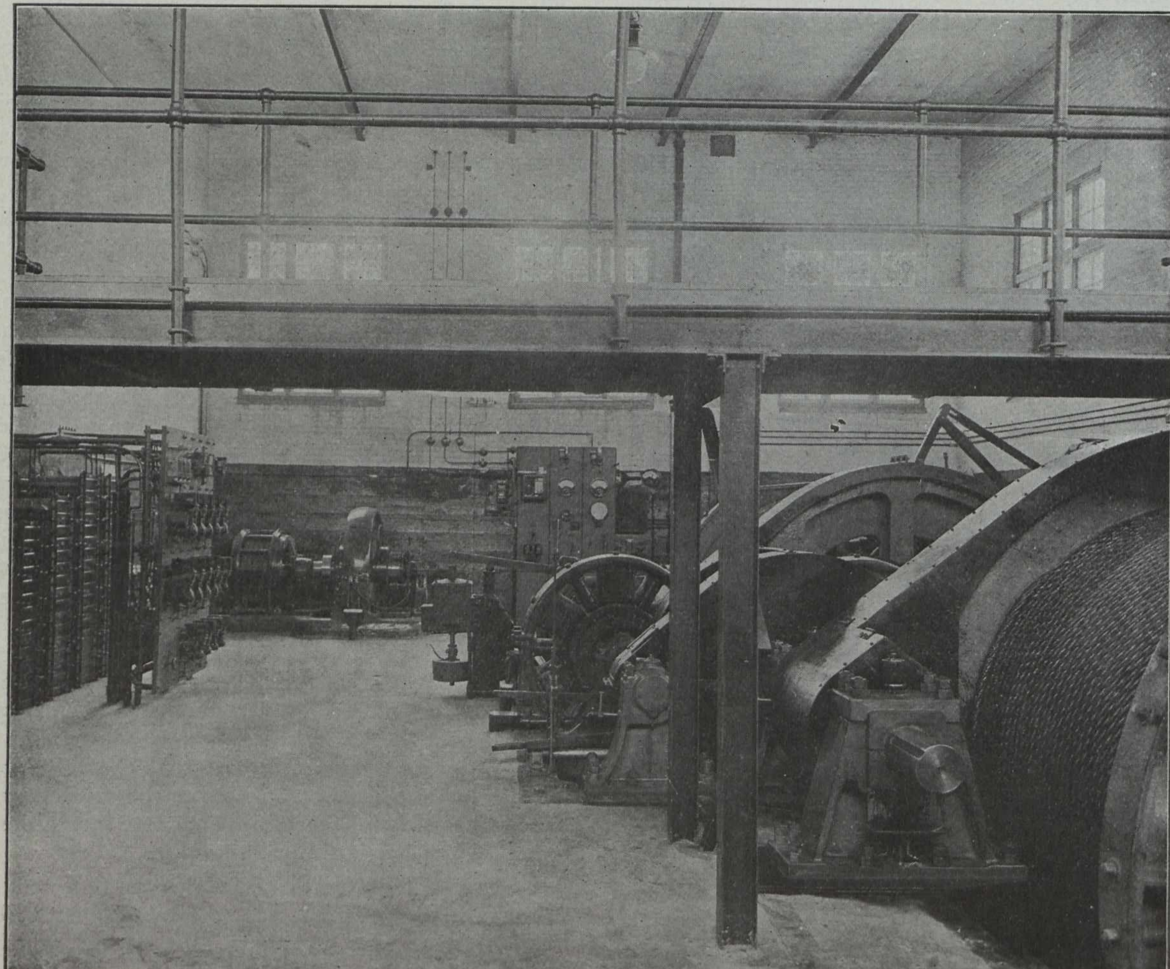


Fig. 3.—Interior Arrangement of Hoisting Machinery and Control Apparatus.

According to a recent report of the Department of Trade and Commerce, there is an immense demand throughout the British West Indies for galvanized iron sheets, both corrugated and plain. The corrugated iron sheets are used almost universally for roofing in the country and quite extensively in the towns for fences. On the estates not only the houses of the managers but all the barracks are roofed with corrugated iron. While some of the peasants have huts with thatched roofs, those that are able to build houses of a little better class often have them roofed with corrugated iron sheets. They stand the climate and protect against heavy tropical rains better than any other roofing.

Editorial

LAYING PAVEMENTS DOWN AND TEARING THEM UP AGAIN.

The detrimental effect upon pavements of being ripped up occasionally for the installation underground of water, sewer and surface drain laterals and connections, together with the unsightly patches by which the pavements are afterwards closed, have been the subject of considerable discussion among municipal officials and ratepayers. Many city councillors have waxed eloquent over it, and not a few poems have been invoked in the crusade against this procedure. Just how far the pursuit of economy warrants the laying of underground services before pavements are put down, is a problem with as many solutions as there are examples. Each case must be considered by itself.

In the campaign against the subsequent opening of street pavements there have been cities that have constructed laterals and connections that have little likelihood of being used for a number of years. In many cases, these have been subjected to danger from electrolytic action and there is little doubt that, after two or three years' disuse, considerable leakage will be developed in the water services, when put under pressure.

The city of Victoria has the matter under close consideration at the present time. Mr. C. H. Rust, city engineer, believes that the heavy cost of street paving works can be reduced by a modification of the practice in vogue of installing all underground services before the pavement is laid. Experience has shown that only a small percentage of the laterals installed in recent years are utilized, especially those opposite vacant property. In Victoria the increased cost of this work has not warranted the outlay, and Mr. Rust recommends that the laying of lateral services be omitted, except in downtown business districts. This does not apply to mains, of course, which should in any case be in before any pavements are laid.

Where the initial outlay for laterals proves a severe tax upon ratepayers and where many of these laterals may lie unused for years, the cost and annual interest thereon soon amount to a considerable sum. For example, in Victoria the cost of a heavy asphalt pavement, thirty feet in width, leaving out all laterals, and constructed in earth, is $6.20 per front foot; in rock, $8.90. The same pavement with lateral connections, in earth would cost $8 per front foot, and in rock $19.28. A light asphalt pavement, thirty feet in width, constructed in earth, without laterals, would cost $5.29; in rock, $7.10; while with laterals, the cost would be $7.98 in earth and $18.37 in rock. These figures include an allowance of 20 per cent. for interest, discount on debentures and contingencies.

While many cities have paid little attention to the placing of services prior to the paving of streets, and while many others at some time or other undertook to follow the plan and afterwards abandoned it, there should be some means of meeting the difficulty to the advantage of the city and the ratepayer as well. A patched pavement is a disagreeable sight, especially when the pavement is comparatively new. It bespeaks lack of forethought. Certainly there ought to be some plan whereby the property owners might be notified, when the new pavement is under contemplation, of the cost with and without the previous installation of services, and the opportunity given them, if they should desire, of having the lateral connections installed at their own expense before the service is put down. Ratepayers would undoubtedly see the economy in such an investment.

METALLURGY IN GREAT BRITAIN.

The manufacture of materials used in the metallurgical industry in Great Britain has made gigantic strides since the outbreak of the war. The necessity for replacing by British-made goods the German and Austrian supplies was immediately in evidence at the outbreak of hostilities, and little time was lost in conducting the industry on a more extensive scale. Spelter is now being made by quite a number of manufacturers. Light steel castings, which previously came from Germany, are being manufactured in England to a much greater extent than ever before, and several new electric furnaces have been installed. Professor Turner, of the Birmingham Metallurgical Society, observes in a recent interview that the chief interest now centres in the less common metals and their alloys, some of which have been almost exclusively manufactured in Germany.

Pure malleable nickel is now being made successfully in Birmingham. Three city firms are interested in the matter, and two of them have already met with considerable success. Cobalt is also being made locally on a considerable scale.

Magnesium is now being made in England on a small scale, and more is required. Tungsten manufacture was established near London before the war, and ductile filaments of pure tungsten for electric lamps has been made in largely increasing quantities since the German supply has been cut off; in fact, all the tungsten that the country requires for the purpose of high efficiency electric lamps may now be made in England.

Tungsten alloys for use in steelmaking are being produced in Sheffield; while pure molybdenum is made near London, and ferro-molybdenum, for steelmaking, in three other localities. The British Empire produces supplies of ores of both tungsten and molybdenum.

Ferro-chrome is of great importance in the manufacture of armour-piercing projectiles, and this alloy is now being made in Birmingham. Ferro-silicon and ferro-titanium are also being produced.

The thermit process is being used in the reduction of pure metals and in the working of copper and various alloys. Plated metals, made by rolling copper, etc., on iron or steel, were formerly almost exclusively obtained from Germany and Austria, but a decided advance in this direction has been recorded in England. The same applies to refractory materials of special quality and for particular purposes, which are now being manufactured chiefly in London and Sheffield and have almost fully replaced foreign supplies.

Referring again to Prof. Turner's remarks on the new chapter which has been started in British metallurgical work, it is stated that many of the English productions now replacing those previously supplied by Germany are quite as satisfactory and even cheaper—in some cases much cheaper—than similar supplies imported before the war.

ENGINEERS' LIBRARY

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CONTENTS.

BOOK REVIEWS.

The Panama Canal. By R. E. Bakenhus, S.B., H. S. Knapp, U.S.N., and E. R. Johnson, Ph.D., D.Sc. Published by John Wiley and Sons, New York City; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. 257 pages; 20 illustrations; 6 maps; size, 6½x9½ ins.; cloth. Price, $2.50 net.

(Reviewed by E. L. Cousins, B.A.Sc.)

This work comprises the history and construction of the canal and its relation to the navy, international law and commerce. It is divided into six parts. Part 1 is entirely of an historical nature; Part 2 covers the route—the design and construction; Part 3 deals with sanitation, costs of work, elements of success, etc. These three portions are written by Mr. R. E. Bakenhus, S.B. Part 4 deals with the relationship of the United States Navy to the Panama Canal, and Part 5 with the Panama Canal in connection with international law. These parts have been written by Captain H. S. Knapp, U.S.N. Part 6 deals with the commercial importance of the Panama Canal, and is written by Mr. Emory R. Johnson, Ph.D., Sc.D.

Part I.—Historical. Some 23 pages of the text are devoted to the historical spirit in regard to the history of the canal idea, which covers the spirit and development of the canal idea from 1269 up until the Spooner Law became effective in June, 1902, and following this the treaty with the Panama Government proclaimed in February, 1904, the time at which the United States took possession of the site and property. While this section is purely historical, the information is set forth in such a way that it makes extremely educational and interesting reading, and is more in the nature of a descriptive article than a review of historical facts. In addition to the purely historical situation, it covers in a general way the various types of construction and routes considered in the early stages of the projected canal idea and deals fully with the final recommendation in 1902 of the final route.

Part II.—Route, Design and Construction. The character and topography of the canal route and adjacent territory, as it was before any work was done, is clearly set forth, keeping in view all the time the route and canal as now built. It deals in a very interesting way with the discussions and differences as to choice of type of canal, that is, whether it would be a sea level or lock canal. Interesting information is also given as to the comparative data and estimates, together with actual costs of the work as carried out. That is, the original estimated costs of lock canal for 85-foot summit, estimated cost of sea level canal and the actual cost of the canal as built with the 85-foot summit. Also extracts from the comment of Secretary of War Taft on report of consulting engineers dealing with the majority and minority reports; also the essential portion of the decision of President Roosevelt in 1906 in favor of the lock canal.

A well deserved description, not heretofore published insofar as the reviewer knows, at least not in such detail, is given in connection with the Gatun Lake and its influence and relation to the American project. Gatun dam, which made Gatun Lake possible, and which is the key to the American canal scheme, is described in elaborate detail, also reasons governing the type of construction that was adopted for this dam. The Gatun spillway is also fully described, giving in detail all reasons for the site chosen and the type of construction adopted.

The most important part of the canal construction, that is, the Culebra Cut, is given in full detail as to how the work was handled and the detailed cost in connection with various portions of the work, class of material encountered, together with the amount and classification of explosives used.

Under the heading of "Geology and Slides" are given in considerable detail the class of material and formation that had to be handled and also deals in detail with the various slides and amount of same, and sets before one very clearly the great probability that the sea level canal might have been extremely impracticable, although probably not impossible to construct, on account of the fact that it would have necessitated going 85 feet deeper than has been done in connection with the construction of the canal, in which event no one can say how great the magnitude of the slides might have been with this type of construction. It covers the Miraflores Lake construction, the location of locks and the reason for changing the lower lock location from close to Balbora to the location as now adopted. The main cause for changing the location is a strategical and military viewpoint, together with foundation considerations.

The details in connection with the construction of the canal locks are clearly set forth and the manner in which the vessels are to be handled through the locks by lock operators instead of under their own steam, together with details of protection against accidents, also costs in connection with the construction. There is also set forth clearly the facts governing the length, draft, and breadth of the locks as decided upon. Detailed information is also given as to sea level sections and terminals and the control of water during construction period.

Part III.—Sanitation, Costs of Work, Etc. It covers in a general way the great care taken in connection with sanitation matters and makes the Panama Canal probably the most marked single example of any great undertaking up to the present time, of the intelligent and thorough application of principles of sanitation. Considerable information is also given in this portion of the work as to the cost of the work, together with the total expenditure to June 30th, 1913.

Part IV.—The Navy and the Panama Canal. Captain Knapp deals with the effect of the shortening of the route from New York to San Francisco by 8,000 miles, and the effect of the 9,000 miles shorter mileage from New Orleans to San Francisco than via Magellan, and its probable effect on future naval appropriations. Statements have been made publicly that the canal would double the effectiveness of the navy. These statements are disputed by Captain Knapp, and he clearly sets forth that while the canal will be a great military asset in times of war, it will not double the effectiveness of the navy, nor, in his judgment, do anything to nearly approach it. He clearly sets forth the effect of the canal and the benefit of naval concentration as being a great military advantage in time of war.

Some interesting information is given as to the saving of time, fuel and oil and the amount of saving in connection therewith by routing by way of the canal as compared with routes via Magellan.

Part V.—The Panama Canal in International Law. It first deals with the Panama Canal and International Law, the Suez Canal Treaty, and the Hay-Pauncefote Treaty and the Hay-Bunau Varilla (Panama) Treaty. These treaties are very fully set forth and to anyone interested in this phase of the question there is a lot of valuable information given. There is no doubt it entailed considerable research work and study in connection with same to place it in the manner in which it is set forth. Captain Knapp also gives in various instances his interpretation of various clauses of the treaties affecting the canal zone in times of war and peace.

Part VI.—Commercial Importance of the Panama Canal. Mr. Johnson clearly sets forth in this portion of the work the commercial importance of the canal or the assistance it will render the industry and trade of the United States and other countries, *i.e.*:

First: As to what effects the new route will have upon the length of time of boats on voyages.

Second: A conservative estimated volume of shipping, Foreign and American, International and Coastwise, that may be expected to use the canal.

Third: Estimating the probable influence which the Panama Canal will have upon freight rates by rail between the seaboard cities of the United States and by ocean carriers engaged in coastwise and foreign commerce.

Fourth: The saving to ocean carriers in fuel cost by using the Panama route.

Fifth: The relation of tolls to the traffic and the revenue of the canal.

Sixth: Consideration of the policy that, in his judgment, the Government should adhere to in the management of the canal, that it may best serve the welfare of the entire country.

This book is exceedingly well written by the various authors of the different portions, and apart from the interests of any one purely in engineering work, it is a book of considerable value and should be in every library on account of the fact that it combines history, engineering and construction, military aspects and the commercialism of one of the greatest works ever projected in the history of the world.

The Art of Estimating the Cost of Work. By William B. Ferguson, Naval Constructor, U.S.N. Published by The Engineering Magazine, New York City. First edition, 1915. 97 pages; numerous tables; 5½ x 8 ins.; cloth. Price, $1.00.

The author presents an explanation and discussion of a systematic collection of unit costs for ordinary estimating purposes, which he compiled from memoranda during four years' work of instructing and training members of the hull estimating and planning staff at a number of naval yards. He advocates the standardization of construction and repair work by unit operations which can be given definite time and cost values, thus permitting estimates to be made with an accuracy usually thought to be unattainable, and, as an effort in this direction, we believe the book will be welcomed by those engineers who are earnestly striving to reduce the art of estimating the cost of work to a more exact science.

By way of introduction, he defines the exact meaning of estimating; and, in view of the fact that in estimating and calculating probable costs (which must be done by comparison and experience) the estimator is bound to some standard of experience, he goes on to define a standard and to show its importance in the pursuit of practical application of data and knowledge by estimators.

The subdivisions of the work are as follows: The Art of Estimating; General Methods by Curves and Graphs; Practical Meaning of Curves; New Construction Work; Repair Work; Classification of Variable Conditions; Cost Data on New Construction; Piece Work Prices; Unstandardized Work; Symbolizing Labor Operations; Needs for Good Estimates; Planning and Estimating by Operations; Preparation and Use of Curves; Estimating Overhead Expense; The Use and Danger of Rough Estimates; Developing and Estimating Section.

The book is admittedly an incomplete treatise on the subject of planning and estimating in manufacturing work, but the examples, description and references to accepted methods will be found most useful.

Masonry as Applied to Civil Engineering. By F. Noel Taylor. Published by Constable & Co., Limited, London, W.C. First edition, 1915. 230 pages; 212 illustrations; 6 x 9 ins.; cloth. Price, $1.50 net.

This is a practical treatise on the design and construction of engineering works in stone and heavy concrete. It is adapted for the use of students as well as for those engaged in practical work. The subject is treated from a utilitarian rather than an artistic standpoint, and in this respect the work differs somewhat from many of its predecessors. Such a treatment involves a certain amount of theoretical consideration of a mathematical nature with respect to the strength and economy of structures. Mathematical formulas have been kept to a minimum, however, and are well counterbalanced by practical examples of a most instructive nature. The contents are as follows: Stones Used on Constructional Work; Labor on Stones and General Remarks on Masonry; Retaining

Walls and Earth Pressures; Dock, Quay, River, Canal and Seawalls; Masonry Dams; Bridges; Towers and Pillars; Monolithic and Block Concrete Construction; and Shoring and Underpinning.

The illustrations, although numerous, have been extremely well chosen and typify, in conjunction with the examples contained in the text, the characteristic features of English practice. Chapters to which particular attention may well be directed are those on Retaining Walls and Earth Pressures and Masonry Dams.

The treatise is well balanced considering its somewhat local nature. In a book of this kind, however, Canadian engineers would expect to see monolithic and block concrete construction dealt with in more than a general way, as it is here in thirteen pages of text. In this small space are covered, in addition to introductory remarks, questions of gravel, sand, cement, mixing, placing, waterproofing, caisson and culvert work.

Theory of Arches and Suspension Bridges. By Prof. J. Melan; translated from the German by Prof. D. B. Steinman, and published by the Myron C. Clark Publishing Co., Chicago. 292 pages of text, 6 pages of bibliography, 122 text figures and 3 folding plates; size, 6 x 9 ins.; cloth. Price, $3.00.

(Reviewed by David A. Molitor, C.E.)

The translation covers the first half of Part 5, Vol. II. of the Handbuch der Ingenieurwissenschaften, 3rd edition, 1906. The second half of Part 5, dealing with the construction of arches and suspension bridges, was not translated. This German handbook is a complete reference library on civil engineering, 6 parts (actually volumes) of which relate to bridges. The 4th edition, which appeared since 1904, comprises seven volumes on bridges.

There is a rather wide gap between the ordinary American text books on structures and Prof. Melan's work, which assumes the reader to be familiar with all the fundamental theorems and laws originated by Menabrea, Castigliano, Mohr, Maxwell, etc., and presupposes a usable knowledge of the higher mathematics and calculus.

The German engineer has this training and also has access to the whole handbook containing practically everything pertaining to bridges in theory and practice. The American engineer is, therefore, at some disadvantage in his efforts to use a special portion of a general treatise without being able to consult the whole work. To this extent at least, the translation must be unsatisfactory both to the translator and the reader.

For many years Prof. Melan's chapter on suspension bridges represented practically the only theoretic work dealing more or less exhaustively with that subject. It thus became very well known by all engineers who had anything to do with suspension bridges and to them this translation will no doubt be valuable.

However, during the last twenty-five years considerable progress has been made in engineering literature, and if one should desire the best obtainable information on suspension bridges, his searches would not be complete without consulting the more recent works, especially Mueller-Breslau, Graphische Statik. This is the more necessary because Melan does not go into graphics as thoroughly as he should to fully bring out the elegance and practical simplicity merited by these general solutions for indeterminate structures.

Since the present translation and the recent work by Prof. Burr on "Suspension Bridges, Arch Ribs and Cantilevers," reviewed in this journal April 30, 1914, p. 679, emanated from essentially the same source, most of the comments there given apply equally to this translation.

The simultaneous treatment of arch and suspension systems chosen by Melan is interesting and instructive in many ways. However, this feature detracts from the practical usefulness of the book for engineers and students alike, because it has a tendency to complicate rather than to simplify the individual problems dealt with. This similarity can be more forcibly presented by a brief discussion showing the universal application of Mohr's work equations to all problems involving redundancy, thus disposing of this interesting subject on the broadest possible conception. It might be well to add that this feature of Prof. Melan's chapter (which first appeared in 1888) was never imitated by any other writer.

It should be made clear that suspension bridges and arches constitute specialties in bridge engineering, and as such require considerable preliminary training in the fundamentals of simple structures and the general analysis of problems involving redundancy. Few of our engineering colleges require advanced work in higher structures except possibly as an elective course and for such a course the present book would be altogether too limited in scope. A thorough grounding in fundamentals pertaining to redundant conditions in any structure, should precede these special problems if the student desires a broad training in structural analysis.

While the above-mentioned "Handbuch" contains all of the prerequisites for a thorough understanding of Part 5, the American student is compelled to obtain his fundamental training from other sources.

To illustrate these points more fully, we refer to page 8, where it is stated: "In statically indeterminate arrangements, the missing equations of condition must be deduced from the displacements of the points of application of the external forces, *i.e.*, from the elastic deformations of the structure. To establish these equations, we may use the theorem of virtual displacements, first applied to the design of indeterminate structures by Mohr. . . . or the theorem of least work established by Castigliano and Fraenkel." At the bottom of this page it is stated that "the graphic process consists in drawing one or more deformation polygons (Williot's displacement diagram or deflection polygon), enabling the indeterminate quantities to be found." However, these theorems and methods are not specially discussed in this volume, but are assumed to be familiar to the student. Also, in many cases there are much better methods for drawing deflection polygons than to employ Williot diagrams, but these are not treated.

On p. 30, Eqs. (66) and (67) represent the work equation and the derivative of this equation. These are given without any proof or statement where they may be found.

As another example of this kind see p. 241, where Eqs. (469) and Eqs. (470) are introduced without any proof or reference being given. These are Maxwell's and Mohr's work equations, which are applicable to any structure.

A few terms have not been accurately translated which might offer a little confusion. Thus, "stab polygon" means link or strut polygon, not funicular polygon, which is the English for "kraefte polygon."

The notation is not always uniform and follows more closely the German text than the customary English usage. There is no convenient index to the notation used, and in the few examples given, metric and English units are employed promiscuously.

The book contains only five short examples besides a two-page example of a 2-hinged arch and 13 pages devoted to a proposed suspension bridge at Quebec, by Gustav Lindenthal.

The bibliography is ten years behind the times, being brought down to 1904.

The publishers are entitled to credit for the excellent typography and general composition of the book, though some of the text figures are not very clear and the folding plates are not at all in keeping with the original German production.

Oxy-Acetylene Welding and Cutting. By Calvin F. Swingle, M.E. Published by Frederick J. Drake & Co., Chicago. First edition, 1915. 190 pages; 76 illustrations; 4x6½ ins.; cloth. Price, cloth, $1.00; leather, $1.50.

The scope of this little book is well indicated by the table of contents, which subdivides its subject-matter into thirteen chapters with the following heads: Welding; Welding Flames; Oxygen; Acetylene; Acetylene Gas Purification and Handling; Oxy-Acetylene Torches; Characteristics of Welding Torches; Welding Installations; Pre-Heating and Annealing; Operating a Welding Installation; Metal Welding Practice; Oxy-Acetylene Cutting, and Oxygen Carbon Removal. These chapters are covered by a well compiled index.

Important features of the work, not evidenced in the title which has been chosen for it, are the operation and care of acetylene generating plants and the oxygen process for the removal of carbon. The book is largely descriptive and is plainly for the practical man. It contains little theory, just enough to enable him to acquire a thorough understanding of the different phases of the subject.

Equipment for oxy-acetylene operations is rapidly being added to shops and plants. The process is superseding a large number of old methods and is now to be found frequently in structural and general contracting work. Books upon the subject are few, and for this reason the clear presentation which this little work contains will likely receive wide appreciation.

Constant Voltage Transmission. By H. B. Dwight, B.Sc. Published by John Wiley & Sons, New York; Renouf Publishing Co., Canadian selling agents, Montreal. First edition, 1915. 115 pages; illustrated; size, 5x7½ ins.; cloth. Price, $1.25 net. (Reviewed by Ralph G. Matthews, B.A.Sc.)

The sub-title of this little volume is "A Discussion of the Use of Synchronous Motors for the Elimination of Variation in Voltage in Electric Power Systems."

To use the author's own words in the preface "the purpose of this book is to urge that more synchronous motors be installed in alternating current power systems and that dependence be placed on them to secure the desirable results of controlling the voltage of lines at the opposite end to that of usual practice and of more than doubling the power load of most lines.

The book is divided into thirteen chapters, arranged in logical and systematic order. In the first chapter, after introducing the subject, the author discusses constant voltage transmission in a general way. A power line, as ordinarily operated, has at some part of its length a noticeable variation in voltage. Constant voltage is required at the receiver end while adjustments are made at the transmitting end. The author points out that the rational place at which to control the the voltage is at the receiver end. This result is attained by the aid of synchronous machines in the constant voltage method. The second chapter points out the limits in alternating current transmission according to present practice, and leads up to the third and following chapters on synchronous motors. He shows their action in counteracting the voltage variation which is the most troublesome feature in designing lines for the transmission of electric power. He likewise discusses the advantages and disadvantages of the system in an effort to show where it is desirable to change over to that system. Finally, since the decision regarding important changes in design and operation must be made according to thorough predeterminations of cost and operating characteristics, the author gives cost comparisons and valuable working formulae, together with carefully worked out examples for these comparatively new calculations.

The book is written in clear and concise language. A noticeable feature of the work is that the author is not afraid to give explanations and definitions of technical terms which, while not exactly unfamiliar to the average reader, are still of uncommon enough occurrence to puzzle one at times. It will well repay one for the short time required to peruse the pages of this volume. Moreover, the book will be found to be a valuable one for reference purposes.

Masonry. By Malverd A. Howe, C.E., Professor of Civil Engineering, Rose Polytechnic. Published by John Wiley and Sons, New York. First edition, 1915. 160 pages; 115 illustrations; 6x9 ins.; cloth. Price, $1.50.

The author's several recent publications, including a text book on Foundations and another on Influence Lines, have met with considerable favor among construction engineers. The present work, which is a short text-book on masonry construction, including descriptions of the materials used, their preparation, and arrangement in structures, furnish a very concise treatment of the subject. It cannot be called comprehensive, but rather, as the author states in his preface, a skeleton for a more extended course of study. Several pages of carefully selected references are added at the end. These references cover completely the available literature in books and periodicals.

One is naturally surprised to note that a consideration of reinforced concrete masonry has been entirely omitted from the book, although to concrete masonry is devoted nearly one-quarter of the entire space. The author gives as his reason the fact that the former subject is fully treated in numerous books. However, the reviewer believes that his treatment of the subject, concise as it is, would be improved materially by a similarly concise reference to reinforced concrete construction.

Part I. deals with materials, *viz.*, natural building stones and artificial building material. Part II. deals with stone, brick and hollow tile and concrete masonry. Part III. gives a classification of railroad masonry and specifications, from the American Railway Engineering Association.

The illustrations are clear and for the most part instructive. Extended use has been made of catalogue cuts of different manufacturers, both of machinery and building materials. Considerable space is devoted to description of various tools, such as hammers, picks, axes, mallets, chisels, etc., but considering the practical nature and use of the subject-matter throughout, these descriptions can by no means be called out of place.

PUBLICATIONS RECEIVED.

Telephone Statistics.—Report of Department of Railways and Canals, Canada, for year ending June 30th, 1914.

Medical Officer of Health, Ottawa.—Report for year 1914, including extensive report of Joseph Race, city bacteriologist.

Department of Mines.—Summary report for 1913, including a number of individual reports. 214 pp.; illustrated; 6 x 9 ins.

Industrial Health-Hazards and Occupational Diseases.—By E. R. Hayhurst for the Ohio State Board of Health. 436 pp.; illustrated.

Forest Products of Canada, 1913.—Report by R. G. Lewis, B.Sc.F., on lumber, lath and shingle production, including list of sawmill proprietors, etc. 54 pp.; illustrated.

Houses for Mining Towns.—By Joseph H. White, U.S. Bureau of Mines. Notes on townsite arrangement, types of houses, foundations, framework, etc. Fully illustrated; 64 pp.

International Joint Commission.—Hearings at different points relative to remedies for the pollution of boundary waters between Canada and the United States. 330 pp.; 6 x 9 ins.

Current Decisions (U.S. Courts) on Mines and Mining, December, 1913, to September, 1914.—Prepared for the U.S. Department of Mines by J. W. Thompson. 176 pp.; 6 x 9 ins.

Men on Service.—Handsome booklet issued by Messrs. John Lysaght, Limited, Bristol, England, giving list of over 1,500 men, employees of the firm, on active service in the war.

Coal Fields of Manitoba, Saskatchewan, Alberta and Eastern British Columbia (revised edition).—By D. B. Dowling, Geological Survey, Department of Mines. 142 pp.; 6 x 9 ins.

Simple Forms for Concrete.—A 24-page booklet issued by the Vulcanite Portland Cement Co., describing the construction of concreting forms for walls, tanks, posts, chimneys, slabs, etc.

Northern Development Branch, Ontario.—Report for 1914 on the construction of roads in Northern and North Western Ontario. Prepared by J. F. Whitson, commissioner. 56 pp.; illustrated.

Minister of Public Works and Labor, Quebec.—General report for year 1914, covering public buildings, railways, industrial establishments, steel bridges, fire protection, etc. 145 pp.; illustrated.

Peat, Lignite and Coal.—Report on their value as fuels for the production of gas and power in the by-product recovery producer. By B. F. Haanel, Mines Branch, Department of Mines. 261 pp.; illustrated.

The Crow's Nest Volcanics.—By J. P. MacKenzie, Geological Survey, Department of Mines. Museum Bulletin No. 4. It deals with general geology, petrography, summary and conclusions. 36 pp.; illustrated.

Canal Statistics for 1914.—Report of Department of Railways and Canals on operations for the season of navigation, 1914, including complete list of canal systems under government control and their general features.

American Type of Isthmian Canal.—Reprint of a speech by Hon. John F. Dryden in the U.S. Senate, June 14th, 1906, prepared for the Panama-Pacific Exposition by the Prudential Press, Newark, N.J. 42 pp.; illustrated.

Coal Fields and Coal Resources of Canada.—By D. B. Dowling, Geological Survey, Department of Mines. Classification according to provinces, distribution and uses, summary of estimates of resources. 174 pp.; illustrated; 6 x 9 ins.

Bituminous Sands of Northern Alberta.—Preliminary report by S. C. Ells for the Mines Branch, Department of Mines, giving general description of deposits, subdivision of sand area, analyses and conclusions. 92 pp. text; fully illustrated.

Non-Metallic Minerals Used in Canadian Manufacturing Industries.—By Howells Frechette, M.Sc., Mines Branch, Department of Mines. Full report on non-metallic mine and quarry products, including numerous tables of minerals used, manufacturers who use them, and list of producers.

North American Cordillera at the 49th Parallel: In three parts.—By R. A. Daly, Geological Survey, Department of Mines. Published as Memoir No. 38. This is an exhaustive report on the geology of the mountains crossed by the international boundary at the 49th parallel, and is based upon six years' field work. Fully illustrated with photos and a complete set of maps.

CATALOGUES RECEIVED.

Platt Products.—Small booklet issued by Platt Iron Works, Dayton, Ohio, illustrating their many types of standard pumps for different services.

Compressors.—A 36-page illustrated booklet issued by the Chicago Pneumatic Tool Co., descriptive of their Class "O" steam and power-driven compressors.

New Pavements for Old.—Pamphlet on resurfacing old pavements with sheet asphalt and asphaltic-concrete. Issued by the Barber Asphalt Paving Co., Philadelphia.

Knox Tractor.—Interesting leaflet showing new model 35 Knox tractor, which is described as a vehicle for "hauling the load instead of carrying it upon its back."

Reinsch-World Screen.—A well illustrated booklet describing this screen used for the clarification of sewage and trade wastes. Issued by the Sanitation Corporation, New York City.

Peterson Power Plant Oil Filter.—32-page catalogue issued by the Richardson-Phenix Co., Milwaukee, Wis., describing the filter and accessory apparatus for central oiling systems. Well illustrated.

Over-Head Travelling Cranes, Runways and Worm-Gear Blocks.—Descriptive leaflets issued by the Herbert Morris Crane and Hoist Co., Limited, Toronto, concerning this equipment manufactured by them.

Municipal Engineers' and Contractors' Plant.—A 36-page illustrated catalogue issued by Murphy-Stedman & Co., Holborn, London, England, describing plant, machinery and requisites manufactured by them.

Hydraulic Presses.—A 40-page catalogue issued by Hollings and Guest, Limited, Birmingham, Eng., illustrating a few of their many different styles of hydraulic presses, pumps and accumulators for many purposes.

Chain Belt Concrete Machinery.—Catalogue No. 60 on mixers, pavers and concrete handling equipment. Issued by the Chain Belt Co., Milwaukee, Wis. Well illustrated and complete with brief descriptions; 64 pp.

Peebles' Works and Manufactures.—32-page illustrated booklet issued by Bruce Peebles & Co., Limited, Edinburgh, describing their works and containing descriptive notes of the various types of plant manufactured.

CANADIAN SOCIETY OF CIVIL ENGINEERS—REGULAR MEETING, APRIL 22nd, 1915.

THE regular programme of the meetings of the Canadian Society of Civil Engineers was varied on the evening of the 22nd instant by having a number of speakers instead of the reading of a long paper. The auditorium was filled and the audience followed the subject with rapt attention until adjournment at 11 o'clock.

The first number was a synopsis of the paper entitled "Tests on the Shearing Resistance of Reinforced Concrete Beams," by E. Brown, A.M.Can.Soc.C.E., H. M. MacKay, M.Can.Soc.C.E., and C. M. Morssen, M. Can. Soc.C.E., which was given by Professor Ernest Brown, one of the outhors. By the aid of blackboard sketches, Professor Brown lucidly described the paper in fifteen minutes. The hearty vote of thanks moved by Mr. Robert A. Ross, vice-president of the Society, was an evidence of the appreciation of the skill and interest of Professor Brown.

The remainder of the meeting was devoted to a discussion of "Dry Rot in Timber." Mr. Frederick B. Brown, M.Can.Soc.C.E., introduced the subject in an informal forty-minute address, illustrated by a large number of magnificent lantern slides. His comments were entirely general and made from the engineering point of view, based upon many interesting examples of deterioration in timber construction affecting the structural strength of members. The illustrations described the startling conditions that have been found in hemlock, spruce, white pine and yellow pine.

Following Mr. Brown, Professor Carrie M. Derick, of the Department of Morphological Botany in McGill University, gave the botanist's viewpoint of the growth of timber-destroying fungi. After referring briefly to the cellular structure of wood, Miss Derick described graphically, by the aid of the stereopticon, the manner and effect of the progress of the mycelium through the wood structure. She also gave a great deal of information about the effect of temperature and humidity upon the various varieties of the fungi under discussion. The third speaker was Mr. F. J. Hoxie, of Boston, the special engineer for the Factory Mutual Fire Underwriters' Associations, and well-known author of "Dry Rot in Factory Timbers." Mr. Hoxie drew upon his most extensive experience with factory timbers, while he dealt with the subject under discussion from the standpoint of mill owners. Illustrating his remarks by a number of beautiful slides, Mr. Hoxie went on to give his experiences with the progress and effect of injurious fungi, referring especially to the influence of air temperature, air humidity, and the rosin content of the timber. Mr. Hoxie showed clearly that the deleterious effects are largely independent of the kind of timber and locality. At the conclusion of Mr. Hoxie's remarks, Dr. John S. Bates, M.Can.Soc.C.E., Director of the Forest Products Laboratory of Canada, described briefly the work being done by the Department of the Interior under his direction. Dr. Bates stated that his experience confirmed in a general way the views of the former speakers. The work of his laboratories, however, had not progressed sufficiently to enable him to give conclusive results.

At the conclusion of the remarks of the principal speakers the meeting was thrown open for discussion, which was joined in by Mr. J. A. Jamieson, Mr. W. Chase Thomson and Dr. J. B. Porter, all members of the Society, and the inquiries elicited were replied to by Mr. Hoxie, Professor Derick and Dr. Simon Kirsch. At the conclusion Mr. John Kennedy, the senior Past President of the Society, after a few complimentary remarks, moved a vote of thanks to the various speakers.

The Chairman, Mr. Walter J. Francis, M.Can.Soc. C.E., announced that the meeting would conclude the session of 1914-1915, and expressed the hope that the interest would continue for the series which will begin in September next.

COAST TO COAST

Galt, Ont.—The town of Galt becomes a city on June 1st.

Winnipeg, Man.—Greater Winnipeg is organizing an immense clean-up campaign to take place during the week of May 2nd.

Moose Jaw, Sask.—The overhead bridge spanning the Canadian Pacific Railway lines at Eighth Ave., to the extreme west of the city, was opened for traffic last week.

St. Thomas, Ont.—The London and Port Stanley Railway, at present in the process of being electrified, will be officially opened on June 12th, according to a recent report.

New Hazelton, B.C.—The Grand Trunk Pacific is reported to be taking on a thousand men for the purpose of finishing the ballasting on the main line between Skeena Crossing and New Hazelton.

Toronto, Ont.—The Provincial Department of Public Works is experimenting at present with oil fuel in connection with the power plant in the Parliament Buildings. If results are satisfactory, a complete system may be installed.

Winnipeg, Man.—On the Hudson Bay Railway grading has reached a point 290 miles east of Le Pas. About 2,500 men will be employed upon this work in the course of a few weeks. At the commencement of operations this spring 600 men were employed.

Sudbury, Ont.—It is stated that work on the line of the Sudbury and Copper Cliff Suburban Electric Railway will be recommended next month. Nearly all the grading has been done and most of the ties are in position, while track laying commenced in Sudbury last year. Work was started on May 1st, 1914, and the franchise calls for completion within three years.

Regina, Sask.—Mr. R. O. Wynne-Roberts, consulting engineer to the city, has advocated the installation of an experimental plant for the aerial treatment of sewage with a view to adopting the new method in the existing sewage disposal plant. It is stated that this may be done at little cost, and would preclude the addition of numerous costly filters to meet future demands.

Edmonton, Alta.—About 800 men are at work on the Edmonton, Dunvegan and British Columbia Railway, according to J. D. McArthur. Some 65 miles of road between Spirit River and Big Smokey are now being graded. On the Canadian Central Railway grading is under way on a 50-mile stretch between McLellan and Peace River, about 400 men being employed. This road is now being operated as far as McLellan. On the Alberta and Great Waterways Railway, which branches from the Edmonton, Dunvegan and British Columbia Railway, about 14 miles north of Edmonton, it is expected that grading will be finished as far north as Fort McMurray this season, about 165 miles remaining to be graded. About 1,500 men are now employed on this work.

PERSONAL

H. H. VAUGHAN, who has been in charge of the locomotive and car department of the Canadian Pacific Railway Co., has resigned in order to devote his entire services to the management of the Montreal Ammunition Co., of which he is president. He will continue, however, to act as consulting engineer in the above capacity.

WILLIAM E. WOODHOUSE, who has been superintendent of motive power and car departments, eastern lines of the C.P.R., succeeds Mr. H. H. Vaughan as chief mechanical engineer of the Canadian Pacific Railway. He entered the service of the company in 1891.

D. T. MAIN succeeds Mr. William E. Woodhouse as superintendent of motive power, eastern lines of the C.P.R. He has been in the service of the company since 1904, and was for some time in charge of the mechanical department at Toronto and also at Vancouver.

Dr. J. W. S. McCULLOUGH, chief officer of health for the Province of Ontario, has been appointed sanitary expert for Ontario on the International Joint Commission in connection with its investigation of the pollution of boundary waters.

ROBSON BLACK succeeds Mr. James Lawler as secretary of the Canadian Forestry Association.

H. OSBORNE has been appointed works manager of the Angus shops of the C.P.R. The Angus shops district has been operated as a separate unit, but will henceforth form a part of the eastern lines.

C. A. ABLETT, general manager of the Siemens Company of Canada, Limited, has resigned and has sailed for England to obtain a commission in an English regiment. Mr. W. Hoult succeeds Mr. Ablett as general manager.

VANCOUVER BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a meeting of the Branch on April 15th Messrs. J. P. Napier and J. McHugh gave illustrated lectures on the remedial works that are being carried on by the Dominion and Provincial Governments in the Fraser River in order to protect and foster the salmon fishing industry which for a time was seriously threatened by the partial blockade of the canyon through railway construction operations and subsequent slides. Mr. Napier, as assistant engineer of the provincial public works department, dealt with the preliminary work which was done by the province in 1913, and Mr. McHugh, engineer to the Dominion Department of Marine and Fisheries, discussed in detail the main scheme undertaken by the federal authorities later. Mr. G. R. G. Conway, president of the Branch, occupied the chair.

According to Mr. McHugh's paper, the work was carried out in the face of the most adverse physical disadvantages. The place where the big slide occurred in February, 1914, which had upset all previous calculations, was near the narrowest part of the Fraser River Canyon, Hell's Gate, where water foams through a restricted passage with terrific velocity. The sides of the chasm are precipitous cliffs, affording no foothold for the workmen. How the operations were conducted formed an interesting story of scientific method, ingenious scheming, painstaking endeavor and courageous effort on the part of engineers and workers alike.

While the masses of rock were being blasted away temporary steps were taken to alleviate the congestion of salmon. Thousands of fish were caught in nets and transferred up the cliffs in baskets and across the most turbulent section of the torrent, and released again. A flume was then built to divert the salmon to the upper reaches. The building of this facility entailed great physical discomfort to the workmen, who had in some places to be suspended by ropes over the sides of the precipitous chasm, and there drenched in icy spray, and often had to pursue their activities beneath the waters.

The work, which was started on March 21, 1914, was completed on March 9, this year. In all, 60,000 cubic yards of rock were taken out, 40,000 being removed from Hell's Gate. The operations cost $108,718.

OBITUARY.

An automobile accident on April 22nd caused the instantaneous death of Mr. Benjamin F. Law, contractor.

The death occurred in Toronto on April 21st of Mr. John A Culverwell in his 49th year. Mr. Culverwell was at one time Canadian representative of the Edison Co. Later he was actively associated with the development of the Trent Canal. In connection with the Northumberland and Durham Power Company and the Central Ontario Power Company he did much towards the development of electric power in centre and eastern Ontario after the Government had undertaken to extend the canal. He was a life member of the Engineers' Club, Toronto, and a member of the Deep Waterways Association of America.

The death occurred in Toronto last week of Mr. James F. Markey, master mechanic for Ontario of the Grand Trunk Railway. He had been in the employ of the company for twenty-five years.

The death occurred on April 10th of Mr. M. A. Viele, of Viele, Blackwell and Buck, New York City. In addition to his numerous connections with public utility corporations in the United States, Mr. Viele was vice-president of the Northern Ontario Light and Power Co., and of the Northern Canada Power Co.

NEW AMMUNITION COMPANY.

The Montreal Ammunition Co., of which Mr. H. H. Vaughan is president and Mr. G. H. Duggan vice-president, is a newly organized concern that will manufacture brass cases for shrapnel and high explosive shells. Heretofore these cases have not been manufactured in Canada, but orders were being filled in Detroit and other cities of the United States. The new company will use a part of the plant of the Dominion Bridge Co. for its work. Mr. Duggan is general manager of the latter company, while Mr. Vaughan resigned his position as chief mechanical engineer of the C.P.R. to devote his time to the new concern.

BRITISH SHIPBUILDERS WANT CANADIAN MACHINISTS.

Vickers, Sons and Maxim, the largest shipbuilders in England, located at Barrow-in-Furness, are asking that 1,000 Canadian machinists come over to work on the submarines and battleships that are being gotten ready on the order of the Government. The men are guaranteed six months' work and their passage both ways.