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The Canadian Engineer

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COBALT LAKE DRAINAGE PROJECT

METHODS ADOPTED FOR DEWATERING COBALT LAKE AND FOR SUPPLYING WITH WATER FROM OTHER SOURCES THE VARIOUS INTERESTS WHICH FORMERLY PUMPED FROM COBALT LAKE—NOTES ON CONSTRUCTION OF SHORT LAKE DAM, PIPE LINES, ETC.

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A QUANTITY of silver estimated at over two and one-half million ounces is blocked out in high-grade ore beneath the bed of Cobalt Lake. It is impossible, however, to mine this ore under present conditions, because the workings would be flooded. The Cobalt Lake Mining Company, which owns the Cobalt Lake property, therefore conceived the idea of draining Cobalt Lake, the area of which is 57 acres, containing nearly five hundred million gallons of water, besides a large quantity of mud and semi-liquids. (NOTE—For personal convenience, the writer has used U.S. gallons, instead of Imperial gallons, throughout this article, as the original lay-out of the work was entirely in terms of U.S. gallons.)

To drain the lake would seem to be merely a matter of pumping and fluming to a lower level, but a number of objections had to be satisfactorily met. The water from Cobalt Lake was being used by the town of Cobalt to supply a portable fire engine which was permanently located on the shore of the lake; also to supply the Northern Ontario Light & Power Company with water to cool its transformers and for use in its compressors. Furthermore, and still more important, about 2,850 gals. per min. were being pumped from Cobalt Lake to supply four concentrating mills.

A method to supply these mills and the other interests affected, was evolved late in 1913 by Mr. M. B. R. Gordon, formerly manager of The Cobalt Lake Mining Company, which concern is now part of the Mining Corporation of Canada. Messrs. C. H. & P. H. Mitchell, consulting engineers, Toronto, were asked by the mining company to report on the feasibility of Mr. Gordon's scheme and upon the details of the whole project. They reported that the scheme was entirely feasible, and about May 1st, 1914, work was begun under the supervision of the writer, with G. F. Hendricks, M.E., as assistant engineer.

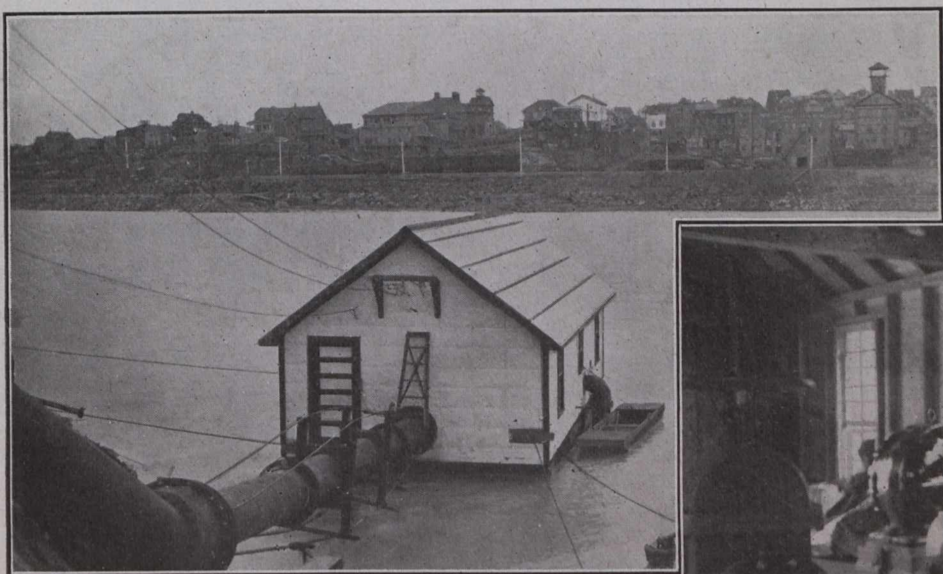


Fig. 1.—Views of COBALT LAKE PUMPING STATION.

Two Centrifugal Pumps are Mounted on Scow, Discharging Through Two Flexible Joints.

It was proposed to discharge the water from Cobalt Lake into a gully which would carry it to Farr Creek and thence to Lake Temiskaming. The quantities of water which had to be supplied from some other source to satisfy the various interests who were using Cobalt Lake, were as follows:

Cobalt Reduction Co.—for concentrating purposes—1,400 gals. per min.

Nipissing Reduction Co.—for concentrating purposes—450 gals. per min.

Town of Cobalt—supply for fire fighting purposes.

The supplies mentioned above are the maximum requirements in each case. It was therefore necessary to supply about 3,500 gals. per min. from other sources.

Although all the above supplies were being obtained from Cobalt Lake, the watershed that is tributary to that lake is insufficient to supply this quantity. This paradox is explained by the fact that the mills which took their

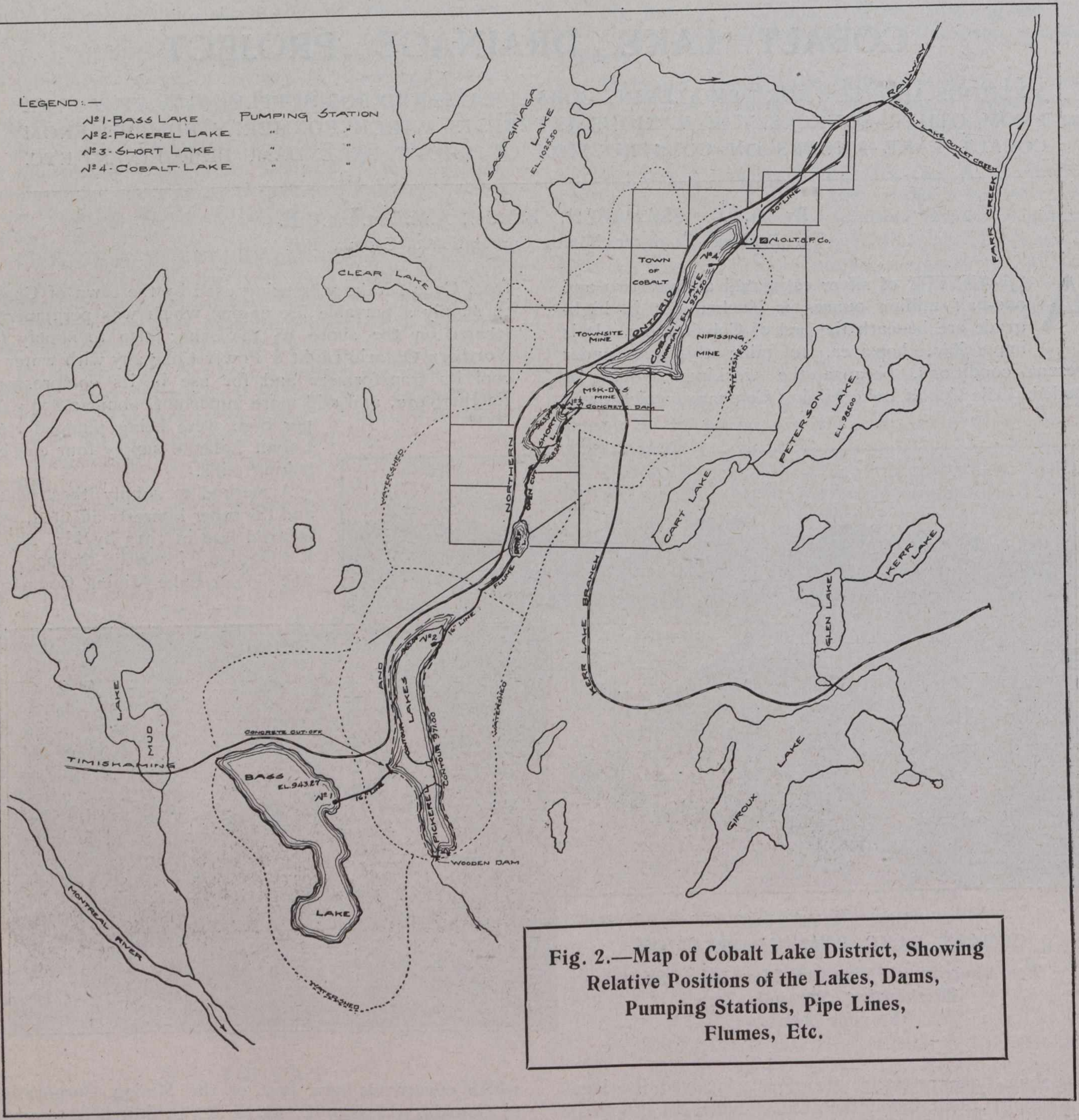


Fig. 2.—Map of Cobalt Lake District, Showing Relative Positions of the Lakes, Dams, Pumping Stations, Pipe Lines, Flumes, Etc.

Cobalt Lake Mining Co.—for concentrating purposes—600 gals. per min.

McKinley-Darragh-Savage Mining Co.—for concentrating purposes—400 gals. per min.

Princess Shaft, La Rose Mining Co.—70 gals. per. min.

Northern Ontario Light & Power Co.—supply for two pumps of 375 gals. per min. each.

supply from the lake, also discharged back into the lake, so that the net amount used was small, the same water being used over and over again.

South of Cobalt Lake, along the T. & N. O. Railway, lies the watershed of lakes North Pickerel and South Pickerel, with an area of 432 acres, and further south of this is Bass Lake, with a watershed of 528 acres. Mr. Gordon's scheme was to conserve all the run-off from these watersheds and to pipe and flume it to a reservoir whence it could be carried to the various mills.

Bass Lake is practically without an outlet, slight seepage into Mud Lake being the only possible discharge, no surface stream existing. A pumping station was built on the north shore of Bass Lake, discharging into South Pickerel Lake. The capacity of this station is 3,500 gals. per min. One De Laval centrifugal pump, direct connected to a Westinghouse 75 h.p. motor, comprises the pumping unit. The head is approximately 55′, including friction. The discharge is through 1,260′ of 16″ wire-wound wood stave pipe.

In order to lift the water from the Pickerel watershed to the Cobalt Lake watershed, a pumping plant identical to that at Bass Lake was placed on a scow at the north end of North Pickerel Lake. This plant also discharges against a head of approximately 55′ including friction, the discharge being through 1,270′ of 16″ wood stave pipe, laid partly on trestle and partly on the ground.

This pipe line carries the water to the height of land between Pickerel and Brief Lakes, and from there it flows north through a closed flume, of two sq. ft. area, for 1,560′ to Brief Lake, which is in the Cobalt Lake watershed. This closed flume was constructed of tongued and

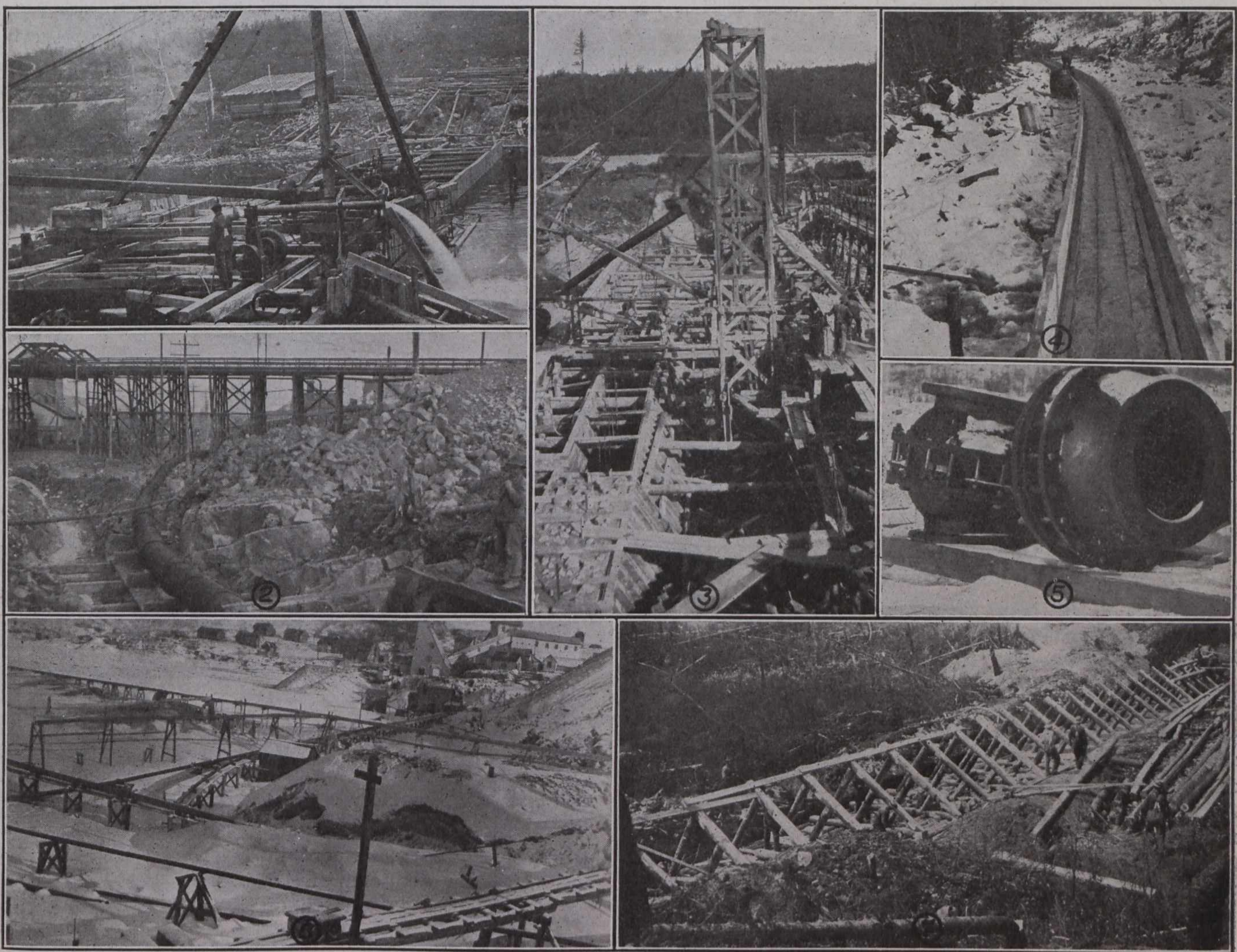


Fig. 3.—(1) Pumping out Cofferdam at Short Lake. (2) Wood Stave Pipe, carrying discharge from Cobalt Lake Drainage Pumps. (3) Short Lake Dam under construction. (4) Flume from height of land to Brief Lake. (5) Flexible Couplings. (6) Pipe Lines from Short Lake to concentrating mills. (7) Timber Dam at South Pickerel Lake.

It was found advisable to raise the level of North and South Pickerel Lakes, which are connected by a surface stream, in order to conserve water during periods of excessive precipitation, so that it would be available for use during dry periods. In order to raise the height of these lakes five feet, a dam was built across the discharge creek which leads to Montreal River, and two smaller dams, or cut-offs, were built to prevent any overflow into the same creek. A cut-off wall also had to be built to keep the high water from flowing into Bass Lake, as the area of the Pickerel Lakes was increased about 25%.

grooved material, and laid to .4 grade, velocity 4.3 ft. per sec.

From Brief Lake the water flows by gravity through an open cut, 1,600′ long, to Short Lake, which is about 22′ below the level of Brief Lake.

Short Lake is used as a storage reservoir and distributing point for the various mills. A dam was constructed across the narrow neck of the lake, near its discharge end. A pumping station was constructed on the dam with the following motor-driven centrifugal pumps:

Two 700 gals. per min. pumps, 113′ head, to supply the Cobalt Reduction Co.; one 600 gals. per min. pump, 105′ head, to supply the Cobalt Lake Mining Co.; one 400 gals. per min. pump, 172′ head, to supply McKinley-Darragh-Savage Co.; and one auxiliary pump of 450 gals. per min. capacity, connected to all three lines. Room was left for another pump to supply the Nipissing Reduction Co. in case that company, which is not now working, should ever desire to start up again. The new Short Lake pumping station takes the place of the various separate stations formerly maintained by the mills. The Princess shaft is supplied by a 2″ pipe through the dam, without pumping. Individual pipe lines lead from the Short Lake station to the various mills as follows:

1,350′ cast iron pipe to McKinley-Darragh-Savage mill; 2,700′ cast iron pipe to the Cobalt Lake mill; and 1,800′ cast iron pipe, plus 600′ of spiral riveted steel pipe, to the Cobalt Reduction Company; the steel pipe being required on account of dangerous ground.

The steel pipe was supplied by the American Spiral Pipe Co., the cast iron pipe by the National Iron Works, and the wood stave pipe by the Pacific Coast Pipe Co.

Another use to which the water of Cobalt Lake had been placed was to supply the fire pump of the Nipissing Mining Company, and it was therefore required that this pump be moved from Cobalt Lake to Peterson Lake, and equipped with a Canadian General Electric auto-starter which enables the pumps to be started or stopped from any one of four points on the company's premises.

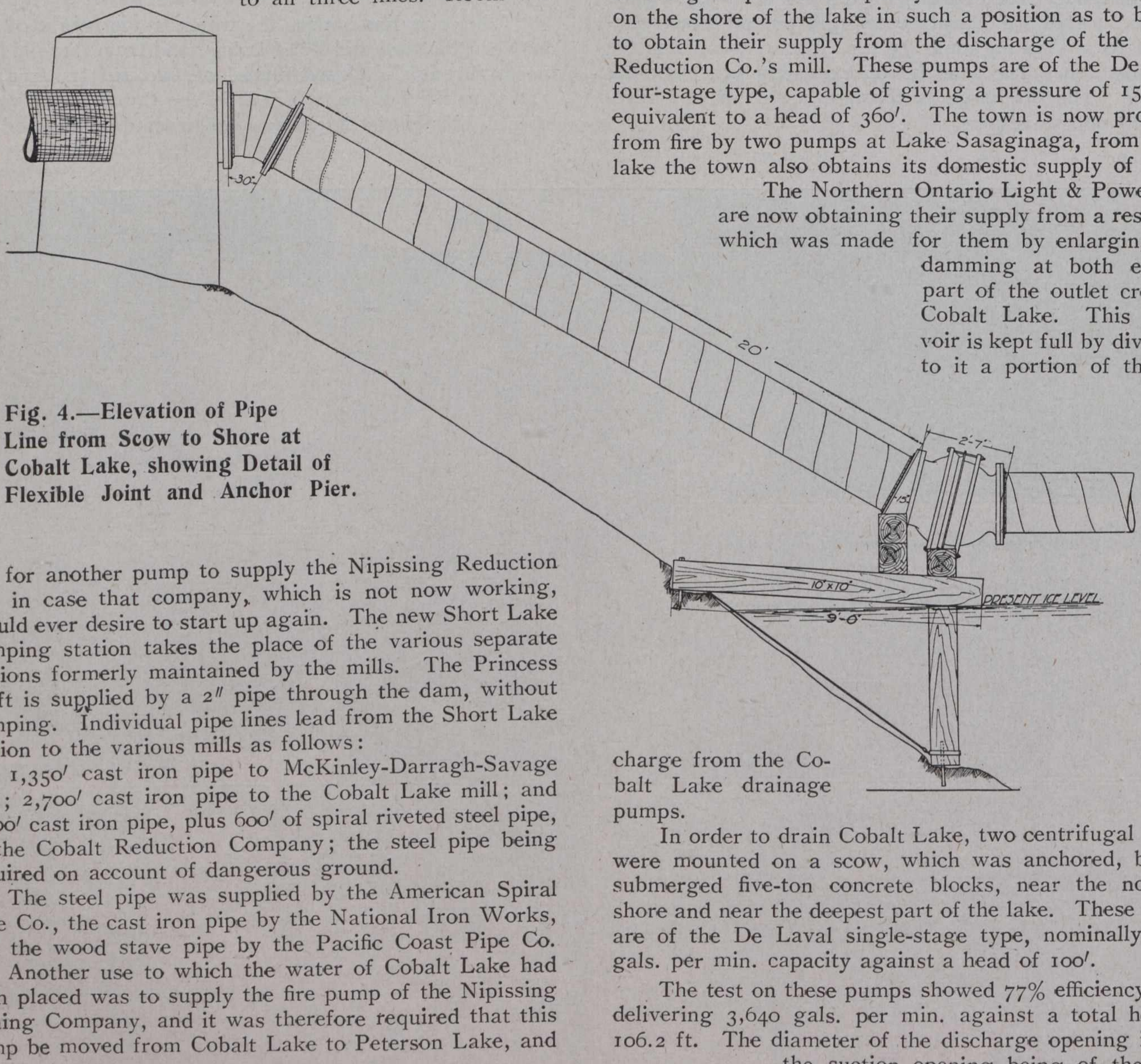


Fig. 4.—Elevation of Pipe Line from Scow to Shore at Cobalt Lake, showing Detail of Flexible Joint and Anchor Pier.

The town of Cobalt also must be supplied with fire protection to make up for the removal of the source of supply of the portable fire engine. Two centrifugal pumps of 600 gals. per min. capacity will therefore be stationed on the shore of the lake in such a position as to be able to obtain their supply from the discharge of the Cobalt Reduction Co.'s mill. These pumps are of the De Laval four-stage type, capable of giving a pressure of 155 lbs., equivalent to a head of 360′. The town is now protected from fire by two pumps at Lake Sasaginaga, from which lake the town also obtains its domestic supply of water.

The Northern Ontario Light & Power Co. are now obtaining their supply from a reservoir which was made for them by enlarging and damming at both ends a part of the outlet creek of Cobalt Lake. This reservoir is kept full by diverting to it a portion of the discharge from the Cobalt Lake drainage pumps.

In order to drain Cobalt Lake, two centrifugal pumps were mounted on a scow, which was anchored, by two submerged five-ton concrete blocks, near the northern shore and near the deepest part of the lake. These pumps are of the De Laval single-stage type, nominally 3,500 gals. per min. capacity against a head of 100′.

The test on these pumps showed 77% efficiency when delivering 3,640 gals. per min. against a total head of 106.2 ft. The diameter of the discharge opening is 12″, the suction opening being of the same size. On account of the grittiness of the slimes and other semi-liquids in the lake, special manganese bronze was used in the manufacture of the impellers, impeller protecting rings and shaft sleeves.

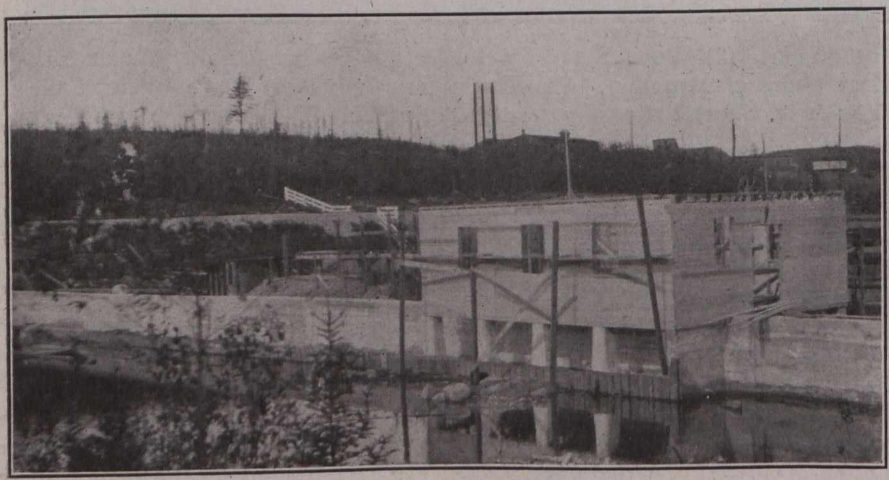


Fig. 5.—Construction of Short Lake Pumping Station.

The pumps are driven by two 125 h.p., 2,200 volts, 3-phase, 1,720 r.p.m. Westinghouse motors. The discharge is through two 20″ flexible joints, one on the scow and one on a crib at the shore, into a 20″ wood stave pipe line, 3,500′ long. The flexible joints permit movement through an angle of 20°. They were supplied by the American Spiral Pipe Company.

The entire works described above have been completed and are in operation, and the actual drainage of Cobalt Lake began on April 26th, 1915, and will likely be completed about June 7th, 1915.

The water from the mills at present flows back into Cobalt Lake. This average flow amounts to about 2,350 gals. per min., so that the pumps are gaining only 4,650 gals. per min. in the drainage operation, without deducting the surface drainage from the Cobalt Lake watershed. It is proposed to maintain a sump in the deeper portion of the north end of the lake, and to allow the mills to continue to discharge into this sump. This will require continuous pumping to keep the water in the sump down to the level desired, and also in order to take care of the ordinary surface drainage. Should it ever be found advisable in order to extend mining operations to unwater the entire lake bed, the launders, or discharges from the mills, could then be piped to the same gully into which the drainage pumps are now discharging. For the present the launders will be carried as open flumes to the sump, the velocities of the discharges being high enough to prevent freezing.

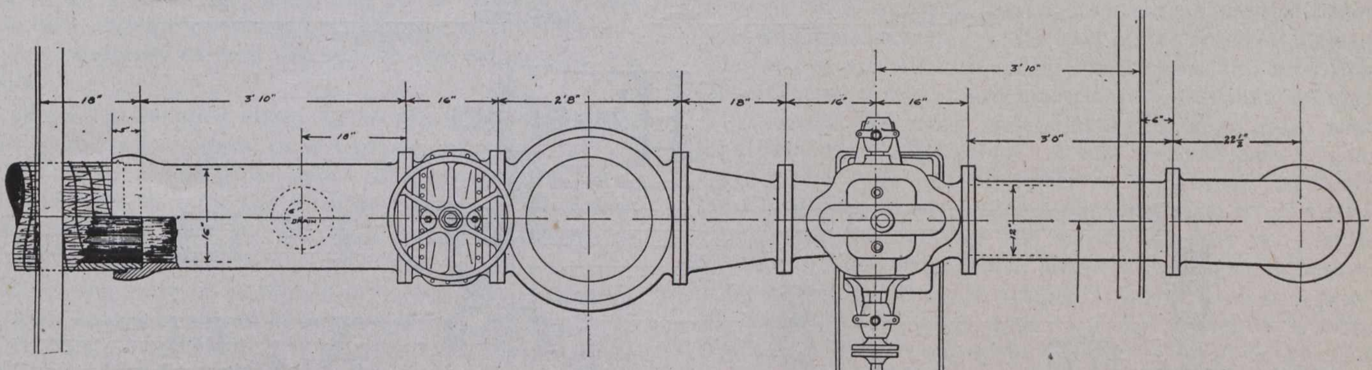
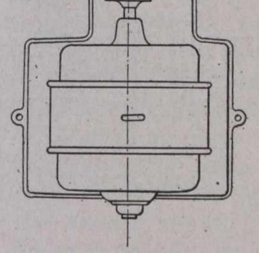



Fig. 6.—Plan of Bass Lake Pumping Station.

One of the largest single operations in the entire work was the dam at Short Lake. This dam is 293′ long, 20′ high, and contains 2,200 cu. yds. of concrete. Two parallel lines of Wakefield sheet piling were driven 30′ apart across the narrow neck of the lake. It was impossible to reach bed rock, but the piling was driven from 10′ to 40′, as far as the ground was permeable. Bearing piles of 8″ to 10″ diameter were driven at 4′ centres over the entire area between the lines of sheet piling, the bearing piles also being driven to a depth of from 10′ to 40′. The sheet piling was carried close to the rock shore on both sides of the lake. A concrete slab 6′ thick was laid over the area of the foundation of the dam, over the bearing piles, and tied into the rock shore at both sides. A concrete cap 14′ high, 10′ wide at the bottom, and 2′ wide at the top, was placed on top of this slab, with batter-face down stream. This cap was also fitted into the rock at the sides. The cap was tied to the slab with reinforcing steel. This dam made a reservoir of Short Lake sufficient for two weeks' requirements for all purposes.

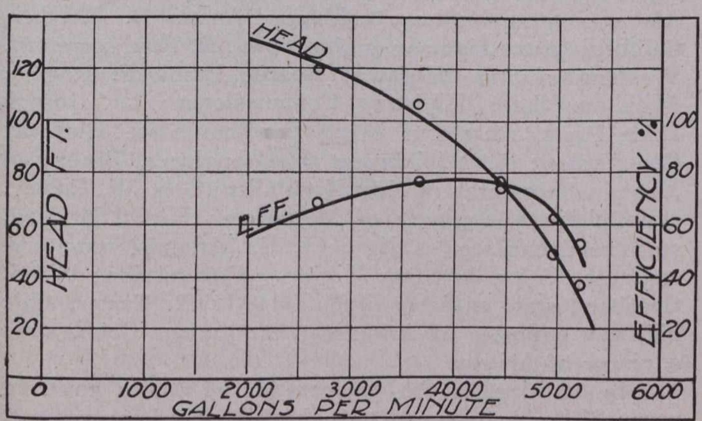


Fig. 7.—Characteristic Curves of Cobalt Lake Drainage Pumps.

The diverting dam at the south end of South Pickerel Lake is 150′ long and 8′ high. It is constructed of timber bents, covered over with two layers of tongued and grooved sheeting, with a layer of Ruberoid waterproof paper between the two sheetings. 3″ x 10″ fir piles were driven to a depth of from 6′ to 10′ along the toe as a cut-off.

As previously mentioned, three other small concrete cut-offs were necessary to retain the water in Pickerel Lake basin. One of these was equipped with a spillway and gate.

A Smith concrete mixer and Marsh & Henthorn hoist were used throughout on the work. The cement was purchased from the Canada Cement Company. All pumps were purchased from the Turbine Equipment Co., Ltd.

A telephone line was built which connects all the pump houses to all the mills. Material for this line was supplied by the Northern Electric Company.

No difficulty was found in obtaining water-tight joints in the wood pipe lines, and as high as 400′ of this kind of pipe was laid by six men in half a day.

The cost of the entire scheme was approximately $110,000, and the estimated annual charge is between $25,000 and $30,000.

A complication that threatened the undertaking in its initial stage was the fact that the town had been using the lake as a place of disposal for its sewage, but this was satisfactorily solved by the order of the Board of Health that the town would be required, regardless of the drainage operations, to carry its sewage to a more distant point and to treat it or otherwise dispose of it satisfactorily.

An intercepting sewer was laid last year by the town to a line and level which enabled it to connect with and receive the discharge from all other sewers, and this intercepting sewer now carries the sewage to the same gully into which the drainage pumps are discharging.

Power for driving the pumps is obtained from the Northern Ontario Light & Power Co., and as this company has various circuits, no interruption has been experienced. The transmission lines have been entirely cleared for 20′ on each side of the line, and all dangerous trees have been cut down. There is no surface blasting which can interfere with the lines.

The plan shown herewith gives the elevations of the various lakes and their relative positions, and the photographs show a number of views of the work during construction.

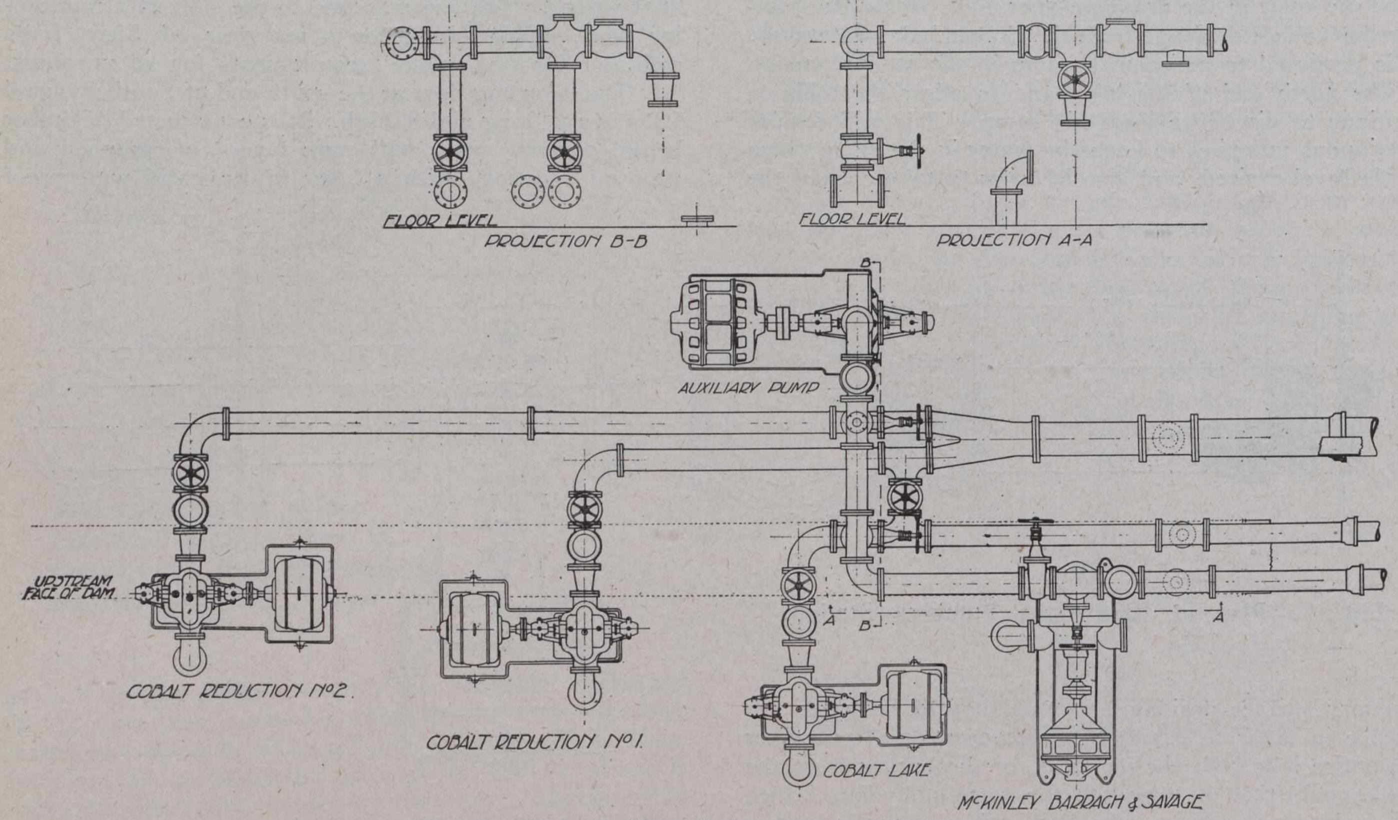


Fig. 8.—Plan of Short Lake Pumping Station.

PAN AMERICAN ROAD CONGRESS.

Among the men who are prominently identified with the good roads movement who will be asked to preside over the sessions of the Pan American Road Congress, which will open on September 13, are Governor Charles W. Gates, of Vermont; Logan Waller Page, Director, U.S. Office of Public Roads; Col. Wm. D. Sohier, chairman, Massachusetts Highway Commission; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, N.Y.; Fairfax Harrison, president, Southern Railway Co.; James H. MacDonald, former State Highway Commissioner of Connecticut, and W. A. McLean, Chief Engineer of Highways and Commissioner of Ontario Public Roads and Highways Commission.

Among other prominent men also identified with highway improvement who will be asked to present papers or open discussions are the following: Arthur W. Dean, chief engineer of Massachusetts Highway Commission; Charles J. Bennett, Connecticut State Highway Commissioner; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment of New York City; H. Elting Breed, first deputy commissioner, New York State Highway Commission; Col. Edwin A. Stevens, state commissioner of Public Roads of New Jersey; Wm. D. Uhler, chief engineer, Pennsylvania State Highway Department; Wm. H. Connell, chief, Bureau of Highways and Street Cleaning of Philadelphia; S. E. Bradt, secretary, Illinois State Highway Commission; Thomas H. MacDonald, Iowa State highway engineer; W. E. Atkinson, Louisiana State highway engineer; Richard Henry Dana, president, National Civil Service Reform League; W. S. Keller, Alabama State highway engineer; Austin B. Fletcher, California State highway engineer; W. R. Roy, secretary, Washington State Highway Board; Frank F. Rogers, Michigan State Highway Commissioner; Dr. Joseph Hyde Pratt, secretary, North Carolina State Highway Commission; A. N. Johnson, road engineer, Bureau of Municipal Research of New York City; Geo. W. Cooley, state highway engineer of Minnesota; E. R. Morgan, state road engineer of Utah; J. E. Maloney, secretary-engineer, Colorado State Highway Commission; W. S. Gearhart, state engineer of Kansas; H. R. Carter, state highway engineer of Arkansas, and Lamar Cobb, state engineer of Arizona.

In addition to the presentation of topics covering practical problems connected with highway improvement, there will also be discussed such important subjects as "Determination of Justifiable Outlay for Individual Roads"; "Convict Labor for Road Work"; "Street Pavements"; "Reconstruction of Old Surfacing"; "Load and Tire Restrictions and Regulations"; "Motor Traffic: Its Development and Trend"; "Maintenance, Methods and Materials"; "Dust Suppression and Street Cleaning"; "Uniformity in Highway Statistics and Data"; "Merit System in Highway Work"; "Essentials of Legislation Governing State Highways"; "Highway Indebtedness: Limitation and Regulation"; and "Educational Work of Highway Departments."

DUST PREVENTION BY USE OF OIL.

THE following notes, abstracted from a bulletin on Dust Prevention, issued by the Ohio Highway Department relate to the proper method of applying oil to road surfaces. It is first pointed out that the method of application and the amount of oil that should be applied must depend upon the kind of oil used, the condition of the surface of the road on which it is to be used, and other local conditions. The light oils should be applied more frequently and in smaller quantities than the heavy oils. The crude or the refined oil may be applied either cold or hot, according to its quality. Most crude oils, and some refined oils, have been applied cold; but it is necessary to heat the heavier oils before they are applied.

The oil is shipped either in barrels containing from about 30 to 50 gals. each, or in steel tank cars containing from 6,000 to 10,000 gals. each. If a heavy oil is used, it is necessary that the car tank be equipped with steam coils in order to heat the oil, that it may be drawn or pumped from the tank.

When the material is shipped in barrels it is customary to heat it on the roadside in heating kettles holding from 4 to 10 bbls., from which it is applied to the road surface by the use of hand pouring pots of about 4 gals. capacity. It is important that these pots be provided with spouts that will spread the oil in such a way as to produce an even distribution, as in this lies the secret of the success of its application. The ordinary water sprinkling spout with the holes punched larger with an 8 d. or 20 d. wire nail, depending upon the grade of material being used, will usually give very satisfactory results.

When the oil is shipped in tank cars, it is usually applied to the road from tank wagons, holding from 400 to 800 gals. Tank wagons used for this purpose may be classified under two heads: (1) Gravity tanks, which allow the oil to flow by gravity through a perforated pipe, which sprinkles the oil onto the road; (2) Pressure tanks, which spray the oil under pressure onto the road through perforated pipes, or a series of nozzles, or a single large hose and nozzle. The pressure is produced either by steam or compressed air in the tank itself, or by pressure in the distributing pipes only, induced by some form of pump.

When the oil is applied to the road surface in the form of a fine spray, which can be done with the pressure tank wagon, a more even distribution and better penetration is secured. The pressure tank wagon is particularly valuable when it is desired to use a very light application of oil. By the use of such a wagon, so light an application as ⅛ gal. per square yard can be evenly spread, while about ⅓ gal. per square yard is as small a quantity as can be uniformly distributed with a gravity tank. The use of the pressure tank has an additional advantage; when the oil under pressure comes into contact with the stone with some force, it blows the dust from the surface, and thus by cleaning the stone secures a better adhesion of the oil. This is very beneficial with the heavier asphaltic oils where it is absolutely essential that the surface of the large stones be exposed and clean in order to insure a good bond. However, if the oils are not too heavy, and the road is gone over several times with the gravity tank and a very light application given each time, a very even distribution can be secured and fairly good results obtained. The tank wagon is sometimes provided with a heating arrangement either in the form of a fire box underneath, or in the form of steam coils to be attached to the roller boiler. With such an equipped tank, the heavier grades of materials may be applied.

In general, it is better to give the middle of the road a heavier application than the sides. This is especially true in the case of the lighter oils and emulsions, and calcium chloride solution, owing to the tendency of these materials to being carried to the sides of the road by gravitation and running water. While in the case of the lighter oils, no cover is necessary after the oil is applied, yet better results are usually secured by covering the oil with a layer of coarse sand. When the heavier oils that require heating are used, it is essential that they be covered with either screenings or coarse sand. Stone, slag or gravel screenings are best suited for this purpose. The screenings should be dry and clean and free from dust, and of a fairly hard material. A size that will pass a ½-in. circular mesh and be retained on a ¼-in. mesh is usually very satisfactory. A size that will pass a ¾-in. screen and even a 1-in. screen is sometimes used with perfect satisfaction. The heavier the grade of oil that is being used, the coarser the screenings may be. If the surface is afterwards rolled, larger screenings can be used than where traffic alone compacts them. Unless a heavy oil that stiffens quickly upon exposure to the air is being used, it is best to allow the oil from 5 to 36 hours' time to be absorbed by the road surface before applying the screenings. It often happens, however, that the road cannot be closed to traffic so long, in which case the screenings are put on immediately after the oil is applied, with very good results. If the oil stands in little pools on the surface after it is applied, it should be gone over with hand brooms and the puddles of oil broomed evenly over the surface before the screenings are spread. This will aid in producing a more uniform surface, and uniformity of surface is not only one of the essentials in building a road, but it is also one of the essentials in maintaining a road.

Dust prevention is so closely associated with road preservation that the two should usually be considered together, for any method of preserving surface will invariably reduce the dust. It might be well to state, however, that such surface treatments of oil do not constitute the building of a road. At its best, it constitutes merely a maintenance proposition. It is a false notion to hold that an old wornout, rough road surface can be made good by the application of a little oil. In order to maintain a good surface, it is essential that the surface be put in a good condition previous to the application of the oil. Therefore, unless it is merely intended to temporarily allay the dust, the holes and ruts should be eliminated from the surface before any oil is applied. The depressions in the road should be cleaned of all dirt and foreign material, the edges cut vertical and the bottoms loosened by picking. The depressions should then be filled with stone, slag or gravel of the same quality and size as the remainder of the road surface, and this material thoroughly compacted by hand ramming or rolling.

Poor results in the use of oil treatments frequently come from the fact that the surface had not been previously cleaned in a proper manner. The practice of some small villages of putting oil on a road surface already covered with several inches of dust and filth, cannot be too severely condemned. When such practice is followed, the street, after every rain, will be covered with a black, oily mud, which may be as objectionable as the dust itself. Before the lighter oils, such as are put on cold, are applied, the surface should be comparatively free of all loose dust and foreign material. Before the heavier materials, such as require heating, are applied, it is very important that the surface be cleaned of all matted dirt, dust and foreign material, so as to expose the large stones in the surface of the road. If possible, the surface should be swept with horse sweepers, and afterwards with hand brooms so as to remove the dust from between the stones to a depth of from ¼ in to ¾ in. The heavier the grade of oil used, the more important it is to have a clean surface on which to apply it. The surface should be dry and the warmer the air temperature the better.

There has been considerable discussion during the past year concerning sprinkling of the stone with water before applying the bitumens, it being claimed by some that better results are secured. While during a dry, dusty time, better results may be obtained by first lightly sprinkling the stone with water before applying the bitumen, this information is likely to be misleading; for it is believed that it is not the presence of water that might cause the better results, but the effect the water has in cleaning the dust from the stone which gives a better adhesion of the oil. Hence, we would conclude that if sprinkling with water before applying the oil is done, it should be on only hot, dry days, and then sufficient time given after the sprinkling for the water practically all to evaporate before the oil is applied. Therefore, we are still warranted in saying that bitumens should be applied only to dry, warm surfaces. During June, July and August is the best time of the year to apply such materials to the road surface.

The amount of oil that should be applied to the road at any one time will depend upon the condition of the road surface, the quality of the oil used, and the nature of the traffic. In general, it may be said that a couple of light applications during the year will give better results than a single heavy application for the same amount of oil. For the lighter oils, on a comparatively smooth surface, an application of not to exceed ⅛ gal. per square yard may be all that should be applied at one time, while on a rough, pitted surface (with the binder swept from the top surface of the road to a depth of from ¼ in. to ¾ in. as much as ¾ gal. per square yard of the heavier oils might give more satisfactory results. Precaution should be taken, however, that there is not an excess of oil applied, as too heavy a coat of the lighter oils is objectionable because of the formation of a black, frothy mud after a rain, while an excess of the heavier oils will form a thick mat on the surface which will be peeled and picked up by the horse-drawn traffic. The heavier the automobile traffic, the greater the amount of oil that can be applied up to a certain limit. The aim should be to put on just sufficient oil (and screenings) to form a thin mat over the surface of the road. This mat should not be of any appreciable depth over the surface of the larger stones, but sufficient to well seal up the voids between them. This will hold the binder in the stones and make the road surface watertight.

ST. JOHN ARCH NEARING COMPLETION.

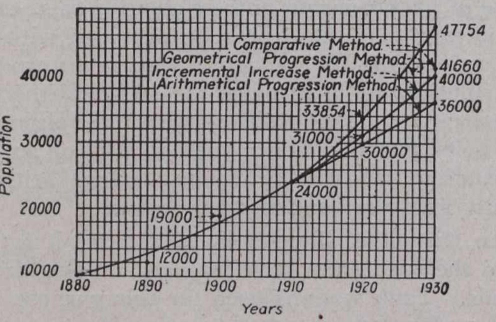
The highway arch bridge at St. John, N.B., described in last week's issue (page 554) is not quite completed yet as it was decided best not to lay the concrete slabs last fall owing to the lateness of the season and the probability of severe frosts. The grading of the approaches was also left over until spring. This work has recently been started and it is likely that the bridge will be completed and opened for traffic in a few months.

ESTIMATES OF POPULATION IN WATER SUPPLY PROBLEMS.

In our issue of May 13th an article appeared which dealt with the problem of determination of static pressure in a water supply system. The author, Mr. N. S. Hill, Jr., in his paper to the American Waterworks Association, also touches upon the question of future population and its estimation, in relation to pipe distribution systems. He describes and compares four methods of estimating future growth, the methods being those of (1) arithmetical progression, (2) comparison, (3) incremental increase, and (4) geometrical progression.

In describing them he states that the first method is applicable only in rare cases and almost uniformly produces estimates which are too low. The method, as its name implies, involves the assumption that the future rate of increase from year to year will be constant, and the same as has obtained in the past, or for some period which may be selected at the choice of the computor.

The comparative method involves the selection of cities, similarly situated, whose population, say 20 years ago, was practically the same as the present population of the town under study. The past growth of such towns



Comparison of the Four Methods of Estimating Future Population.

is then taken fairly to represent the probable future growth of the one in question.

By the incremental increase method, the population of a town by decades is ascertained as far back as records have been kept. The actual gross increase in population from decade to decade is determined. Then the increase in the increase is determined, or the increment of increase for each decade. The actual increase as determined for each decade is averaged, and also the increment of increase. In making the estimates of future population, the population at the end of the first future decade is obtained by adding to the present population the average increase plus the average increment per decade thus found, and the future population at the end of the second decade by adding to the estimated population at the end of the first future decade, the average increase plus twice the average increment, and so on.

The geometrical progression method involves the determination of the compound rate at which the population of a city has increased in the past, then applying this compound rate to the present population, to determine the future growth.

By way of comparison, the author presents the curves on Fig. 1 giving the results of applying each of the four methods to the population of a typical city. The population between 1880 and 1910 as expressed by the curve is that returned by the census. The populations from 1910 to 1930 are those computed by the four methods.

It will be noted that the incremental increase method is about a mean of the several methods, and experience has shown that it frequently falls in this way in towns of normal growth. No single method, however, is applicable to all conditions and judgment must be exercised in estimating future population.

While these methods are commonly employed in estimating the future population of a community as a whole, it is generally desirable to subdivide the total population by districts in order that the size of the pipe intended to supply individual localities may be proportioned intelligently.

Whereas the commercial and manufacturing use of water and the water required for fire service are practically independent of the distribution of population, the domestic and public demand for water follows the distribution of population very closely and, therefore, a study of the distribution of population enables one to make a reasonably intelligent estimate of the probable local demands for water for the last two purposes named. After the local demand for water required for domestic and public uses has been determined through the study of population distribution, the water required for manufacturing, commercial and fire purposes in the sub-divisions used for localizing the domestic and public supply may be added from knowledge of the specific use of water for commercial, manufacturing and fire purposes in those districts.

A distribution system to be economically built must be designed to meet the conditions of some future year. In this year the distribution of population may, and usually will, be quite different from the distribution on the date of design. On the date of design some districts may be fully built up, and it would obviously be erroneous to assume that the future domestic and public water requirements in such districts will increase in the same proportion as for growing districts, or as for the city as a whole. It is possible, however, for the designer to establish a reasonable figure representing the probable density of population in any section in the city considered. He may then, in apportioning the total future population by districts, avoid exceeding this figure in any built-up district, and by the exercise of a little judgment and with a knowledge of the local conditions, apportion the balance of the total growth to the more sparsely settled districts and thus obtain a fairly accurate future distribution of population, and hence of domestic and public water consumption.

Subdivision by wards is convenient for the purpose of apportioning local consumption in different districts and may be made without difficulty as the ward populations are usually given in the census returns.

Where ward boundaries include large areas, a further subdivision may be made, if desired, by estimating the population by registration districts. Knowing the total registration in a given city or ward in a given year, and the population in the same year, a ratio may be established between the population and the number of registered voters. By applying this ratio to the number of registered voters in a given registration district, its population may be closely approximated. This refinement, however, is not usually necessary.

While all estimates of the population of a city, or a section of it, are based largely upon the past growth, it is essential, however, that proper regard be had for special conditions which have tended abnormally to accelerate or retard the rate of growth prior to the date of the design so that proper allowance may be made in the assumed or computed future rate of increase. The percentage growth in communities generally decreases as the population increases, although the total annual increase may be greater in each successive year. It is not always safe, therefore, to apply percentages based on past growth to estimates of the future growth. The author of the paper states that it has been his policy not only to base estimates of future growth upon the past increase of population, but to check such estimates by comparing the estimated growth during, say, the next twenty years with the past growth of similarly located towns whose population twenty years ago was about equal to the present population of the town under consideration.

HIGH-PRESSURE STEAM TEST OF CEMENT.

THE Journal of the Franklin Institute for May publishes the following communication from the U.S. Bureau of Standards relative to the value of the high-pressure steam test of Portland cement. It is an abstract of one of the Bureau's technologic papers and was prepared by Messrs. R. J. Wig and H. A. Davis.

The use of high-pressure steam as a means of determining the soundness and cementing quality of Portland cement was advocated as early as 1880 by both Michaelis and Erdmenger. It has been recommended and used by others from time to time until recently, when a form of this test was advocated and introduced into specifications for the purchase of Portland cement as the Force autoclave test. Many brands of American cement would not regularly meet the requirements of this test, and its recent introduction led to a controversy between cement manufacturers and consumers. The manufacturers of Portland cement contended that this test was an abnormal one, and the behavior of a cement when so exposed was no criterion of its ultimate behavior as normally used in concrete. Furthermore, it was suggested that this test be introduced into the United States Government specification for Portland cement, and it was for these reasons that an investigation of the value of the high-pressure steam test was undertaken.

This investigation included a study of the physical properties of cements that were sound after exposure in high-pressure steam and cements that failed to meet the requirements of this test. Tests were made of the tensile and compressive strength in mortars, compressive strength in concretes, and the linear change of neat cement prisms stored in air, in water, and treated in high-pressure steam.

The qualitative high-pressure steam test consisted of subjecting a pat of neat cement, after storing for the first twenty-four hours in a damp closet, to steam at a pressure of 300 pounds per square inch for one hour, in a steam-tight boiler, the total time in the boiler being three hours. A cement was said to have passed this test if the pat was hard and sound when examined after this treatment. The quantitative high-pressure steam test consisted of moulding six neat cement briquettes, storing them twenty-four hours in a damp closet, then treating three of them in steam at 300 pounds pressure for one hour in a steam-tight boiler, the total time in the boiler being three hours. The six briquettes were then broken in a cement testing machine, and a cement was said to pass the high-pressure steam test if the treated briquettes showed higher tensile strength than the untreated.

Eighteen two-barrel samples of cement, composed of seven different brands, were obtained for testing in concrete. The cement of some of these samples passed the high-pressure steam test, and the cement of other samples did not. The concretes prepared from these cements have been normally exposed to the atmosphere for two years or more and tested for compressive strength from time to time. Sufficient specimens were prepared to continue the tests for ten years.

The following is a brief summary of the results of this investigation:—

The general soundness tests show that some cements mixed neat which are sound according to the standard atmospheric steam test but unsound in high-pressure steam exhibit signs of unsoundness when stored under normal conditions in dry air. This unsoundness may require nine months or more to develop in neat cement specimens.

The strength tests of mortars and concretes fail to show any difference in the cementing quality of cements that pass the high-pressure steam test and those that fail to meet the requirements of this test.

There is but small difference, if any, in the linear change of prisms made of cement that passes the high-pressure steam test and prisms made of cement that fails to meet the requirements of this test, whether stored in air or water.

Seventy per cent. of a total number of fifty-one brands of Portland cement tested passed the high-pressure steam test.

Cements normally unsound in the atmospheric or high-pressure steam tests will generally be found to be more sound than the original cement if the coarser particles are removed. While fineness is not essential to soundness, it appears usually to be the coarse particles of a normally unsound cement that cause the expansive action resulting in cracking and disintegration of the hardened cement in the accelerated tests of soundness.

A cement originally unsound in the high-pressure steam test will usually be found sound if exposed to this test after ageing from two to six months.

The following conclusions are drawn from the results obtained:—

1. The high-pressure steam test should be made on all cements that are to be incorporated in cement mortar or concrete products that are to be cured in steam at pressures above atmospheric.

2. The high-pressure steam test may be of value as forecasting the behavior of neat cement or a very rich mortar when exposed under normal conditions in dry air, but it does not forecast the behavior of cements in concrete as normally exposed.

3. Cement passing the high-pressure steam test is not superior in cementing quality, as determined from the compressive strength of concretes, to cement that fails in this test.

4. Cement passing the high-pressure steam test does not make more permanent or durable concrete than cement which meets the requirements of the standard specifications but fails in this test.

5. Cement failing to pass the standard specification atmospheric steam test, but meeting the other requirements of the standard specifications, shows in some instances a normal strength in concrete.

6. For practical work under normal conditions of construction, the results of this investigation fail to show that the high-pressure steam test is of value as a means of determining the ultimate soundness of concrete.

GARBAGE REDUCTION AT CLEVELAND.

The following figures relating to operating results of the garbage-reduction works at Cleveland, Ohio, are from the 1914 report of Mr. F. W. Cummings, superintendent:

	In 1914 Total.	Per ton.
Cost of reduction	$141,415.12	$2.5373
Earnings of reduction	194,585.57	3.4916
Net earnings	53,170.45	0.9543
Depreciation	12,924.52	....
Gross earnings	66,094.97	....
Cost of collection	164,769.52	....
Loss on live stock	1,089.00	....
Cost of reduction	141,415.12	....
Total cost	$307,273.64	$5.3135
Total earnings	195,221.35	3.503
Cost over earnings*	$112,052.29	$2.0105

	In 1913 Total.	Per ton.
Cost of reduction	$113,057.34	$2.16
Earnings of reduction	157,010.81	3.013
Net earnings	43,953.55	0.853
Depreciation	....	......
Gross earnings	....	......
Cost of collection	142,584.38	......
Loss on live stock	1,088.50	......
Cost of reduction	113,057.34	......
Total cost	$256,730.22	$4.904
Total earnings	157,705.49	3.013
Cost over earnings*	$ 99,024.73	$1.891

*Appropriated by the city out of general fund.

The following analyses of tankage and of grease, as determined by the city chemist, are from samples collected from two carload lots of each on February 10, 1915:

(Percentages of Total Sample)

	Moisture	Fat	Ammonia	Potash	Bone Phosphate	P_2O_5
Tankage (*a*)	2.77	1.45	3.89	0.69	12.95	5.43
(*b*)	4.61	1.70	4.04	0.75	12.40	5.68

	Moisture	Hydrocarbon	Dirt	Total Impurities
Grease (*a*)	0.61	2.84	0.10	3.55
(*b*)	0.51	2.80	0.10	3.41

The contract price per ton for tankage is based on the following unit (parts in 100) prices of fertilizing value, as shown by analysis: Ammonia, $2; potash, $0.70; bone phosphate, $0.10. Thus, sample (*a*) would yield : (3.89 × $2) + (0.69 × $0.70) + (12.95 × $0.10) = $9.555 (f.o.b. at plant).

The grease now brings $4.37 per 100 lb. (f.o.b. plant), with a deduction for moisture and for unsaponifiable matter.

In the last decade Canada added more than 10,000 miles to her operative railway mileage. On basis of population this country has the highest ratio of railway mileage in the world, one mile to every 240 people.

The Government has appointed Mr. H. R. MacMillan, its Chief Forester, special commissioner to proceed to Australia to study market conditions for British Columbia timber and to arrange with the Australian Government for better terms and a broader market.

1914 PUBLIC WORKS IN LETHBRIDGE, ALTA.

The following figures are from the report for 1914 of Mr. A. M. Grace, Commissioner of Public Works, Lethbridge, Alberta:—

Sanitary Sewers.

	Length in feet			
	8-inch.	10-inch.	12-inch.	Total.
Constructed	928	508	2,124.2	3,560.2
Not yet constructed.	3,428	226	....	3,654.0

Subway.

This contract was awarded to the city and sublet at the same prices to Lethbridge contractors. This was done to keep the work in the city. The final estimate was paid on:

Grading	8,784 cubic yards
Excavating	1,312 cubic yards
Piling	13,108 lineal feet
Concrete: Class I.	952 cubic yards
" Class II.	320 cubic yards
" Weeping Drains	142.5 lineal feet

High Pressure System.

13th Street North	14-inch steel	1,430 feet
5th Avenue North	12-inch steel	4,638 feet
Total		6,068 feet

Watermain Extensions.

12th Ave. and 13th St. South	8-in. steel	250 ft.
Lane between 13th and 15th Sts. ..	6-in. steel	690 ft.
15th St. between lane and 14th Ave.	6-in. steel	1,150 ft.
Total		2,190 ft.

Storm Sewers.

This work had to be done in connection with the subway, and started from Second Avenue North with 24-inch pipe up to First Avenue South, and a piece forty-eight feet long across 13th Street South at First Avenue.

13th St. from 2nd Ave. N. to 1st Ave. S.	24-inch	770 ft.
1st Avenue South		50 ft.
Total		820 ft.

GYPSUM IN CANADA.

In reviewing to considerable length the Department of Mines report by L. H. Cole on "Occurrence, Exploitation and Technology of Gypsum" Engineering (London) closes with the following remarks:

"The conclusion to which we are rather reluctantly driven from the study of this careful digest of the condition of an important industry is that there is room for the exercise of greater enterprise and, possibly, for the employment of larger capital. In the last six or seven years the increase has been inconsiderable, and by no means uniform. The number of operatives employed is comparatively small, in the largest works usually not more than 100 or 120. In the arts and manufactures gypsum plaster and calcined gypsum are finding many new applications, and the demand for the raw material should steadily increase. The Government are fully alive to the need of assisting development, and this report shows their willingness to foster an industry whose extension would be eminently beneficial to the Dominion."

CANADIAN CANAL TRAFFIC IN 1914.

THE statistics compiled by Mr. J. L. Payne, comptroller of statistics for the Department of Railways and Canals, Ottawa, place the volume of traffic through all the canals of Canada during 1914 at 37,023,237 tons, as against 52,053,913 tons in 1913—a decrease of 15,030,676 tons. The distribution of traffic, together with decreases and increases, was as follows:—

Canal.	Tons.	Increase. Tons.	Decrease. Tons.
Sault Ste. Marie	27,549,184	......	15,100,140
Welland	3,860,969	290,255	....
St. Lawrence	4,391,493	89,066	....
Chambly	436,905	....	118,697
St. Peters	54,180	....	17,334
Murray	83,907	....	96,669
Ottawa	335,132	....	30,306
Rideau	151,739	....	19,484
Trent	67,715	11,915	....
St. Andrews	42,013	....	39,282
Total	37,023,237	391,236	15,421,912

It will be observed that the unprecedented falling-off in traffic during the year 1914 occurred almost wholly at Sault Ste. Marie. Of the total decrease of 15,030,676 tons, 1,748,669 was in Canadian and 13,282,007 in American waterborne commerce. The decline in American traffic was very largely in the movement of iron ore from the head of Lake Superior to ports on Lake Erie.

The gross traffic through the canals since 1905 has been as follows:—

Year.	Tons.	Year.	Tons.
1905	9,371,744	1910	42,990,608
1906	10,523,185	1911	38,030,353
1907	20,543,639	1912	47,587,245
1908	17,502,820	1913	52,053,913
1909	33,720,748	1914	37,023,237

The stringent nature of lighting regulations now existing in cities and towns of Great Britain is naturally disadvantageous to road users. The Automobile Association and Motor Union have taken the matter up in London and have made the suggestion that the responsible authorities in the Metropolitan area arrange for the curbs at darkened corners and street-refuges to be whitened. As a result a number of authorities have instructed their surveyors to take the necessary steps to whiten the curbs at certain places within their jurisdiction. This will undoutbedly be of considerable assistance in minimizing the possibility of accident, and the hope is expressed that the action which is being taken in London will be followed by the authorities in the various large towns where lights have been considerably reduced under the regulations made by the Home Secretary.

The United States Bureau of Mines has been endeavoring to increase safety in mines and to abolish conditions which tend to impair the health of miners. Much study has been devoted to the kind of explosives used in mining and the conditions under which these explosives can be used with least danger. Several years ago a bulletin was issued on explosives for coal miners. Another is now in press, devoted to explosives for metal miners and quarrymen. It contains chapters on combustion and explosion; blasting and mine explosives; fuse, detonators and electric detonators; firing blasts by electricity; the use of explosives in excavation work; the use of explosives in quarrying; the use of explosives in metal mining and tunnelling; drilling and blasting methods on New York rapid-transit tunnel; magazines and thaw houses; permissible explosives, etc.

LATERAL FLEXURE OF STRUCTURAL MEMBERS.

THE subject of lateral flexure of hollow pieces is considered by M. Henri Lossier in a paper appearing in March 6th, 1915, issue of Le Génie Civil. It is shown how errors in calculation may be made, and avoided. Referring to the diagrams, the writer points out that steel or reinforced concrete pieces of construction often involve elements under compression, constituted by two parallel members *A*, united at equal intervals by cross-pieces *B*, so as to form a rigid structure. At *M*, for instance, is shown an iron structure in which the members *A* consist of channel irons and *B* (see *N*) of double pieces of sheet metal. In *O* the members are angle iron and the cross pieces sheet metal, crossing each other at right angles. In either case each unit carries with it at least two rivets. *R* shows a hollow element of length *L*, containing four equal rectangles and being under the action of an axial compression *P*.

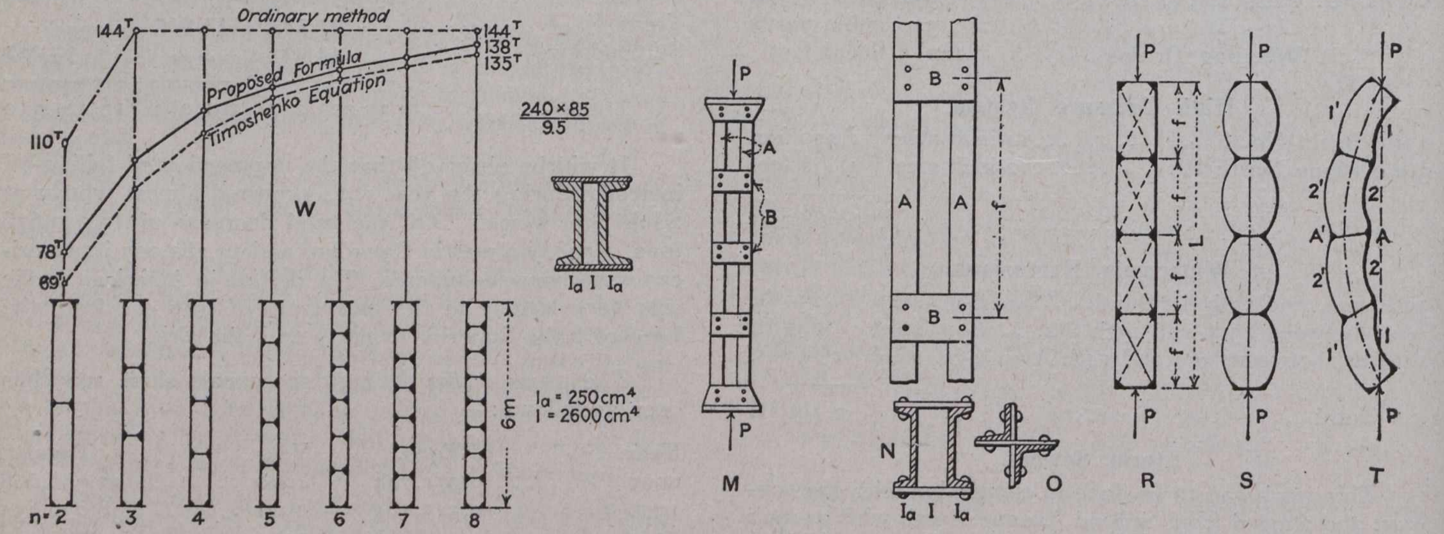


Fig. 1.—Diagrams of Lateral Flexure of Hollow Pieces.

It is usual to compute the stresses on such an element by considering it as being similar to a solid prism having the same moment of inertia and then taking its resistance to lateral flexure as being equal to that of a trunk or length *f*, taken between two consecutive cross-pieces. Such a method of computation, which would be all right if the cross-pieces were supplemented by diagonal members (indicated in Fig. *R* by dotted lines), would be correct for this case only if the flexure of the element occurred as indicated in Fig. *S*, that is, with the axis remaining rectilineal all through the deformation. Actually, however, the flexure will occur by a lateral bending of the axis, as shown in Fig. *T*.

Because of such a deformation the following takes place: (*a*) The normal stresses, of which the initial value for each member is *P*/2, undergo a decrease in the convex member *A′* and a corresponding increase in the concave member *A*. This effect has its maximum value in the central trunks 2-2′.

Because of the absence of diagonal stays and rigidity of the structure, secondary flexures occur both in the members and cross-pieces; these flexures, which are functions of the shearing stresses, reach their maximum values in the end trunks 1-1′.

The author recommends, therefore, for the calculation of such elements, the following formula and states that the fatigue of members will increase indefinitely as long as the stress *P* exceeds the critical value of P_f equal to

$$P_f = \frac{\pi^2 EI}{L^2}\left[\frac{\alpha}{1+\frac{I+2I_A}{2.5n^2 I_A}\cdot\alpha}\right]$$

where *E* is the modulus of elasticity of material, *L* length of flexure, I_A the moment of inertia of the member *A*, *I* the moment of inertia of the entire element,—that is the two members, *A*, $n = \frac{L}{f}$. α is a variable coefficient which is a function of the number of sections *n*, and has the following values:

n =	2	3	4	5	6	7	8	∞
α	1.62	1.22	1.11	1.07	1.05	1.04	1.03	1.00

This formula is not new and its first member is simply the Euler formula, giving the bending resistance of a solid prism having a moment of inertia equal to *I*. The second part, which will be referred to later on as *k*, has a coefficient smaller than unity, towards which it tends as the number of sections increases, so that for $n = \infty$, $k = 1$. In other words, *k* represents the ratio of the resistance of a hollow prism to that of a solid prism. The author recommends, therefore, the adoption of the following rule: In a piece under compression, consisting of two parallel members connected into a rigid structure by cross-pieces located at equal distances from one another, the coefficient of permissible work is equal to the coefficient for a solid prism of the same moment of inertia multiplied by a coefficient *k*, less than unity, and given by the formula

$$k = \frac{\alpha}{1+\frac{I+2I_A}{2.5n^2 I_A}\cdot\alpha}$$

From a numerical example, the author obtains curves shown in Fig. *W*, in which he uses for the upper curve (ordinary method) the Euler formula; next, the full drawn out curve represents what he would obtain with the formula proposed in this article, and finally the third curve is obtained by the Timoshenko formula, which the present writer uses in the form

$$P_{cr} = \frac{1}{\frac{L^2}{E.I.\pi^2}+\frac{f^2}{24E.I_A}}$$

obtained by neglecting the deformation of the cross-pieces. This figure shows that with the exception of very small values of *n*, it gives results fairly close to those obtained by the Timoshenko formula which apparently tends to prove its correctness, as the Timoshenko formula is one of late date and apparent reliability.

GREAT BRITAIN AND THE STEEL TRADE.

THE position held by Great Britain in the steel trade of the world was the subject of an article appearing in a March issue of "Made in Britain," from which the following abstract is made:—

Living, as we are, in the steel age, it is perhaps not surprising that the mind instinctively classifies nations according to their relative positions as iron and steel producers and traders. The non-technical man, therefore, on the strength of a tradition that was until recent years acknowledged throughout the world, unhesitatingly places Great Britain first in the list. Thirty years ago that idea would have been quite sound, for then Great Britain was by far the largest iron producer in the world, with an output of nearly 7½ million tons of pig-iron—the raw material of all iron and steel products—compared with some 4,000,000 tons in the United States, about 3,700,000 tons in Germany and 1,500,000 tons in France. To-day, however, Great Britain takes a bad third place, with an output of only 10½ million tons of pig-iron, while the United States leads with about 30 million tons under normally prosperous conditions, and Germany takes second place with about 19½ million tons. The production of pig-iron, however, represents only part of the case, so we may examine the next stage—the manufacture of steel in its preliminary or ingot form. Here the position is relatively similar, the United States retaining a hopeless lead and Germany more than doubling British production. In passing, it may be remarked that the growth of the German steel output has been almost phenomenal; it has trebled in about the last fifteen years.

The moral to be drawn from the foregoing facts, however, is not that Great Britain is decadent, as some wise men with a little knowledge would have us believe; the fact is that she obtained a good start in the matter of industrial progression and the development of natural mineral resources, and placed herself in a position which was not really in keeping with her size, population or resources. America, on the other hand, was a country in practically the infancy of development and it was not then known that her natural resources of coal and iron—the two essentials for a great steel industry—were so immense as to dwarf those of the older countries. We now know that it is vain to dream of competition with America in the matter of quantity of coal and iron output, though that fact, of course, does not discount the importance from a commercial standpoint of the British coal and iron industries. To-day we have, and are likely to retain for very many years, a vast coal-exporting business, amounting in 1914 to 62,000,000 tons, exclusive of 18,500,000 tons shipped as bunkers, while the fact that in the same year we exported 4,000,000 tons of pig-iron and manufactured iron and steel (apart from machinery of all sorts, hardware, etc., and ships), testifies to the hold which we have kept on the world's markets.

When it is recalled that these exports included railway rails and material, plain and shaped bars of a large variety, joists and girders, hoop and strip iron and steel, sheets and plates, tinplates, galvanized sheets, forgings, castings and a variety of other descriptions representing the sale of a large amount of skilled labor and technical knowledge in manufacturing, it will be seen that Great Britain, though superseded, is not useless in the steel trade.

A fact that is of interest is, that the rise of the German industry has been chiefly due to the technical discovery in the early 'eighties of two Englishmen—Thomas and Gilchrist—who, by the discovery of what is known as the basic process of steel making, rendered valuable and usable the hitherto useless phosphoric ores of Germany. The same process has permitted the economic development of one of the greatest ore fields in Europe—that lying in the Lorraine area and extending into both French and German territory. This fact incidentally explains the rise in the French iron production from about 1½ million tons in 1886 to 5½ million tons in 1913.

Not only has Great Britain given a lead to the world in the inception of the great steel age, but she has been in the front rank in the scientific and technical discoveries that have produced the modern steels on which engineering in all its branches is now dependent. The limitation set by the nature of wrought iron—the chief form of commercial iron in the days before Bessemer astonished the world by his process of producing what is now known as mild steel—rendered the progress of engineering, as we now understand the term, practically impossible. The cost of producing steel by the pre-Bessemer process confined the material to tools and similar appliances, and all stuff for work of any size was perforce a combination of wrought iron and cast iron. To-day we have almost every grade of steel, from mild forgeable qualities suitable for the varied requirements of the structural engineer to the tool steels of glass-scratching hardness and which will cut other steels and cast irons at even a red heat—a thing which would have been accounted an extraordinary absurdity a few years ago. British initiative and research is responsible for these developments also.

In the face of these facts there would appear to be no reason for pronouncing the decadence of Great Britain in the great steel industry, nor is there any cause for such a pronouncement in a general sense. The world is continually presenting new fields for the disposal of steel and iron products of every description, from the raw pig-iron and the plain bar of steel to the highly-complex finished machine or locomotive; and Great Britain is still one of the countries to which consumers in these markets first appeal. The years of steady development of plant and machinery, processes and technical skill, cannot be duplicated readily; even the raw materials are handy in a new country. Moreover, many countries (Sweden and Spain are good examples) with ore resources lack fuel resources, with the result that they are rather exporters of raw material to Great Britain and other producers of manufactured goods, than producers themselves.

PUBLIC WORKS IN BRITISH COLUMBIA.

The estimates of expenditure of the British Columbia Government includes appropriations for the Public Works Department of $3,171,850. This sum includes $598,100 for works and buildings and $2,466,800 for roads, streets, bridges and wharves. Mr. J. E. Griffith, Deputy Minister and Public Works Engineer, informs us that his department purposes proceeding with the extension of the court house at New Westminster, the preparation of the site for the government buildings at Prince Rupert and the erection of several schools and other buildings throughout the province. There will not be much new work undertaken this year in connection with highways, states Mr. Griffith. The funds are ample, however, for the carrying out of extensive improvements to existing roads and for the proper maintenance of the present highway system.

LOCK ENTRANCE CAISSON, PANAMA CANAL.

IN connection with the various equipment required for the maintenance of the Panama Canal locks, there is a huge floating gate or caisson which will be used for closing the entrance to any one of the lock chambers of the Panama Canal, when it is desired to paint or make repairs to any one of the mitering lock gates, and for similar use in the Balboa dry dock. It also can be used for unwatering any one of the lock chambers, for the purpose of making an inspection of the culvert, rising stem gates, or cylindrical valves. Its construction and use is most interesting, as indicated in the following description written for the "General Electric Review" by L. A. Mason of the maintenance engineering staff of the canal.

The clear width of the lock chambers is 110 feet. Beyond the line of the emergency dams, the approach is widened by an offset of three feet on both sides. The

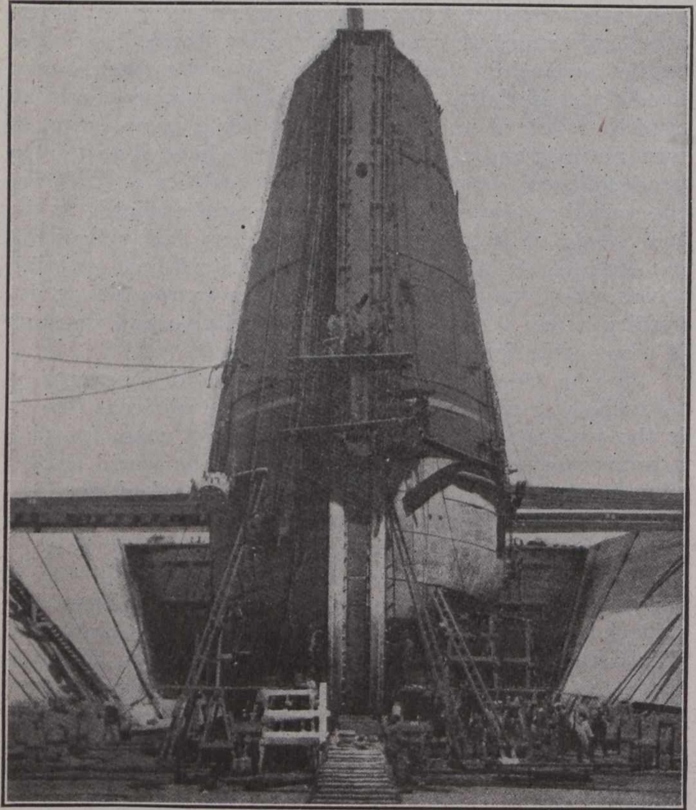


Fig. 1.—Caisson Under Construction for Panama Canal Locks.

shoulders so formed, with the connecting horizontal sill across the bottom of the chamber, afford a frame or seat into which the caisson is fitted to dam off the interior of the lock chamber.

This is accomplished by floating the caisson from its mooring position by means of a tug boat, or other motive-power water craft, to the particular lock chamber entrance which is to be dammed. After being placed in its recess across the lock entrance, water will be let into the lower compartments, thereby causing it to sink until properly seated. When this is completed, an electric power cable will be connected from the main power cables, provided within the lock walls, to a terminal box located on the top deck and at the end of the caisson. This point is electrically connected through the switchboard within the caisson to the various motors that operate the pumps. The pumps will then unwater the lock chamber, and the water pressure on the outer side of the caisson will force it securely against its seat in the masonry.

When it is desired to remove the caisson, the lock chamber will first be filled with water by opening the culverts within the lock walls. This will balance the water pressure on both sides of the caisson, at which time the water within it will be pumped out, thereby causing it to float and allow it to be towed away.

The caisson is designed for use at all of the lock entrances, and has a light-draft of 32 feet to permit its being handled conveniently through the various locks. The top of the sill at the Pacific end of the Miraflores locks is 50 feet below mean sea-level, and with the tidal fluctuation which raises the level of the water as high as 11 feet above mean tide this requires that the caisson be sunk to a draft of 61 feet when used at high tide. Provision for a proper freeboard requires an aggregate depth of the structure of 66 feet. The achievement of statical stability at the various depths of immersion without undue bulkiness or excessive weight in the different drafts makes the caisson of especial interest.

In form, the bottom of the hull is convex, the ends pointed, and the sides sloped inward from the maximum width of 36 feet, at about one-third the way up from the keel, to a breadth one-half as great at the top deck.

A typical transverse cross-section of the caisson resembles in outline the vertical section through a pear-shaped, carbon-filament electric globe. The horizontal lengthwise sections vary with the inward slope of the sides; in general, they resemble those of the ordinary vessel of commerce, and may be described as flattened ellipses, blunt at the ends in order that they may connect to the vertical end-girders, or stems. The maximum length of the caisson from vertical end to vertical end is 112 ft. 6 in. The extreme length is 113 ft. 10 in. This includes the timber cushions.

It is desired that the side walls of the locks shall carry practically all the static load from the caisson when it is supporting the water pressure. Accordingly, there are a number of horizontal decks and breasthooks, or short decks, between the main decks at the ends which carry the hydrostatic load to the vertical ends. A system of vertical framing built intercostally and extending from the keel to the top deck transmits the panel loading to the various horizontal decks and breasthooks. The essential features of the structure are the transverse and longitudinal framing, with bulkheads; the horizontal plate decks, girders and stringers; the girders at the vertical ends and along the keel; the end breasthooks; and the sheathing plates to cover the skeleton for forming the hull proper. These elements are made from open-hearth structural steel.

The transverse framing system consists of nine cross-frames, spaced 12 feet apart from the middle of the caisson and extending to its entire height, and the intermediate frames, spaced two feet apart between the main cross-frames. All are built intercostally between the five horizontal decks.

The last cross-frame at each end is made water-tight, by the same principle as is used in merchant ships, in order to form peak trimming tanks for maintaining a level keel when placing the caisson in its recess across any one of the lock chambers. The seven other cross-frames serve as swash bulkheads for controlling the water within it.

The five horizontal decks are located at the respective following distances above the centre-line of the keel plate: 16 ft., 25 ft., 37 ft., 49 ft. and 65 ft. The 16-ft. and 25-ft. decks are entirely plated over with the exception of openings left to allow for the removal of pumps, valves, etc.

The 37-ft. deck is entirely plated over and is made absolutely water-tight. It has water-tight manholes for gaining access to the various compartments below and water-tight hatches for the removal of the pumps or valves in case it is necessary to make repairs, etc., to them. This deck is made of sufficient strength to withstand a hydrostatic head of 25 ft. Upon it is placed the various motors for operating the pumps, the switch-board, the water gauges, the chain lockers, etc. The horizontal deck 49 ft. above the centre-line of the keel is of the open-truss construction, and has diagonal bracing for the central two-thirds of its length and plating covering for the ends. The top deck, 65 ft. above the centre-line of the keel, is plated over from end to end and has openings for manholes, skylights, deck cranes, companionways, ballast compartment vent pipes, and scuppers.

The breasthooks, or short decks, of which there are six in number, serve to transmit part of the loading from the horizontal decks to the vertical end-girders. In addition to the decks and breast hooks, there are located equidistant between the keel and the 16-ft. horizontal deck two lines of intercostals extending longitudinally and securely riveted to the transverse frames and to the sheathing.

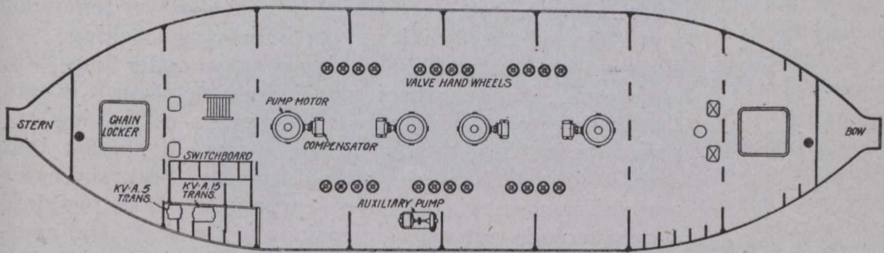


Fig. 2.—Plan of 37-ft. Deck Showing Lay-out of Apparatus.

For transmitting the end reactions from the horizontal decks and breasthooks to the vertical end-girders, or stems, steel castings are provided and made to fit very closely between the horizontal decks and breasthooks and the vertical ends, to which they are securely riveted.

The skeleton or framing is entirely sheathed over with steel plating worked in in-and-out strakes, running longitudinally over the transverse frames, making lap seams and butt joints which have double splice plates. Around all of the openings in the plate decks, and in the sheathing, doubling or reinforced plates are fitted. To protect the sheathing when manoeuvring the caisson near the lock walls, fenders are provided on the exterior of the sheathing along the 25-ft. and 49-ft. levels, and vertical fenders are placed between the horizontal ones at seven of the amidship cross-frames. The fenders are built of bent plates, securely riveted and caulked to the sheathing plates; the space between is filled with "Petrolastic" cement—a by-product of crude oil. Its specific gravity is 1.02; its expansion at a temperature of 110 deg. is 0.0018, and its melting point lies between 150 and 200 deg. F.

Because of the long towing distance from the place where the caisson was built, two large towing rings are provided and are securely fastened to the sheathing and to the 43-ft. breasthook at both ends and on each side of the caisson. As a means for towing the caisson from its mooring position to any one of the lock sites, there are three towing rings provided which are securely riveted to the sheathing along the level of the 37-ft. horizontal deck on both sides of the caisson.

Along the exterior of the keel and the vertical ends, steel castings (the cross-sections of which are channel-shaped) are provided and are securely riveted to the keel, vertical ends, and sheathing. Into these there are neatly fitted and bolted British Guiana greenheart and Australian ironbark timber cushions. There is also a cushion fitted along the sides of the keel and along the sides of the vertical ends, which are also made of the timbers mentioned. These cushions come into contact with the caisson's seat provided in the lock chambers and form a water-tight seal.

ELECTROLYTIC CORROSION IN SOILS.

In a recent issue of the Electric Railway Journal, Messrs. L. A. Stenger and E. H. Scholfield describe some laboratory experiments intended to prove that electrolytic corrosion of metallic structures takes place under certain conditions naturally, and is not dependent entirely on stray traction currents. There are two classes of cases which are considered. First, there is a case where a metal such as cast iron or steel contains impurities in its structure, and, secondly, there is the case of the metal, like lead, which is ordinarily considered non-corrodible, but which is none the less liable to corrosion if in contact with two soils of different compositions,—*i.e.*, containing two different electrolytes. These two cases were studied experimentally, a large number of soils being collected for the purpose of the tests, and in both cases it was established that corrosion, undoubtedly of an electrolytic nature, was set up, owing to the natural action of the soil, and quite apart from any effect which could be due to stray currents. Cast-iron samples, where corroded, were covered with a hard scale of rust and soil; the pits in the cast iron were local, and filled with carbon and black iron oxide. The lead samples showed the presence of both the gray and the brown oxides. Potential differences up to one volt were generated by placing different metals in contact with certain soils, or by placing two pieces of similar metal in contact with different soils.

PROGRESS ON ROGER'S PASS TUNNEL.

The announcement which appeared in last week's issue to the effect that a $300,000 contract had been awarded for lining another section of Roger's Pass tunnel indicates that very substantial progress has been made during recent months,—progress comparing favorably with the tunneling records published a few months ago.

At the end of March about 10,000 feet of the pioneer tunnel had been driven from the eastern portal and about 6,000 feet from the western portal. The main tunnel had been driven for 4,580 feet from the eastern portal, and for 4,439 feet from the western portal.

Such good tunneling progress has been made that it is now expected that the project will be completed and ready for service during the summer of 1916, although the specified date of completion is January 1st, 1917.

The tunnel is being constructed by Messrs. Foley Bros., Welch and Stewart, for the Canadian Pacific Railway Company.

THE STABILITY OF QUAY WALLS ON EARTH FOUNDATIONS.

In spite of the large amount of experience which has been gained in the construction of quay walls, it is still one of the most difficult problems in engineering .o design a wall on an earth foundation with confidence that it will be stable when completed. A warehouse or a bridge can now be designed not only with the assurance that it will bear its load, but also with a knowledge of its factor of safety sufficiently accurate to satisfy the designer that material has not been wasted. But the same cannot be said of a retaining wall on a soft bottom—at all events not of a wall, say, 40 to 80 ft. high, such as is commonly needed to sustain the quays of a modern dock. Even if the designer of such a wall is assured that it will stand, he cannot with any confidence tell you what factor of safety it possesses.

The cause of his uncertainty is, of course, the difficulty of ascertaining the actual lateral pressure imposed by an earth backing and the actual resistance offered by an earth foundation. His difficulties are thus different from those of the engineer who has to design large masonry dams. The latter structures are invariably placed upon a foundation of solid rock, and the designers' chief care is that the stresses in the masonry of which the dam is composed shall not exceed a safe limit. The dock engineer, on the other hand, has to be confident that his wall shall not move as a whole on the comparatively soft material on which such structures have, in general, to be placed.

The problems which he encounters are dealt with in a recent paper by F. E. W. Shields, M.I.C.E., presented to the Concrete Institute (Great Britain). The paper considers the uncertainties and difficulties which the designer of a quay wall has to face, and, in a measure, ascertains how far calculations can assist him, and how far he must trust to judgment based on experience. The importance is emphasized of collecting information upon this subject in the hope that by degrees these difficulties and uncertainties may be cleared away.

A retaining wall may fail as a whole in two ways—by sliding forward on its base, or by overturning; the former mode of failure being by far the more common.

The conditions of stability in a gravity wall are summarized thus: The forces tending to thrust the wall outwards (generally the lateral pressure of the earth backing) must be at least equalled by the forces tending to restrain it or thrust it inwards. The latter forces are generally the pressure of the water under it in front of it, the resistance of the earth in front of its toe, and the horizontal resistance to shear at the base of the wall. If these horizontal forces balance, the wall cannot slide forward.

The resultant of the outward forces, however, is almost at a higher level than the resultant of the inward forces. Thus a couple is formed tending to overturn the wall about its toe. This couple induces a counter-couple tending to keep it upright. The forces forming this counter-couple consist, on the one hand of the weight of the wall acting vertically downwards, together with the weight of any earth or water which may lie above the base of the wall, and on the other hand the upward resistance of the earth under that base.

If the upward resistance of the earth beneath the wall is capable of forming with the downward weights a couple at least equal to the overturning couple, the wall cannot overturn.

In order that the earth beneath the wall shall be capable of forming this righting couple, two things are necessary. It is obvious that the centre of the earth's resistance must be forward of the centre of gravity of the wall and of other loads on the base, and generally it is forward also of the mid-point of the base of the wall. Consequently the intensity of upward resistance is generally greatest at the toe and least at the heel. To preserve stability the resistance at the toe must not be greater than the maximum which the earth is capable of offering, and that at the heel must not be less than the pressure induced by the tendency of the earth to rise at this point.

Calculations for the stability of quay walls cannot be always relied upon, and failures on the one hand and waste of material on the other are liable to occur even to the must careful and experienced designer. This, however, is not saying that such calculations should be entirely ignored. On the contrary, they are most useful in suggesting means for increasing in the most economical manner the stability of designs, which are known or suspected to be weak.

The author of the paper deals with some devices which have been used for increasing the stability of quay walls, namely: (1) Admission of water into dock, (2) sinking foundations deeper, (3) building buttress walls in front of main wall, (4) making wall wider, (5) removing a portion of the backing, (6) improving backing, (7) sloping base of wall, (8) driving piles under base, (9) anchor ties, (10) lengthening toe. In conclusion it is said that owing to the difficulty and expense of making experiments on large walls, it is the more important that careful records be kept and published of both successes and failures in this class of structure. Such records should include not only dimensions of the wall, and careful notes as to the nature of the materials employed, but also the calculations for stability, with the formulæ used, the assumptions made for the values of constants in those formulæ and the reasons for such assumption.

It is, of course, unlikely that it will ever be possible to design large quay walls purely from rules and without some measure of judgment, but if a body of information could be collected and analyzed, it would help to clear away some of the uncertainties which now beset the troublesome problem.

NEW GRAND TRUNK SUBURBAN TYPE LOCOMOTIVES.

Six suburban type locomotives have recently been put into service by the Grand Trunk Railway between Montreal and the outlying centres of Vaudrieul and St. Hyacinthe, 24 and 37 miles distant respectively. The traffic on these lines was previously handled by 4—4—2 suburban type locomotives with 17″ x 22″ cylinders and a total weight of 128,600 pounds. As this traffic increased, 20″ x 26″ moguls and ten-wheelers were also used. New suburban cars have recently been placed in service which weigh 138,000 pounds as compared with 75,000 pounds weight for the older class of cars. The number of cars in a train has also been increased.

The new engines are handling an average train of 7 cars. Trains of 5 cars were the average with former power.

Some features of the engines are: the combination of the Gaines combustion chamber and a security brick arch, Schmidt superheater, outside steam pipes, vanadium cast steel frames, self-centering valve stem guide, extended piston rod, improved throttle lever bracket, and long main driving box.

NEW OVERHEAD BRIDGE AT MOOSE JAW

STEEL TRAFFIC BRIDGE OF TWO PIN-CONNECTED THROUGH SPANS WITH TIMBER TRESTLE APPROACH OVER THE CANADIAN PACIFIC RAILWAY TRACKS AT EIGHTH AVENUE WEST.

THE Canadian Pacific Railway Company's main line from Montreal to Vancouver runs east and west through the city of Moose Jaw, and divides it into two parts. In order to provide traffic facilities between these two districts, the Railway Commission ordered the erection of an overhead bridge across the C.P.R. tracks and near the centre of the city, known as 6th Avenue Overhead Bridge. This bridge was completed about four years ago at a cost of about $90,000. In order to accommodate the increasing traffic between the two sections of the city, a subway was completed at the east end of the city in 1913, at a cost of $125,000.

The new overhead bridge, which Mayor Pascoe opened a week or two ago, has been constructed at the western end of the city in order to give farmers from the southern part of the surrounding country a ready means of access, not only to the north, which is the principal business part of the city, but also to the Government terminal elevators, which are situated about half a mile west of this bridge.

The structure is 1,170 feet long, and comprises two approaches on timber trestles, the one from the north being 645 feet long, and the one from the south 150 feet long. These trestles are comprised of fir pile supports carrying frames 15 feet apart made up of 12″ x 12″ timbers. The stringers rest on 12″ x 12″ caps, and are of 6″ x 6′ timber spaced 2 feet 1 inch apart. Provision is made on the left-hand side of the roadway, which is 30 feet wide, for street car line, the rails for same being carried on 12″ x 16′ stringers. A 3″ x 16′ flooring was placed on the stringers. The flooring of the structure was paved with 3-inch wood block paving laid in accordance with the city of Moose Jaw's standard specification. The flooring was covered with a coat of tar, and while the tar was hot a double ply of tar paper was applied, on which was placed sand half an inch thick, in order to form a cushion for the wood block paving. On the east side of the structure a sidewalk 6 feet clear was constructed, carried on double 3″ x 12″ timber, which was jointed to the caps, a cross-brace of double 3″ x 12″ being carried from the outer extremity of this timber to the frame work.

Views of the 8th Avenue Bridge, Moose Jaw.

The remainder of the bridge is comprised of two steel spans of 157 feet and 218 feet respectively. Both spans are pin-connected through trusses, giving a clearance of

23 feet 8 inches from the base of rail of the Canadian Pacific Railway tracks which pass underneath the bridge at an angle of 80 degrees 30 minutes. These spans are supported on reinforced concrete piers supported on two pedestals 15 feet square at the base with reinforced concrete arch connections. The three piers contain 790 cubic yards of concrete, while 2,660 lineal feet of piling were used in the foundations. Both spans are fixed at the southern end, and have the expansion free end to the north. The two spans contain 428 tons of steel. Both spans have a clearance of 30 feet on the roadway horizontally, and a clearance from the crown of the road of 19.4 feet.

The same type of flooring and paving is provided on the steel as on the wooden approaches. The floor is carried on 8″ x 16′ stringers resting on floor beams with 40″ x 3″ web. The panels of the small span are 17 feet 2 inches wide. Those of the larger are 17 feet 10¾ inches. The sidewalk is carried on the east side of the structure outside the main truss, and has a clearance of 6 feet. It is supported on two 4″ x 3⅓″ x ⅜″ angles supporting ⅜-inch plate, and has specially designed 5½-foot circular posts which carry 2½-inch tubing spaced 10 inches apart vertically.

The loading for the bridge is 5,000 lbs. per foot on the street railway, with impact of 50 per cent. of live load, and on the roadway 100 lbs. to the square foot. The sidewalk is figured at 80 lbs. per square foot. The total cost of this structure was approximately $87,000, which was distributed by the Railway Commission as follows: $5,000 from the Railway Crossing fund. Twenty-five per cent of the remainder to be borne by the city of Moose Jaw, and 75 per cent. by the Canadian Pacific Railway Company.

Messrs. Carter, Hall, Aldinger, of Winnipeg, were the contractors for the concrete work, timber approaches and decking, while the Hamilton Bridge Company were responsible for the steel construction. The whole structure was designed by the Canadian Pacific Railway Company's engineer, per C. D. McIntosh, divisional engineer, of Moose Jaw, while the interests of the city are looked after by Geo. D. Mackie, engineer-commissioner.

GROUND WATER SUPPLIES.

WHILE ground waters have always been used for domestic water supply purposes, their general use in connection with public supplies is of comparatively recent origin. In America it is the smaller places which are so supplied. In Germany, though, a large proportion of the municipalities derive their water supply from such sources.

Ground water is derived chiefly from that portion of the rainfall which is absorbed by the soil, but also to some extent from the surface water sources, water from which finds its way into the surrounding ground. Ground water sources may be roughly divided into springs, deep wells (sometimes called artesian wells), shallow wells and filter galleries. Of these the filter galleries are those which are, probably, the least commonplace. These filter basins derive most of their supply by filtration from some adjacent surface source. Usually they are not far beneath the surface of the ground. The proportion of the water obtained from the surface source varies greatly, in some cases being nearly the entire supply. In a few cases the yield of wells or filter basins has been increased by discharging water on the surface of the ground in the vicinity, thus creating what might be termed an artificial ground water.

The quality of a ground water supply is almost sure to be good if it does not receive drainage from a considerable population located near the source of supply or if it is not hard and does not contain iron or manganese. The iron is due to the passage of the water through organic matter which uses up the dissolved oxygen which the water may contain, and leaves it with carbonic acid in solution. The iron in the sand is readily dissolved by this solution. Then, as the water penetrates sand containing free oxygen, the iron is precipitated again and largely remains with the sand.

The relative merits of driven wells, dug wells or filter galleries are dealt with in a practical and concise manner by Mr. W. S. Johnson, who recently read a paper before the Boston Society of Civil Engineers on the whole subject of ground water supplies. Mr. Johnson claims that beyond question the dug well is the most satisfactory, provided the conditions are favorable and if the expense is not too large. Where water is obtained from some neighboring water source and the depth of porous material is small a filter gallery parallel to the shore of the surface source may be desirable. Where the water-bearing soil is at some considerable depth it is almost invariably much cheaper to obtain water by means of tubular wells.

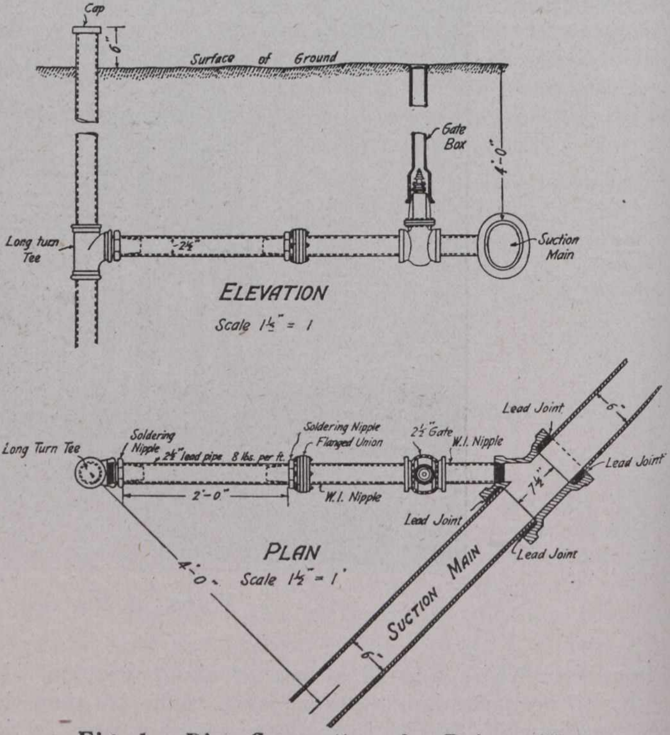


Fig. 1.—Pipe Connections for Driven Well.

Between these two extremes the best method to adopt must be determined by local considerations. One of the advantages of the dug well is that there is a large body of water in store from which to draw while the pumps are being run, and when this is exhausted the well has the time until the pumps are next operated to recover. This means that pumps of larger capacity can be used than with the driven well plant. Furthermore, under these conditions the average suction is likely to be less, as in the case of driven wells the ground water level at the wells goes down quickly when the pumps are started. Perhaps the chief advantage, however, of the large well is the avoidance of troubles from sand and air which are likely to occur in any driven well plant.

Another type of well, used considerably abroad, and to some extent in this country, is a large pipe 6 ins. or 8 ins. in diameter, which is driven into the ground and water is drawn from this well by means of a smaller pipe inserted in the larger one. This avoids the troubles with air and sand to a very large extent, but is, of course, somewhat more expensive.

A modification of this type is being used with very good success where sections of cement pipe or of tile pipe 2 ft. in diameter are sunk by dredging on the inside of the pipes to the required depth. Water is drawn from these by means of small suction pipes connected up as in the case of tubular wells. These wells are comparatively inexpensive and have proved very successful, avoiding most of the troubles which occur with the ordinary driven well.

The cost of a system for collecting ground water varies greatly with the local conditions.

The construction of tubular wells and the method of making connections with the suction pipe are of the greatest importance, as the leakage of a small quantity of air will cause endless trouble; and it is also desirable that it should be possible to cut out any particular well from the system.

The usual size of driven wells is 2½ ins. The adoption of this size is simply the result of experience, as it is found that this is about as large a pipe as can well be driven under ordinary conditions, and it is, of course, desirable to have the pipe as large as is feasible. For the well, an extra heavy wrought-iron pipe should be used, as in the process of driving the pipe receives very hard treatment and it requires a heavy pipe to stand the strain. The pipes are driven with open ends except in the case of very fine sand, when stringers have to be resorted to. The bottom length of pipe is perforated with a large number of small holes about ¼ in. in diameter for a distance of perhaps two feet from the end of the pipe.

The two methods of driving the pipes most commonly in vogue are the tripod and the platform methods. The use of the tripod is simpler, but the platform has the advantage of carrying the weight of the men upon the pipe, which assists materially in sending the pipe down with each blow. It would seem that raising the weight by a rope would be much easier for the men than to stoop down and lift the weight, as is necessary with the platform. Men, however, seem, if anything, to prefer this method to the tripod method.

After the pipe is driven and washed out, it is cut off at the level at which the suction is to be placed. A long-turn T is put on and then the pipe is continued up to somewhat above the surface of the ground, the object of the extension to the surface being to provide access to the well for cleaning out, as sand is likely to work into the pipe. The well is then connected to the suction with 2½-in. pipe and a lead gooseneck, each connection being provided with a gate so that it can be shut off in case it gives trouble. The object of the piece of lead is to give flexibility to the connection and prevent danger of leakage.

There is always a certain amount of sand which finds its way into the water, and to prevent this from getting into the pumps a sand chamber is put on the suction. This sand chamber is simply a large chamber in which the velocity of the water is sufficiently checked to permit the sand to drop out of the water.

Air is one of the great troubles in a driven well system, and in some cases pumps are installed which operate automatically to remove the air either from the top of the sand chamber or from a special air chamber constructed for the purpose.

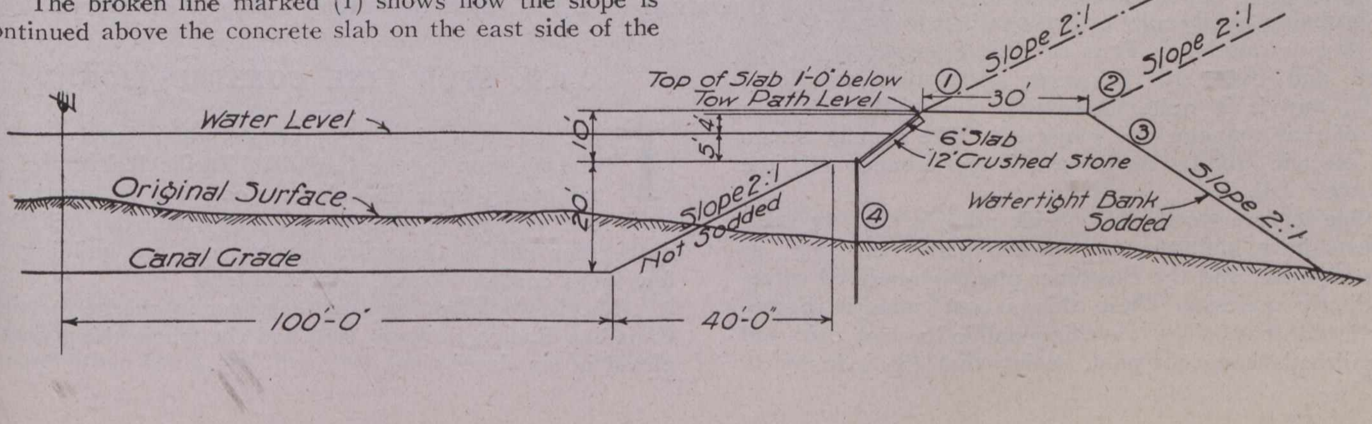
The development of the oil engine in connection with public water supplies is responsible in a very large measure for the increase of ground water supplies in recent years. The cost of construction and operation of a steam pumping plant is so great as to discourage a small town from installing a supply where these are necessary. The oil engine, however, is so much cheaper in first cost, and the cost of maintaining it is so small, that it is more economical to put in a pumping system and pump water from some nearby ground water source than to go to any considerable distance for a gravity supply.

WELLAND SHIP CANAL EMBANKMENT.

In connection with the article which appeared in last week's issue of *The Canadian Engineer* descriptive of the method adopted of protecting the slopes of the new Welland Ship Canal, the accompanying diagram, prepared from a sketch furnished by Mr. E. P. Muntz, the writer of the article, will be found of interest. The drawing, which is a typical half-section of the canal prism, requires the following explanation:—

The broken line marked (1) shows how the slope is continued above the concrete slab on the east side of the Canal, on which side there is no tow path. The dotted line (2) shows the continuation of the slope above the tow path in cuts on the west side. The full line (3) shows the back slope of the watertight embankment wherever it occurs on either side. All three slopes are being sodded.

The line marked (4) indicates the location of the 30-foot piles in the 70-foot cut on the Queenston Road. The function of these piles is fully described in the article.



UNITED STATES RAIL PRODUCTION IN 1914.

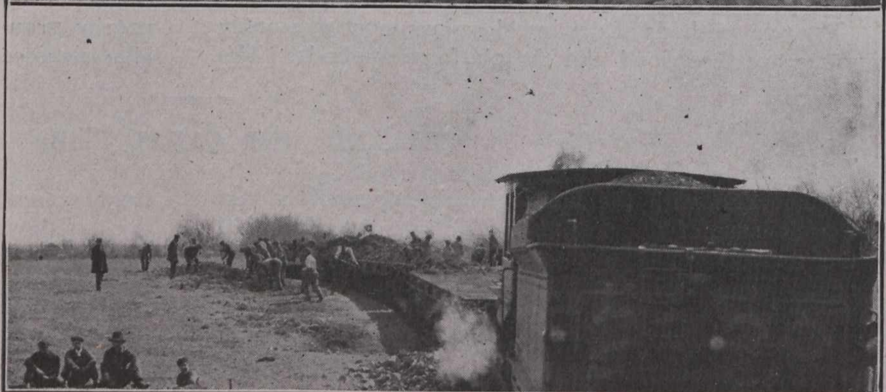
THE total rail production of the United States' mills was 44.5% less last year than in 1913, and 51% less than that of 1906, the record year. The high production in 1906—over twice that of last year—was due in large measure to the demand for heavier sections to replace a large proportion of the rails then in service, rails that were found incapable of standing up under the heavier cars and locomotives that had rapidly come into vogue.

Records are not frequently broken in rail production, and it may be several years before the 1906 record is passed. Such a thing is not new in production statistics. There was a maximum reached in 1887, due to the building of new road, and that record was not broken until 1899, 12 years later. Moreover, there were heavy imports in 1887, so that the apparent consumption of that year was not exceeded until 1901, 14 years later.

It may be interesting to estimate where the rails went. The total United States production in 1914 was 1,945,095 tons. The exports were 174,680 tons, or 62% less than in 1913, so that the export trade fell off more than the domestic. There was 238,423 tons of rails under 50 pounds per yard, and while some of this tonnage was exported the major part stayed at home and did not go to steam roads, but to various industrial operations. Then there was 136,889 tons of girder and high T rails for electric and street railways, a decrease of 29.9 per cent. from 1913, or much less decrease than there was in the total. Then there was a tonnage of standard T rails that went to industrial operations and to electric lines. Making allowance for these various items, it appears that in 1914 there was about 1,300,000 tons, or a trifle more, that went to the regular steam roads.

It is of interest also to note that the Bessemer rail has almost disappeared. Of rails reported by processes (excluding the tonnage of re-rolled rails) Bessemer comprised only 17.5%, whereas it was not until 1911, three years earlier, that the open-hearth rail passed the Bessemer. Even this 17.5% of Bessemer rails in 1914 was probably nearly all "exceptional" in one way or another. Thus of rails 85-pound and over the Bessemer proportion was only 10.9%, and it is quite likely that a considerable part even of that tonnage was exported. The regular steam and electric roads have practically abandoned the Bessemer rail.

One feature worthy of consideration is that the steel interests have built the open-hearth plant necessary, at great expense, and the Bessemer plant is rendered correspondingly useless. These things cost money. Somebody has to pay. The travelling public has not paid and the railroads have not paid, seeing that the industry in 1906 made practically 4,000,000 tons of rails, with scarcely any open-hearth, and the average annual production since then has been less than 3,000,000 tons. The Steel and Metal Digest speaks up for the steel mills, and asserts that these mills have quietly stood the expense with no public word of complaint.



Ballasting Operations on C.P.R. Spur to Cavalry Camp, Near Dorval, Que.

C.P.R. SPUR LINE CONSTRUCTION.

THE accompanying photographs refer to a recent construction by the Canadian Pacific Railway of a temporary spur line about 2,000 feet in length to the new cavalry remount camp which the military authorities of the Dominion government are building a few miles east of Dorval, near Montreal.

Mr. R. McKillop was the engineer in charge for the Canadian Pacific Railway, and had the whole thing completed in six days' time.

Editorial

WATER POWER INVESTIGATION IN NOVA SCOTIA.

The Nova Scotia Water Powers Commission, created about a year ago by the Government of the Province of Nova Scotia for the purpose of investigating and reporting on the whole question of water power administration, development and use in Nova Scotia, has recently effected a co-operative arrangement with the Dominion Water Power Branch of the Department of the Interior, covering a physical investigation of the water power resources of the whole province.

An engineer of the Dominion Water Power Branch has been attached to the staff of the commission with headquarters at Halifax, N.S., to have personal direct charge of the field surveys that will be carried on under the co-operative arrangement. For the present year the work will be confined to the power rivers of immediate importance, but will be gradually extended to cover all the rivers of the province.

COUNTIES AND THEIR ENGINEERS.

The qualifications which a county engineer should possess are pretty well defined, although not required everywhere in the same degree. Some counties, by virtue of their size, topography, population and position with respect to centres of industry, commerce or other environments, command a calibre of service which not every county engineer can give. The prevalence of rivers and streams, of roads and crossings, of materials of construction, etc., in a well-settled county materially effects the nature of its requirements as to the engineering ability of him, in whose charge are placed the duties of economical maintenance and further improvements. There are too many counties that are backward in municipal development largely as a result of placing their engineering problems on the shoulders of totally unqualified men.

The following letter is from an engineer whom we know to have viewed the particular case to which he refers, in a broad-minded manner and from the viewpoint of a man of experience in matters pertaining to municipal engineering work. The letter reads:

"It may be of interest to members of the profession to learn that for several years one of the largest and most important counties of the Province of Ontario has had occupying the position of county engineer, certain individuals who do not, with any reasonable or accepted interpretation of the term, possess any of the qualifications characteristic of a civil engineer.

"A few years ago the county council appointed to occupy this position one who was, by neither education nor training, an engineer, civil or otherwise, but who had been a councillor and when defeated had apparently to be granted some consideration by his colleagues. Last year this gentleman died and the county council soon after appointed another councillor as his successor. Although some practical and professional engineers were among the applicants for the position they were entirely ignored, the competition being between two councillors, and politics evidently the only qualification necessary, in addition to presumption. The successful applicant was a retired farmer.

"The question as to what constitutes a civil engineer is in order, evidently, for the enlightenment of the councillors of the county in question. I know of no better than the following definition: 'One whose occupation, pursuit, or profession consists of the art and science of utilizing the forces and materials of nature for the benefit of mankind.'

"I understand the appointment of county engineer is provided for under and by virtue of the Municipal Act, and amendments thereto, R.S.O. and that the Act fails to provide a penalty in case of abuse thereof in the manner already indicated.

"It certainly cannot be maintained, nor is it tenable, that calling or appointing a farmer to be a civil engineer constitutes him such in the light of law, logic or commonsense, and any such appointment is fraudulent, and his efforts at engineering a menace to the safety and welfare of the public.

"Consider the outburst of indignation if this or any other council attempted to menace the office of county solicitor by the appointment of a farmer or any other person unqualified for that office. The County Bar Association (legal), the Law Society of Ontario, and every legal practitioner would soon be in array to squelch such impertinent and high-handed action.

"It seems clear that because the profession, occupation or pursuit of civil engineer is not incorporated in Ontario, this council considers itself free to impose on both the constituents and the engineering profession in the manner indicated, but they, nevertheless, do not escape the fact that such appointments are both illegal and fraudulent. The Act calls for the appointment of an engineer, not a farmer, jeweler, or follower of any other pursuit, and the payment of county funds to any other than a bona fide engineer constitutes the payment of such funds under false pretences."

This instance is but a companion to a number of others. The position of county engineer in this particular case is no place for an amateur. The county should awake to an early realization of the backward state of its drainage work as well as other phases of its development. It should have a competent engineer in charge. If it depends on a retired farmer plus politics to pilot it to the position it should hold among the other counties of Ontario in the matter of municipal improvements, it should not be surprised, in a few years, to find itself in advance only of those of its kind, whose shortsightedness has been still more pronounced.

"ONCE BIT, TWICE SHY."

A reader calls our attention to a letter which appeared in "La Lumière Electrique" and which is being circulated by the syndicate of engineers, boilermakers, and foundrymen of France to all firms engaged in the trades named. After offering official statements on the war in six languages for circulation to foreign clients and agents, the letter points out that the Germans and Austro-Hungarians who were resident in France before the war, whilst ostensibly earning their living, were at the same time assiduously preparing for war, and urges its readers to guard against similar tactics in the future. To this end, all French concerns are adjured never more to employ Germans or Austrians in any capacity whatever; never to accept the gratuitous services of young Germans or Austrians who may present themselves as "volunteers"; and not to renew agencies for enemy firms after the war, but to deal in or purchase only apparatus, etc., of French manufacture, or, if not made in France, of Allied or neutral origin, the principle being to abstain rigidly, in view of the mentality that has been unmasked, from commercial transactions with the Germans. The syndicate places its services at the disposal of readers, to furnish them with the names and addresses of French, British, American or other firms that make apparatus such as they have been accustomed to procure from Germany, or, in the case of items hitherto manufactured only in Germany or Austria-Hungary, to assist in the establishment of such manufactures in France.

In commenting upon and upholding this wise procedure, the "Electrical Review" (London) states:

"We wonder how many British firms that accepted the services of young Germans, 'desirous of learning the language' at a nominal price, have paid for their seeming economy with the loss of customers worth tens of thousands a year to them, on the return of their artless pupils to the Fatherland, loaded with detailed information regarding their trade and clientèle. Nevermore!"

There is a great deal of truth in the above, and it undoubtedly suggests a policy well worthy of adoption in Canada.

NEW EQUIPMENT FOR THE INTERCOLONIAL RAILWAY.

The Intercolonial is spending nearly $3,000,000 this year on equipment. This includes 12 super-heating locomotives, 10 Pacific type locomotives, 6 consolidated locomotives, 4 switching locomotives, ballasting equipment and rail loaders, 200 steel flat cars, 250 steel gondola cars, 4 light wrecking cranes, 8 sleeping cars, 4 steel sleeping cars, 4 baggage cars, 2 postal cars, etc. Some of this equipment has been delivered and placed in service. Double-tracking was part of an ambitious programme, which called for the outlay of several million dollars, but this is postponed for the time being. As regards the condition of the roadbed, the new and strengthened bridges, the new and enlarged stations along the line, and the new modern equipment, gradually being placed in service—the system shows marked and gratifying improvement. An outlay of $24,000 has just been made for safety appliances for equipment.

NEW OFFICERS, AMERICAN WATERWORKS ASSOCIATION.

At the convention last week of the American Waterworks Association, at which there was a registered attendance of 650, Nicholas S. Hill, Jr., of New York, was elected president; Leonard Metcalf, of Boston, vice-president; J. M. Caird, of Troy, N.Y., treasurer, and Carleton E. Davis, of Philadelphia, and C. H. Rust, city engineer of Victoria, B.C., trustees.

The next convention is to be held in New York City.

COAST TO COAST

Merritt, B.C.—Track laying has been completed between Miday and Merritt.

Walkerton, Ont.—The town's water supply has been rendered adequate by an additional well about 250 feet deep, recently driven near the reservoir.

Fredericton, N.B.—It is rumored that the St. John Valley Railway Co. may let a contract shortly to complete its line between Gagetown and Centreville.

Montreal, Que.—The civic officials are talking of buying out the Montreal Tramways Co. and establishing a municipal system, the total cost of which, in addition to projected lines, is estimated at about $50,000,000.

Saanich, B.C.—The municipality will shortly commence the installation of a $375,000 waterworks system, debentures for which have recently been floated. It is expected that a $450,000 pavement project will also be under way shortly.

London, Ont.—A reorganization of the city management, effecting a consolidation of all engineering departments, including the waterworks, parks, hydro, London and Part Stanley Railway and others, is being talked of. Arguments are advanced in favor of the project.

Fort McMurray, Alta.—The Athabasca and Great Waterways system is built for 140 miles to Lac La Biche and 106 more miles of steel are to be laid down by this fall to Fort McMurray, its northern terminal and junction with the Hudson's Bay steam boats plying on the Athabasca River.

Cartierville, Que.—The municipality is contemplating purchasing the water supply system from the Montreal Public Service Corporation, the price being about $65,000. The project has met with the approval of the ratepayers, and the municipality now plans to construct a filtration plant. F. A. Grothe is mayor.

Victoria, B.C.—The last length of pipe on the Sooke Lake water supply system was completed on May 8th, when the Pacific Lock Joint Pipe Co. laid its last section on the concrete flow line. It is expected that the system will be put in operation at an early date, supplying the city with about 17,000,000 gallons a day.

Hamilton, Ont.—A proposal to construct a hydro-electric railway from this city to Port Dover was discussed at a largely attended meeting of municipal representatives last week. Another project was given consideration, *viz.*, a radial line planned to pass through Hamilton and connecting the Niagara peninsula with municipalities on the Georgian Bay.

Montreal, Que.—Some 30 machinists and foundry men sailed from here last week for England, and about 35 left from Toronto via New York, to work in the engineering shops at Barrow-in-Furness. Hon. T. W. Crothers, Minister of Labor, is making provision for the employment of Canadian workmen in shell manufacture in Great Britain.

Fort George, B.C.—A report has it that the Pacific Great Eastern Railway, which is being constructed between this point and Vancouver, will be continued almost due north from Fort George to a junction with the network of railways which it is expected will be built by the Peace River and Athabasca Railway and others, and ultimately continued to the Yukon.

Guysboro, N.S.—From an announcement made by the Minister of Railways and Canals last month, it is believed that an extension of the government railway will be built next year. The plan of the route runs from Sunny Brae to Lake Eden, thence to a point at Country Harbor Cross Roads, thence following the valley of Salmon River to Guysboro; thence around the head of Chedabucto Bay up the shore of the Strait of Canso to Mulgrave.

Prince Rupert, B.C.—The last pontoon for the Grand Trunk Pacific dry dock was launched last week. The dock and shipbuilding plant will be ready, with a complete complement of machinery for ship repairs, by August 1st next. The oil tank equipment at Prince Rupert is also completed and a few days ago the first oil-burning locomotive brought train No. 1 into the Pacific terminal. In a short time over the whole of the Grand Trunk Pacific line from Jasper westward oil-burning locomotives will be operating.

Regina, Sask.—The city council has practically completed arrangements for the construction of the following improvements: Concrete sidewalks, $10,000; plank sidewalks, $7,500; storm sewers, $132,599; domestic sewers, $10,688; sewage disposal and connections, $16,500; waterworks pumps, wells, mains and connections, $75,100; street railway extensions, $10,000; health and relief (construction), $1,655; light and power distribution, power house, $29,117. Total, $293,159. The portion of the money expended on improvement works which will be paid in labor is $145,111.

Vancouver, B.C.—The Second Narrows bridge, which has been occupying the attention for some years of the Burrard Inlet Tunnel and Bridge Co., received a further set-back recently. The District of North Vancouver has taken the stand that no money can be advanced for the project until the subsidy by-laws, passed three years ago, are again submitted to the ratepayers. Articles in issues of *The Canadian Engineer* for August 20th, 1914, and March 4th, 1915, described the contemplated structure and the method adopted by the various municipalities concerned of meeting the expenditure.

North Temiskaming, Que.—The sub-structure of the new steel bridge at this point is now ready for the erection of steel. The construction of concrete piers commenced last summer and was finished in April, the cost of the substructure being about $50,000. The large centre pier measures 8 x 27 at the top, 28 x 60 on the river bed, and is 55 feet high. It is distant some 240 feet from the shore piers on either side. The shore abutments are 70 feet wide at the base, and are 80 feet distant from the nearest piers. There are five piers in all. The cement work was done by Messrs. Lynch, Peckham and Gorman.

Toronto, Ont.—A heavy gale swept the water front on Sunday last sinking a large pile driver which broke loose from its moorings off Ward's Island and damaging to the extent of about $14,000 the "Cyclone" dredge, at work off Fisherman's Island. This dredge, the largest in the world, is the property of the Canadian Stewart Company, and is engaged in reclamation work, pumping sand from about 700 feet from shore into the industrial site, at Ashbridge's Bay, of the Toronto Harbor Commission. It has a capacity of 20,000 cubic yards of material per day, and can discharge it at a point over 4,000 feet from the suction point. The damage to the outfit included the loss of a coal scow, a derrick scow and about 700 feet of unanchored pontoons.

PERSONAL

E. S. MATHIESON, of Amherst, N.S., has been appointed town engineer of Trenton, N.S.

W. C. BLACKWOOD, B.A.Sc., has been appointed director of physics for the Central Technical Schools, Toronto.

W. C. C. MEHAN has been made general superintendent of the Grand Trunk Pacific lines between Edmonton and the coast.

GEORGE H. GREENFIELD, of Montreal, has been appointed plant engineer of the Canadian Car and Foundry Company, with headquarters in Montreal.

C. E. BROOKS has been appointed acting superintendent of motive power for the Grand Trunk Pacific Railway with headquarters at Transcona, Man., vice Mr. J. Billingham, resigned.

A. J. GORRIE, formerly superintendent of the Quebec division of the Canadian Northern Railway, has been appointed superintendent at Quebec for the Transcontinental Railway.

W. A. COWAN, formerly of the Intercolonial, and W. B. WAY, formerly of the C.P.R., have been appointed to the staff of Mr. F. P. Brady, division engineer for the Transcontinental Railway at Cochrane, Ont.

J. P. KIRKPATRICK has been appointed division superintendent at Edson, Alta., of the Grand Trunk Pacific, and is succeeded as superintendent at Regina by Mr. H. McCall, formerly superintendent at Melville, Sask.

A. P. LINTON, B.A.Sc., assistant chief engineer, Board of Highway Commissioners for the Province of Saskatchewan, addressed a meeting of the Regina Engineering Society last week, his subject being "The Construction of the Traffic Bridge at Saskatoon."

JOSEPH RACE, city chemist and bacteriologist, Ottawa, has recently been requested by the Board of Works to undertake the examination of all materials used in connection with asphaltic roadway construction. Mr. Race has had previous experience of roadway work in England and assisted in the preparation of the specifications which were ultimately adopted by the Roadway Board of England practically without modification.

The following are the officers of the Canadian Society of Forest Engineers, just elected to serve for three years: President, Clyde Leavitt of Ottawa, Forester to the Dominion Conservation Commission and Chief Fire Inspector for the Dominion Railway Commission; Vice-President, H. R. MacMillan, Chief Forester of British Columbia; Secretary-Treasurer, Ellwood Wilson, Forester to the Laurentide Company, Limited.

At its 13th annual meeting last week the Canadian Railway Club elected the following officers for the ensuing year: President, Mr. L. C. Ord, works manager, Angus shops; first vice-president, Mr. R. M. Hannaford; second vice-president, Mr. George Smart; executive committee, Messrs. T. C. Hudson, E. E. Lloyd, J. Hendry, C. Manning, E. B. Tilt and Prof. H. O. Keay; audit committee, Messrs. W. S. Atwood, W. H. Winterrowd and F. A. Purdy; secretary, Mr. James Powell; treasurer, Mr. W. H. Stewart.

OBITUARY

As intimated in last week's issue, the disaster which befell so many prominent personages enroute for Europe on the "Lusitania" caused the death of Mr. James Barr, who, on leave of absence from the city engineering department of Toronto, was on the way, accompanied by Mrs. Barr, to visit his father, Mr. John Barr, managing director of Messrs. Glenfield & Kennedy, Kilmarnock, Scotland, well-known hydraulic engineers. Both lost their lives.

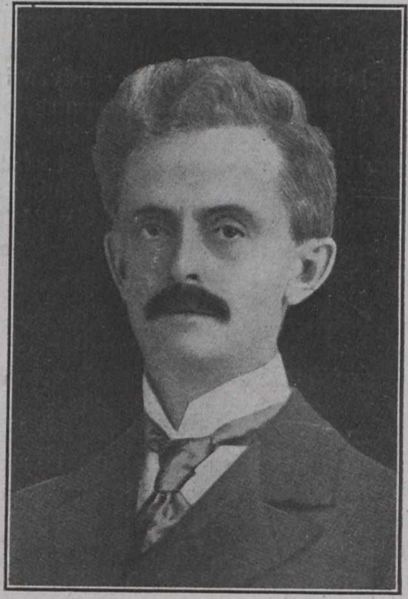
Mr. Barr was born in 1885 and was educated at Kilmarnock Academy and the University of Glasgow, from which he graduated in 1907 with the degree of B.Sc. in engineering. He distinguished himself in engineering research and was awarded a research scholarship, which he devoted to a study of the hydraulics of the V-notch weir. The results which he obtained have received much well-merited publicity and praise in the engineering press of Europe and America.

After graduation, Mr. Barr spent some time in the employ of Komnick Elbing, an engineering firm in Germany, and in the works with which his father is associated, Messrs. Glenfield & Kennedy, Kilmarnock. He came to Canada in July, 1910, and entered the employ of the John Inglis Co., Limited, Toronto. Toward the end of the year he joined the staff of the works department, City Hall, Toronto, as an assistant engineer. His distinguished ability and high intellectual gifts gained for him a series of promotions, and he became chief assistant to Mr. Milne, mechanical and electrical engineer for the city. In 1913, still retaining this position, he was placed in charge of the Victoria Park scheme for an additional water supply for Toronto. Last year he was elected a member of the American Waterworks Association.

The Late James Barr.

Mr. Barr was one of the most brilliant young waterworks engineers of the American continent. He was full of energy, and took a keen delight in his profession. The son was worthy of the father.

A very prominent engineer and financier in the person of Dr. F. S. Pearson, of New York, was one of the victims in the sinking of the "Lusitania." Dr. Pearson was associated with a large number of interests, among which might be mentioned the Dominion Steel Corporation, Mexican Light, Heat and Power Co., Mexican Tramways, Barcelona Traction, and Brazilian Traction. Dr. Pearson was born in Lowell, Mass., and had devoted much of his career to engineering undertakings. He was the son of a contractor.



The Late Dr. F. S. Pearson.

The attention of our readers is called to the fact that the late Dr. Pearson was not associated with the firm of S. Pearson & Son, Limited, as many believe. Both were responsible for much engineering development in Mexico and Brazil, but Lord Cowdray of S. Pearson & Son, Limited, is of English birth. He is also the son of a contractor, and in their careers the two Pearsons had much in common.

COMING MEETINGS.

NATIONAL CONFERENCE ON CITY PLANNING.—June 7-9. This year's Conference to be held in Detroit, Mich. Secretary, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Annual meeting to be held in Atlantic City, N.J., June 22nd to 26th. Secretary, Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Charles Warren Hunt, 220 West 57th Street, New York.

INTERNATIONAL ENGINEERING CONGRESS.—To be held in San Francisco, Cal., September 20th to 25th, 1915. Secretary, W. A. Catell, Foxcroft Building, San Francisco, Cal.