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The Canadian Engineer

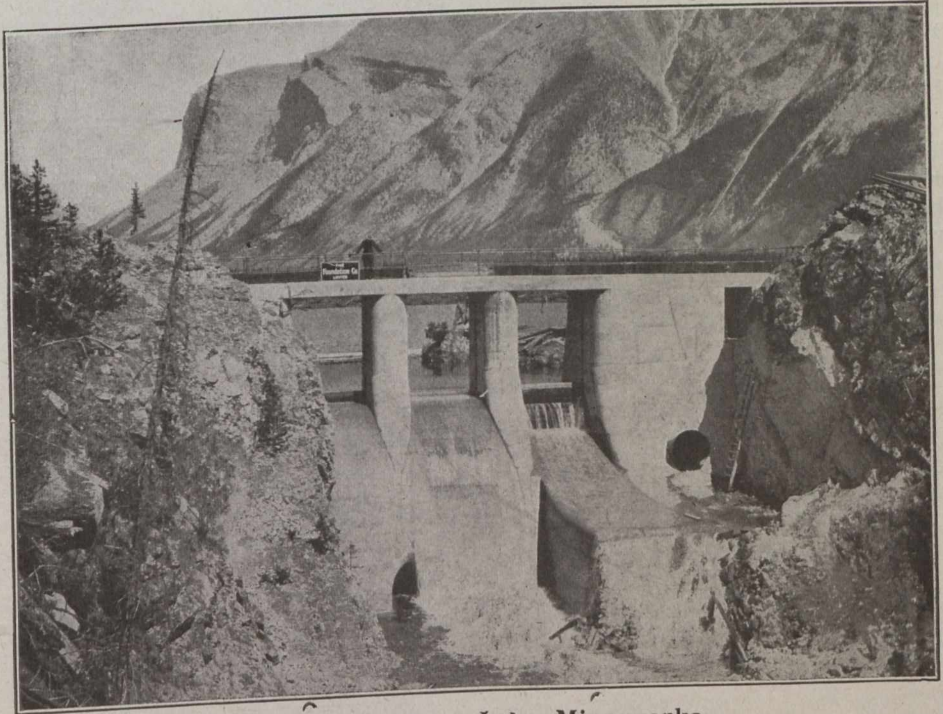
A weekly paper for engineers and engineering-contractors

CANADIAN NATIONAL PARK DEVELOPMENT

ASTONISHING FIGURES OF VALUE OF TOURIST TRAFFIC AS COMPARED WITH OTHER SOURCES OF REVENUE—ROAD BUILDING AND OTHER ENGINEERING PRACTICE INVOLVED.

IN taking stock of our natural resources in Canada there is one potential source of wealth that is often overlooked, and that is the value of scenery. The value of forests, minerals, water powers and agricultural products is easily recognized, but because the revenue which scenery brings to a country is an indirect one its importance is often forgotten and seldom estimated at its actual value. From countries such as Switzerland and Italy, which are pre-eminently scenic countries, it is possible to see what the possession of striking natural beauty means by virtue of its power to attract tourist traffic.

The tourists attracted by Switzerland's mountains are one of her most profitable industries. It is estimated that in 1913, the year before the outbreak of the great war, they brought her a tourist traffic which was worth the enormous sum of $250,000,000. These figures are startling, but they are borne out by those from other countries. The value of tourist traffic to France in the same year was placed at $600,000,000; that of Italy at over $100,000,000. The palm groves and orange blossoms of Florida are known to be worth more to her than all the products of her soil, while the pine woods of Maine, in addition to their value as timber, bring in a revenue of $40,000,000 per year from the tourists they attract. The yearly tide of travel from the United States to Europe before the war was estimated at from three to four hundred million dollars, while the harvest reaped from visitors by the three great tourist cities, London, Paris and Berlin, was placed at over $30,000,000 each in one year.



Minnewanka Dam, Lake Minnewanka.

These are enormous sums but the estimate with regard to Canada is equally striking. W. T. Robson, organizer of the Canadian Travel Association, formerly general advertising agent of the Canadian Pacific Railway, recently made a careful estimate of the value of the tourist travel which came to Canada in 1913. His figures, which are given at the bottom of this page, show a total of $50,000,000, giving this source of revenue fourth place among our natural resources.

The total number of visitors at the two chief resorts in the Rockies — Banff and Lake Louise — during the past five years was 321,823. Almost half of these were foreigners. It is estimated that the foreign tourist spends about $100 in transportation, and in addition spends large sums in hotels, liveries, souvenirs, etc. But, taking $100 as an average expenditure, which is declared by those who know to be a very low one, the amount of money left in Canada during this period by these visitors alone amounts to over fifteen million dollars.

There is no doubt that the Canadian mountains are as capable of attracting a large tourist traffic as any other scenic district in the world to-day. Famous travellers and

Comparative Revenue Figures for the Year 1913.

Field crops	$509,437,000
Forest products	161,093,000
Minerals	102,300,000
Tourist traffic	50,000,000
Fisheries	43,667,000

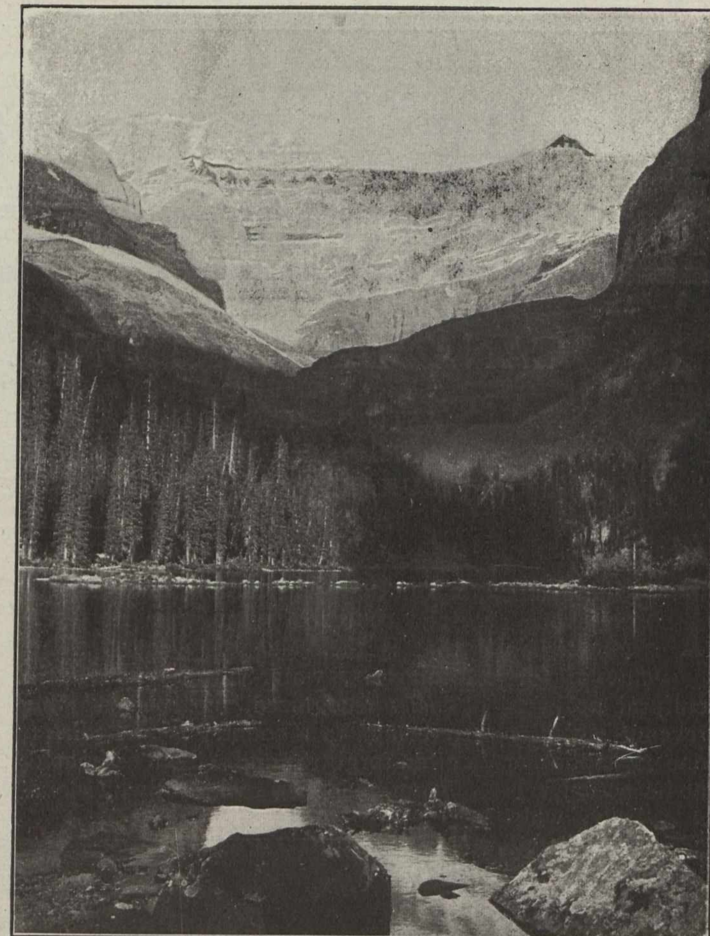
mountain climbers unite in agreeing that there is no mountainous region, not even excluding the Alps, which offers so many attractions to nature-lovers as do the Canadian Rockies. Dr. Langstaff, the celebrated Alpinist, writing in the London "Field" after his visit to Canada, said:—

"In the Canadian Rockies and Selkirks there is a country waiting for recognition which, I believe, is destined to become the playground of the world. In no other region on the globe do peak and cliff, lake, cataract and stream, form such a perfect combination as is to be found, not in one but in hundreds of places, in these glorious ranges. The fascination of the Canadian mountains is such that merely to travel through them and camp amongst them is sufficient reward for anyone who is not blind."

Canada, Queen of the Broad Spaces, as she has been picturesquely called, has been setting aside large areas of her most beautiful and wonderful natural scenery which, fortunately, were still part of the national domain, as Dominion Parks. There are now about 8,000 square miles or over five million acres set aside in these great reservations "for the benefit, advantage and enjoyment of the people of Canada," as the Act creating them says, for all time. All the natural beauty which they contain is forever safe from spoliation at the hands of private or selfish interests. Although this area is about half the total area of Switzerland it is none too generous for what the needs will undoubtedly be in years to come.

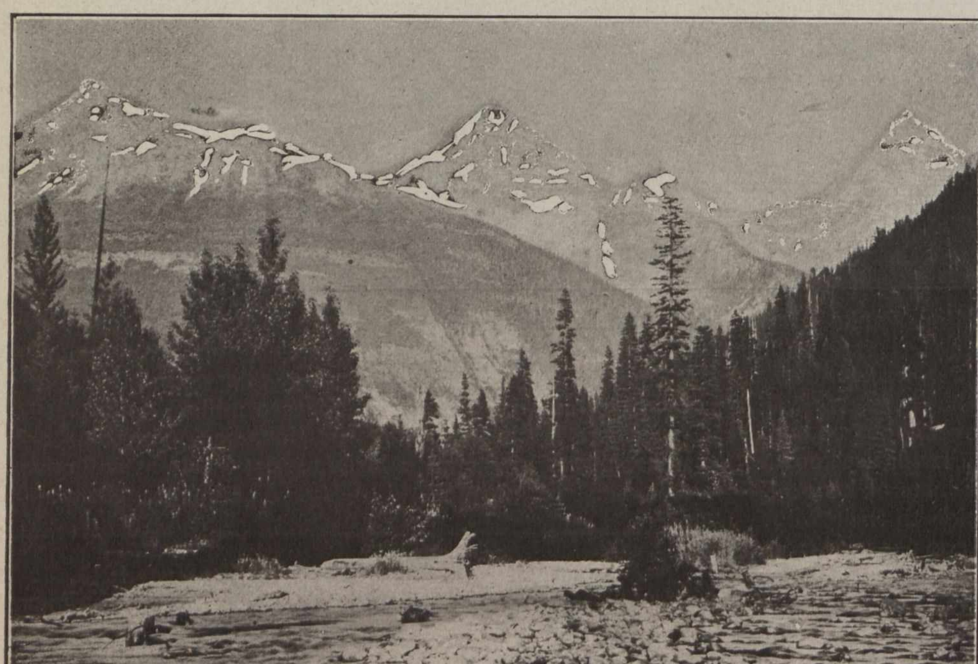
Lord Bryce, then Ambassador to the United States, in a speech to the Ottawa Canadian Club, just before his departure for England, commended the Canadian Government for its foresight in this regard, and said:—

"I hope you will set apart more and more of those magnificent areas of scenery which you possess in the Rocky Mountains for the enjoyment of the people, looking forward to a day when the population of Canada will be tenfold what it is now, and when the value of places where pleasures of nature can be cultivated and where the wild animals can be preserved and where the charm of solitude can be enjoyed—when the value of these things will be even greater than it is at this moment."



Lake O'Hara, Yoho Park.

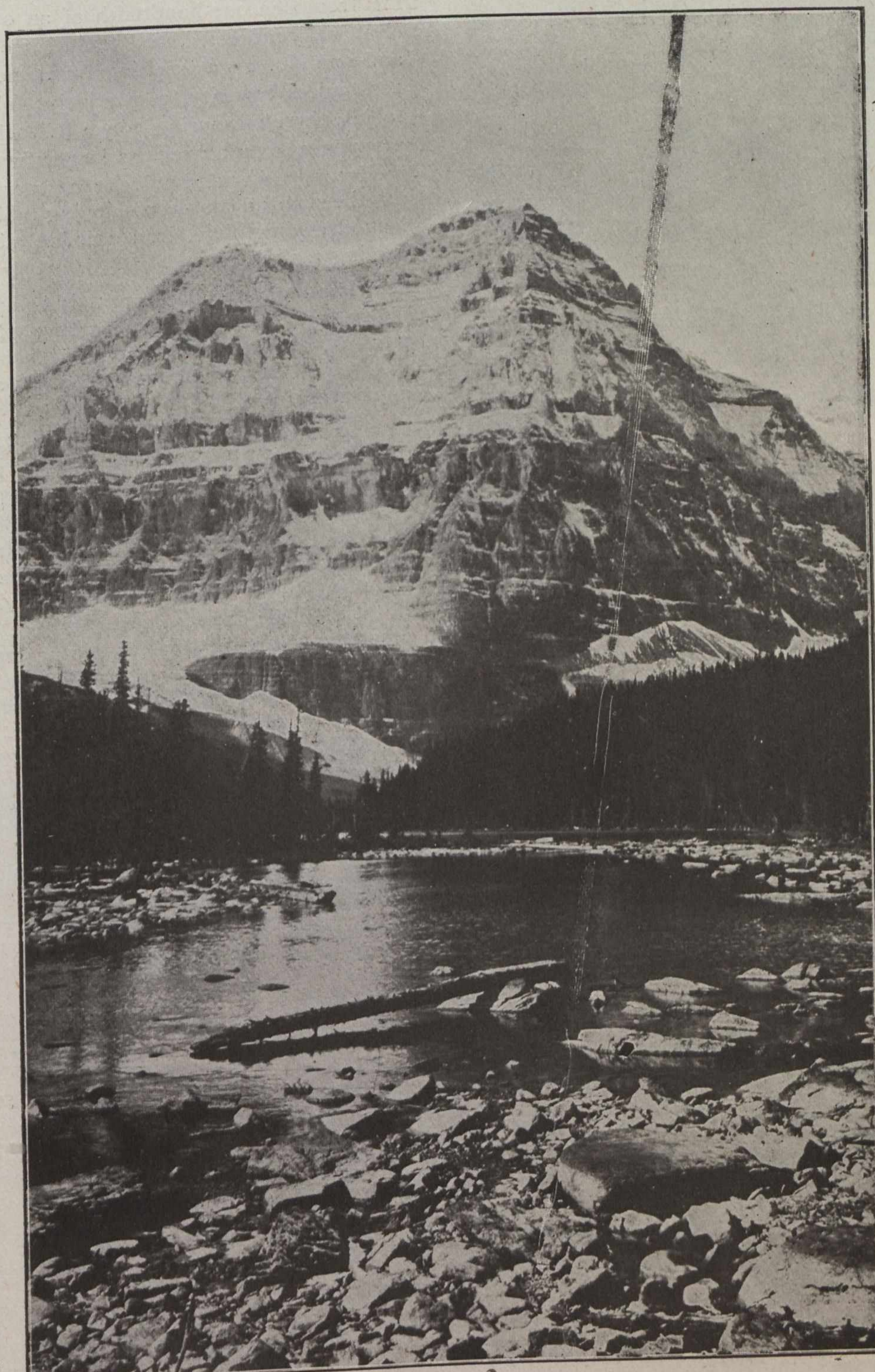
In order that these areas might receive the attention which they appear to deserve, the Dominion Government about four years ago created a special branch to take charge of the Dominion Parks. This branch has control of all matters within the parks. In addition to the building and maintenance of roads and other matters concerned with development, it has charge of the forest and game protection and the entire administration of all townsites. In Banff, the principal townsite, with a population of about 1,500, the government owns all the land, which is leased at a nominal rental for business and residential purposes. It also supplies and maintains all the services demanded by an up-to-date town—water and sewer systems, telephone, street sprinkling, garbage collection, fire protection, etc. The town itself is being laid out and developed in accordance with the advice of eminent town planners, and there seems no reason to doubt that in future years it will become one of the most beautiful mountain resorts in the world. Among its attractions are the hot sulphur springs, well-known for their curative powers, which rank with the famous springs at the United States government reservation in



Route to Nakimu Caves, Glacier Park.

Arkansas. Last year the government opened at the lower springs what is undoubtedly one of the finest public baths on this continent. It is built on the lower side of Sulphur Mountain, commanding a picturesque view of the Bow Valley and the surrounding peaks, its native limestone and red tiles blending harmoniously with the landscape. The chief feature is a large, open, swimming pool, 150 feet long by 35 feet wide, supplied by the hot sulphur water which issues through a cave from the side of the mountain. There is, in addition, an older bathing establishment higher up on another side of the mountain. It is possible even in zero weather, with icicles forming around the edges of the pool, to enjoy a warm bath of about 90°.

This park is also being rapidly opened up to the motorist. The new automobile road from Calgary to Vancouver passes through the park, touching Banff and two or three of the smaller townsites. The Dominion Government is building the sections that lie within the parks, and has already completed the grading of the road which extends from the eastern limits of Rocky Mountains Park to the summit of the mountains. The average grade is 4% with a maximum of 6.5%, and the road passes through the heart of some of the finest scenery in the parks. A branch section which will be appreciated by motorists is also being constructed from Castle to the famous Lake Louise. Three miles of this road, which will total eighteen in all, were built this summer by the alien prisoners who were quartered in the park, and it is intended to prosecute the completion of the remaining fifteen as rapidly as possible next season.

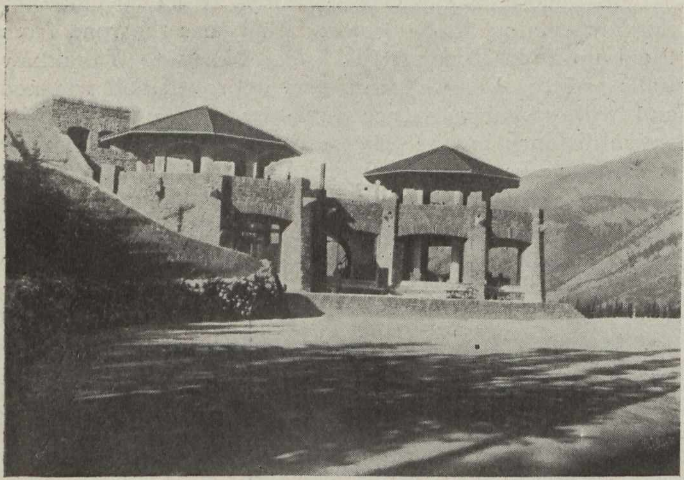


Mount Ball, near Banff, Rocky Mountains Park.

In Yoho Park, also, preparations are being made for the introduction of the motor. This year the road from Field up to the wonderful Yoho Valley to Takakkaw Falls and the Yoho Glacier, was improved and widened and will probably be accessible by automobile for its entire distance by the fall of 1916. A motor loop road is also under construction from Field to Ottertail Valley, returning by way of the Kicking Horse Canyon and the Natural Bridge. When these roads are finally completed, traffic to the parks will no doubt be increased by large numbers of motorists who will want to take advantage of the opportunity of spending a holiday in their favorite way among scenery of unparalleled grandeur.

This active policy of development with regard to the Dominion Parks indicates that the government believes they are a sound business investment, and in this view they are in line with the policy regarding parks adopted in New Zealand and the United States. But their greatest value, after all, cannot be reckoned in dollars and cents. They have great potentialities of wealth, but they are worth more for their potentialities of pleasure and vitality. They are great playgrounds set aside forever so that the time may never come in Canada, as it has already come in England and Scotland and is fast coming in the Eastern United States, when a great majority of the forest scenic areas will be in great preserves owned by the wealthy, into which the people are not allowed to come.

The Canadian parks are in reality the people's estates, providing facilities for the best kind of recreation, that which is found by getting close to nature in the great



Exterior of New Bath-house, Banff.

out-of-doors. As such, they are reservoirs of pleasure, happiness and vitality whose value it is impossible to estimate.

The Canadian National Parks.

Name.	Location.	Area, sq. miles.
Rocky Mountains	Eastern slope of Rockies	1,800
Yoho...........	Western slope of Rockies	560
Glacier.........	Summit of Selkirks	468
Jasper..........	Eastern slope of Rockies	4,400
Waterton Lakes.	Southern Alberta	423
Revelstoke	Summit of Mt. Revelstoke	100
Elk Island......	Lamont, Alberta	
Buffalo.........	Wainwright, Alberta...	
St. Lawrence Isls.	Thousand Islands ....,	

BRITISH COLUMBIA ASSAY OFFICE.

The Dominion Assay Office in Vancouver has an equipment of the latest design, according to the "Mining World." In the melting room is a bullion balance, with two sets of weights and one set of test weights, each ranging from one one-hundredth of an ounce to 500 ounces; electrically protected steel vaults; two No. 7, one No. 4½, and one No. 2 gas melting furnaces, of 1, 200, 400 and 100 ounces capacity, respectively; four cast-iron pouring tables, three measuring 2 by 4 ft. each and one 2 by 3 ft.; a swinging crane over the larger furnaces for lifting the melts; a crusher and pulverizer for crushing and pulverizing the slags; a cast-iron shipping table, electric drill, gas-heated drying plate, iron crucible table, cleaning bench, cooling tank, etc.

The muffle furnace room is equipped with four gas-muffle furnaces; a fume chamber; platinum parting apparatus, consisting of two dipping hooks, two boilers, and two trays, each containing 36 cups, and other necessary apparatus.

The loss in weight by assaying is seldom more than the one-hundredth part of an ounce. Two assays each are made by two assayers, these assays to agree within 1.6 of a part, otherwise the bar must be remelted and re-assayed. For the fine gold contained in the deposit $20.67 per ounce is paid, and the price paid for the silver is according to the market value.

This office during the month of October received 238 deposits, valued at $458,053, as compared with 147 deposits, valued at $155,441, during the month of October, 1914, an increase of 91 deposits and of $302,612.

Berg Lake and Tumbling Glacier, Jasper Park.

HYDRO-ELECTROLYTIC TREATMENT OF COPPER ORES.

In a paper presented at the San Francisco meeting of the A.I.M.E., Robert R. Goodrich described the treatment of a porphyry ore by a process including the following steps: Oxydizing roast, leaching with sulphuric acid and electrolytic precipitation of the dissolved metal. A summary of the paper follows:—

The most suitable temperature for roasting the Arizona porphyry copper ore, containing sulphides, in order to render it amenable to acid leaching methods is between 600° C. and 725° C. The more finely ground the material the shorter the time required for the roasting so as to produce the maximum amount of soluble copper: materials which will pass through a 20-mesh screen and remain on 80 mesh require about 2 hours roasting at 600° C. to 725° C.; and when ground to pass through an 80-mesh screen the time required is about 1¼ hours. If the roasting is concluded at temperatures above 800° C., the oxidized copper is converted into a compound which is insoluble in dilute sulphuric acid. The longer the roasting is conducted above 800° C., the greater the amount of insoluble copper produced.

A heated solution is necessary to leach efficiently the copper from the roasted material. A 10% H_2SO_4 solution at 100° C. leached out, in from 3 to 6 hours, all the copper from all roasted materials (through 40 on 80 mesh, through 80 mesh, whole through 20 mesh), except material through 20 or 40 mesh, in which case the extraction was not so high.

The nature of the anode is an important factor in securing depolarization by sulphur dioxide gas.

Depolarization with consequent saving in power is accomplished when using sulphur dioxide gas with a carbon anode, while there is no depolarization with a lead anode.

The depolarization by sulphur dioxide gas, even with carbon anodes, does not reach the theoretical amount, being between 45 and 65%.

The amount of depolarization effected by sulphur dioxide gas when used with carbon anodes varies with the current density, being a maximum at low current density.

The method of introducing the sulphur dioxide gas into the cell is unimportant. All that is necessary is that it be introduced in some way, and in such quantity that the electrolyte is saturated with the gas, so that there is some escaping by bubbling at the surface.

A smoother deposit of copper forms when using sulphur dioxide gas as a depolarizer than when not using it.

In the electrolysis of an acid solution of copper sulphate, when sulphur dioxide is not supplied to the cell and when one is endeavoring to carry electrolysis to the point of complete extraction, a soft spongy deposit begins to form on the cathode before the complete extraction of the copper is effected. There is also a considerable rise in polarization when the copper contents of the electrolyte becomes low.

In the electrolysis of an acid solution of copper sulphate, when sulphur dioxide is supplied to the cell, the copper contents of the electrolyte may be reduced to a very small trace with the formation of a good, firm cathode, without rise in polarization toward the end. Current density and energy efficiency remain high to the end. It is only when prolonging the operation beyond the time when but a small trace of copper remains that sulphide of copper forms as a thin coating on the cathode.

Lead anodes do not peroxidize or deteriorate appreciably when used with or without the introduction of sulphur dioxide into the electrolyte.

A novel idea—step arrangement of process—makes feasible the depositing of copper continuously, while the copper contents of said electrolyte in the respective steps remains constant. A plant composed of several steps of such cells may be operated so that a liquor strong in copper flows to the plant continuously, and the liquor which outflows from the plant is depleted of its copper.

The circulation of the electrolyte by the step arrangement increases the current efficiency. Such rapid circulation is not possible in plants as ordinarily arranged.

PIPE-LAYING ACROSS SMALL STREAMS.

An example of laying a small cast-iron pipe across a narrow stream is presented by Mr. Chas. R. Gow, contractor, Boston, in a paper read recently before the Boston Society of Civil Engineers. The crossing being part of a sewer line, a maintenance of grade was essential. The stream was approximately 75 ft. in width and about 5 ft. in depth at the time when the work was done. As the river was used for boating, no obstruction which would interfere with such use was permitted. The bed of the stream was gravel overlaying a deposit of mud. The crossing was located close to and parallel with an existing highway bridge, from which all of the work was carried on.

A platform steam derrick mounted upon rollers was erected on the bridge so that it could be moved back and forth as the work progressed, the boom being long enough to reach out over the pipe location. A small orange peel bucket was used to remove the gravel slopes at either bank as well as to dredge the shallow trench necessary for the pipe. A pair of wooden leads containing a pile-driving hammer were suspended from the boom end, which was securely guyed in position, while spruce piles were driven in bents of two, the same being spaced 3 ft. on centres. There were 22 piles or 11 bents required in all.

It was necessary to cut and cap the piles at an exact grade, and as the cutting point was more than 5 ft. under water, the following method was devised to accomplish the purpose:

A light riveted steel cylinder 6 ft. in diameter and 10 ft. in length was lowered over a bent of two piles until it rested vertically upon the bottom. To seal the bottom edge, some sand and gravel was deposited around the outside. A pulsometer pump was then swung out by the derrick, the suction lowered into the cylinder, and by means of a steam connection with the hoisting engine the water was removed from the interior of the cylinder so that men could enter, cut the piles with an ordinary cross-cut saw, and cap them at the required grade with 6-in. by 6-in. timbers. When this operation was completed, the cylinder was withdrawn and placed over the next bent of uncut piles.

When all of the pile bents had been thus capped, the pipe was assembled on the bridge, the joints leaded and caulked, and by means of the derrick and a guyed gin pole, the entire length of pipe was suspended over the desired location and lowered through the water till it rested on the pile caps previously placed. A diver was employed to wedge the pipe securely in place, this being the only part of the work on which a diver was used. The pipe was then backfilled with some of the dredged material. The entire cost of this work exclusive of the cast-iron pipe and lead for joints was $561.

CONSTRUCTION METHODS AND EQUIPMENT OF RAILWAYS.*

By William Griffith Sloan, M.Am.Soc.C.E.,
Chief Engineer, MacArthur Brothers Company.

THE operations involved in the construction of railways have always required the employment of large numbers of men, the majority of whom constitute what is known as unskilled labor, in contradistinction to the various classes of mechanics ordinarily called skilled labor.

Due to the decrease in the amount of available unskilled labor and the great decrease in the efficiency of those available, the increase in labor-saving devices and appliances for railroad construction work has been rapid during the past twenty-five years; but due also to the physical conditions entering into construction of this kind, methods which would be entirely suitable for one piece of work would not be at all adaptable for other work in many ways similar, and the result has been a great diversity of such labor-saving appliances in an attempt to meet the various conditions.

Railroad construction divides itself into the following principal classes of work:—

1. Clearing of trees and underbrush and the grubbing out of roots.
2. The excavation and transportation of earth and rock to form the roadbed.
3. Tunnels.
4. Construction of bridges, which has the following sub-heads: (*a*) Timber bridges; (*b*) Concrete and masonry bridges; (*c*) Culverts of metal or earthenware pipes; (*d*) Steel superstructures of bridges.
5. Tracklaying.
6. Ballasting.
7. Structures, such as stations, water stations, shops, etc.

Clearing and Grubbing.—The work included under this division is carried on to-day in much the same manner as it has been for many years past, except that the lack of efficiency in the labor available for this work is particularly noticeable. The hardy axemen are fast disappearing, and the axe in the hands of the foreign laborer is not an effective tool. The writer has seen many railroad clearings that looked more as if the trees had been gnawed down by beavers than felled by axes.

So far as the grubbing is concerned, there are a number of stump-pulling appliances, which together with the traction engine, which has developed rapidly in recent years, and the explosives now manufactured for the purpose, have enabled this work to be done more effectively and cheaply.

Excavation.—It is under this classification that probably the greatest development of construction appliances has been made. The work of excavation, using the word in its broad sense, includes the loosening of the material, the loading of same into a means of conveyance, conveying to the place of deposit, and depositing in place.

The first of these operations depends primarily upon the character of the material to be handled, and to some extent on the means of conveyance to be used and the disposal. In the construction of railroads, materials of all degrees of hardness and toughness are encountered, and it is sometimes necessary to deposit material in a position where it must resist the action of water, and where larger pieces of rock are required; or again, it may be deposited in a low embankment where the larger pieces of rock can not be used. All of these conditions, as above stated, affect the manner in which the work must be done.

Of the various methods in use, the following are probably representative:—the pick, the plow, drills and explosives.

Under the latter heading come some of the most interesting and valuable developments and improvements to be found in the development of this art. The blasting of rock has been known and practiced for several centuries, but since the invention of dynamite this work has been carried on in an entirely different manner and to far greater effect.

The drill has progressed from the old hammer and steel and churn drill to the highly effective air drill of to-day, carrying with it a corresponding increase in capacity for the removal of rock at very much less cost. There has also been adapted to the removal of rock on railroads, during the past few years, the well drill, by which large and deep holes are drilled throughout the excavation to be made, and large sections of it so loosened by the simultaneous shooting of a number of these holes that steam shovels are enabled to work continuously for long periods before it is necessary to do further blasting, thus obviating the moving back of the shovel and other equipment before each shot is made, as is necessary where only the face immediately ahead of the shovel is shot.

The second of these operations, *viz.*, loading, has also shown many interesting developments. In much of the railroad construction carried on to-day, the material is loaded into the means of conveyance by men with shovels, alter having been loosened with the pick, if necessary, in the same manner as has been done since the early days of railroad construction.

Likewise, much railroad work is done by teams and scrapers, of which there are a number of kinds. Those commonly in use are the drag scraper and fresno for short hauls, and wheel scrapers for the longer hauls, the material being loaded by dragging the pan of the scraper through the material, which has previously been loosened by a plow, if necessary.

Of the above mentioned, the fresno is the latest development and is almost wholly taking the place of the drag scraper. Hauls in excess of 800 to 1,000 feet can not be made economically with a wheel scraper. Formerly, where long hauls were necessary, much of this work was done by hand loading into wagons or small cars.

In certain classes of material the elevating grader is used for loading into wagons. This consists of a plow which turns its furrow onto an elevating belt, which in turn deposits the material in wagons driven alongside. The grader is propelled by either horses or traction engine. The elevating grader furnishes a means of doing work very cheaply, where conditions are suitable. The material to be handled must be such, however, that it can be carried over the belt, and in stoney or very sandy ground this is not practicable. Many miles of the Western prairie railroads have been constructed by the use of graders depositing direct in the embankment from long borrow pits on either side of the line of railway.

Where the amount of work to be done is sufficient, and justifies its installation, the steam shovel furnishes in many cases the best and most satisfactory method of loading material. It has the advantage of being adapted to handle either earth or blasted rock, and the roots and stumps of trees do not interfere with its operation as in the case of team or hand work. In fact, it is not necessary to grub out the stumps ahead of the shovel on work which is being done by this method.

*From a paper presented at the International Engineering Congress, 1915, in San Francisco, Cal., September 20-25, 1915.

Material from the steam shovel is usually loaded into cars and hauled by locomotives to the place of deposit. The development of the steam shovel has been in the direction of capacity rather than change in type, and there are found on railroad work to-day shovels weighing from 20 tons to 110 tons.

The so-called drag-line, which is primarily adapted to the handling of material where the points of deposit and of excavation are both within reach of the machine, is now being used to some extent in the loading of cars and wagons, and to that extent is taking the place of the steam shovel, its particular advantage being that it can dig much below the grade on which the machine travels, which is a great advantage, particularly if the material is wet and the ground soft and swampy.

There are several types of drag-line machines, the basis of all of them being a heavy steel bucket which is carried forward either from the boon or cableway and drawn back through the material to be handled, during which operation it loads itself, and then is raised and carried to the point of deposit and there automatically dumped. Where conditions are favorable, material can probably be handled cheaper by this method than by any other method in use to-day.

The operation of conveying is accomplished in various ways. It is to meet the requirements of economy in this operation that developments have been made not only in it, but in all other operations involved in excavation.

In the old days when much railroad embankment was made by men using wheelbarrows, it was good practice to continue their use only so long as the time, and consequently the cost, of transporting from the pit to the dump and returning did not exceed that of loading, which in practice limited the distance earth could economically be moved by this method to about 150 feet. If the distance were greater, some other method was resorted to, the cost of transporting necessitating the change.

The cost of transporting is often reduced by increasing the capacity of the conveying medium, which in turn has required new and improved means for loading the larger conveying mediums, and in very many other ways can be seen the far-reaching influence of this operation for a general development throughout the whole field.

Where scrapers are used, the scraper with its load is drawn by horses to the point of deposit and there dumped. Likewise, where elevating grader and wagons are used, conveying is accomplished in the same way. Where steam shovels are used, conveying may be done by wagons if the haul is short, but it is ordinarily accomplished by the use of cars and locomotives. The track for these cars may be either narrow gauge, 3 ft., or standard gauge, 4 ft. 8½ in., the determining condition as to the gauge used being, first, the amount of work to be performed at any particular point by the plant, and second, the accessibility of same from an existing railroad or other means of transportation. The large, heavy cars and locomotives required for standard-gauge work are moved only with considerable difficulty through a rough country.

The operation of depositing the material, in the case of work in which teams and scrapers and wagons are used, is the simple one of dumping the material and leveling off same by men with shovels. Where material from steam shovel is being deposited in railroad embankments, if the height of the embankment is more than 4 or 5 feet, it is necessary, in order to avoid continually raising the track, to build trestles or other means of support for the track on which the material is brought to the dump. Such trestles are constructed generally strong enough to support only empty cars, the end of the fill being maintained at grade to furnish support to the locomotive and loaded cars which are dumped as they pass over the end of the fill.

Where the 3-foot-gauge cars are used, the dumping is accomplished by tipping the car sideways by hand and allowing the material to run out. This is also the case with the smaller cars up to a capacity of, say, 6 or 7 yards, where standard gauge cars are used; but there are also cars having capacities up to 30 yards used on standard-gauge work where the dumping is accomplished by the use of compressed air furnished from the locomotives.

Cars of this capacity are not generally used on new construction work, being more often used for the filling in of trestles and otherwise improving existing lines of railway, and are largely taking the place of the flat cars and plow, which were much used formerly for this purpose.

After the dumping of the cars, a certain amount of spreading is necessary, which is generally done by men, in case narrow-gauge plant is used; on heavier work, where larger amounts of material are being used on standard-gauge work, the spreader is often used for this purpose. The spreader consists of a heavily weighted car having adjustable wings on either side, which in passing over the track, levels off and spreads the freshly deposited material by means of these outspreading wings. Spreaders are now to be had in which the adjustments are entirely actuated by compressed air.

As a substitute for temporary trestles on very high and short fills, there has in recent years been used a type of cableway bridge, which has proved of considerable economy.

While on the subject of excavation, it is proper to mention two other interesting methods by which this work has been accomplished within the past few years: these are the construction of railroad embankment by use of the hydraulic dredge, and also by the so-called hydraulic sluicing method.

Tunnels.—The history of tunneling is most interesting, extending as it does from the most ancient times, when the work was carried on by barring and wedging and by fire and water, used alternately to heat and quench the rock, down through the seventeenth century, when the introduction of gun powder entirely changed the method of doing this work. The amount and character of work done under the old methods is amazing. The great development came, as in the case of the rock excavation mentioned above, with the invention of dynamite and the improvement of drilling machinery; and while the study of the different methods used in this country and abroad for the driving of tunnels, and also of the different types of drilling and other machinery, would be most interesting, it can not be undertaken here, it being sufficient for the purpose of this paper to briefly mention some of them.

The determination of the method to be followed in the driving of a tunnel always involves the questions of progress and cost, such a method being adopted as will give the maximum of the former consistent with a reasonable cost, all things being considered. This does not necessarily mean that the above mentioned maxima and minima are absolute; but rather, having assumed a certain justifiable cost, the method must be such as to produce a maximum of progress, and vice versâ.

The points at which work may be carried on in driving a tunnel are obviously limited by economy. Generally speaking, the two ends of a tunnel are accessible for this purpose at reasonable expense. To afford additional working faces, shafts must be sunk, and the problem of how many, if any, are justified, must be solved.

If the tunnel in question is the critical part, as regards time, in the construction of some large project, the cost of several shafts and the adoption of rapid but expensive methods of tunnel driving may be justified.

In the driving of any railroad tunnel, or other tunnel of large cross-section, through rock, the work is carried on by first driving a drift or tunnel of smaller cross-section, called a heading, somewhere within the cross-section of the finished tunnel. The purpose of this is to facilitate the excavation of the remaining part of the cross-section of the tunnel by affording two free faces to the rock which is to be removed, which greatly increases the effectiveness of the explosive.

The size and shape of the heading should be such as to permit a maximum of progress and leave the remaining cross-section in the best shape for its removal. The location also should be such as to permit the easiest removal of the remaining cross-section. To a considerable extent, the location depends upon the character of the rock, a bottom heading is often the best where the rock is self-supporting, and a top heading where the rock requires timbering for support.

It will be evident that the driving of a heading, with its constricted working space, does not admit the use of labor-saving appliances for handling the material, and is entirely a question, except as to the use of drilling machinery, of hand labor. It will also be evident that the progress of the whole tunnel is entirely dependent upon the progress in the heading.

In European practice where the greatest records of progress have been made, they have been accomplished by driving two, or even more, headings connected by cross drifts to facilitate the removal of the material and ventilation. Due to the relatively low cost of labor in Europe, this has been done without increasing the cost of the whole tunnel excessively.

In the United States, however, these methods have not been generally followed, a single heading usually being driven, with consequently slower progress.

It is in the removal of the remaining cross-section of the tunnel, after the heading has been driven, that labor-saving appliances have been developed, principal among which is the application of the steam shovel operated by compressed air for the loading of blasted material into cars.

There have also been constructed for work of this kind, drill carriages mounted on cars which, in turn, are carried on a track, and which permit the removal of the whole battery of drills before each shot is made, and the replacing of same, as a unit, as soon as the muck has been sufficiently cleared away to permit.

Machines of this kind have also been combined with loading devices, consisting of belt conveyers onto which the blasted material is shovelled by men and conveyed automatically into cars, which in turn are hauled away by either horses or electric locomotives.

During the last few years there have been brought out a number of so-called tunneling machines, the general principle of which has been a large reciprocating, and at the same time revolving, cutter-head so mounted on a track as to be brought into contact with the face of the rock, which is gradually broken down by blows of the cutter-head, the pulverized material being either washed back by flow of water or carried back by a system of conveying belts. These machines have all been, however, in the nature of an experiment and have not been brought to a state of development where they may be considered of practical use.

In and around New York City during the past decade, there has been carried on a very large amount of subaqueous railroad tunnel construction, in the doing of which there have been developed many interesting applications of compressed air, special designs of shields and grouting machines, and other devices for handling the excavated material and cast-iron plates and concrete with which these tunnels have been lined.

Bridges.—The trend of bridge construction of railroads is altogether toward the construction of permanent structures. With the great increase in use of concrete for this purpose, and the decreasing timber supply, there are comparatively few timber bridges now being constructed. What few frame timber bridges are built are in inaccessible places where it is out of the question, within the limits of economy, to bring in steel or other material, and where suitable timber is abundant on the ground.

There is, of course, still being constructed a considerable amount of timber trestle work, and outside of the approved appliances for driving piles and the pneumatic and electric hand drills for drilling holes for drift bolts, there has been little development in labor-saving appliances in this work.

The enormously increasing use of concrete for railroad structures has practically revolutionized the branches of railroad construction in which it has been used. Aggregates for concrete are far more generally and cheaply obtainable than stone for masonry, and its use does not require the skilled labor necessary for the construction of masonry structures; and by the combination of concrete and steel, to form so-called "reinforced concrete," the actual quantity of concrete required in many structures is far less than would have been required if they had been constructed of masonry.

The developments in the art of making and placing concrete and appliances for same have been many and of varied kinds.

Portland cement has practically entirely taken the place of natural cement, which was formerly largely used. Many types of concrete mixers have been put in the field, of which there are a large number which are entirely practical and economical of operation. Likewise, various types of dumping buckets for handling the concrete have been devised; and during the last few years a considerable amount of concrete has been handled from the mixer to the structure by elevating it in a tower and dumping it into a chute, through which it flows to the place of deposit.

For the smaller drainage openings on railroads, cast iron pipe is probably principally used. Both vitrified earthenware pipe and pipes of reinforced concrete are used to some extent; the latter shows an increasing use.

The increase in locomotive and train loads has required increase in the capacity of railroad bridges; and developments in bridge-shop practice and equipment, erecting machinery of increased capacity and field-riveting appliances have all influenced the changes in bridge design.

Plate-girder bridges are replacing truss spans up to 100 feet or more in length; and there is a growing tendency to use riveted bridges for spans up to 150 feet or more, the considerations being greater rigidity and economy, and being made possible by power field-riveting machinery and more effective and powerful erecting appliances. The use of concrete in connection with steel spans, as for floors or protection to members, should also be noted.

Tracklaying.—Economical and rapid tracklaying is dependent upon having at all times a supply of the necessary materials, including rails and ties, delivered on approximately the location where they are to be used.

In prairie country where teams can be used for the purpose of distributing this material, the distribution is accomplished in that way; but in country where it is impossible to distribute by teams, some other method must be devised.

Where the amount of track to be laid is small, the work is usually done from a work train and rail car, handling the material from the work train by hand. To facilitate this handling, where long stretches of track are to be laid, there have been devised tracklaying machines. The general principle of them all is to furnish a means of conveying the ties and rails ahead of the work train, depositing them approximately at the point where they are to be used.

Generally only one-half the number of ties are carried forward and bridles are used to hold the track to gauge while the work train passes over, after which the remaining half of the ties are put in place and the track is spiked. By this method a well organized crew should easily lay 2 miles of track per day.

Ballasting.—Ballasting, where done on a large scale, is accomplished by the use of bottom-dump cars for depositing the ballast alongside or between the rails, after which the track is raised with jacks and the material tamped under the ties by hand.

Structures.—As in the case of bridges, concrete has entered very largely into the field of miscellaneous railroad structures, such as stations, water stations, shops, etc.

In many cases, the smaller structures are made as a monolith at some central plant, loaded onto cars and shipped to the place where they are to be used. This particularly applies to the switchmen's houses and similar small structures.

Some very interesting water stations, including the tanks, have been constructed of concrete, and as above stated, where permanent structures of this character are to be built, concrete is very generally used.

Summary.—In reviewing the whole field of the development in railroad construction methods and equipment, it is probable that the increasing use of concrete would stand first, after which would come the development of the modern explosive as a means for easily and cheaply facilitating the movement of the large volumes of earth, rock and other material necessary for the construction of our railroads.

The Winnipeg Aqueduct Construction Co. has a large Bucyrus dragline excavator, which has had frequent occasions to operate over soft muskeg. The method employed is as follows: A strip of 4" x 5/8" strap iron has been spiked to the centre of both the front and back edges of all pads or platforms. When it is necessary to move ahead, the bucket is swung around and lowered so that the teeth catch under the pad which the machine has just passed over. The strip of iron thus protects the edge and prevents it from being gouged out. A direct pull on the dragline will cause the machine to move up without any difficulty. The original skids on the dragline have been replaced by a solid piece of 10" x 18" timber 30 feet long aid flat and shod with a 1/2 inch plate. This makes a lower and wider skid bearing area. These wider skids were found necessary after the machine has passed through a stretch of muskeg 12 to 15 feet deep. This muskeg was so saturated with water that when water pockets were encountered, they would gush out in front of the machine into the trench breaking the muskeg back at times as far as the centre of the machine. These gushes would frequently flow for a short while as thick as a man's body. The decision to put on the broader skids was arrived at after a 1 1/4 inch steel cable had been broken in attempting to pull the machine out.

MANITOBA MUNICIPAL CONVENTION.

THE recent annual convention of the Union of Manitoba Municipalities, held on November 23rd, 24th and 25th, in Stonewall, will doubtless be of interest to many engineers. Municipal matters in the province were discussed with a seriousness of purpose and a concentration which showed that the different mayors, reeves, aldermen, councillors and secretary-treasurers attending as delegates are alive to their responsibilities as representatives of the people.

The predominant feature of the proceedings was patriotism. It was shown in the passing of a resolution petitioning the Provincial Government to impose, through the municipal councils, a direct tax of one mill on the dollar on all the rateable, assessable wealth in the province; the money so obtained to be used as the voluntary Patriotic Fund is now—for the relief and comfort of families of soldiers now on active service. It was shown in all the speeches delivered at the banquet in Winnipeg given to the delegates by the Manitoba Good Roads Association, at which the Honorable Robt. Rogers was the guest of honor.

As befitting its importance to the various municipalities represented, and to the province as a whole, the subject of good roads received considerable attention. Mr. A. McGillivray, the Manitoba Highway Commissioner, was present and gave a short address, explaining the working of the Good Roads Act which has now been on the statute books for about three years. He also answered a number of questions raised by delegates.

One of the resolutions passed by the convention reads as follows:—

"Whereas roads leading from the country through towns and cities are largely used by people coming from the country; and whereas, as a rule, such leading roads, especially in the outlying portions of towns and cities are not paved by reason of such parts in towns and cities not being thickly populated; and whereas it would be greatly to the advantage of residents in the country surrounding towns and cities that such leading roads be paved; and whereas the bringing of such leading roads under the operation of the Good Roads Act would be an inducement to towns and cities to pave the same; therefore the Union of Manitoba Municipalities in convention assembled is of the opinion that roads leading from the country through towns and cities should be brought under the operation of the Manitoba Good Roads Act and that towns and cities be given the benefit of government grants under said Act, the same as rural municipalities."

At present, the rural municipalities are the only ones receiving government aid under the Good Roads Act. If the above resolution were enacted by the Legislature into law it would enlarge considerably the sphere and scope of the Act.

Another resolution brought up and very properly voted down was a complaint that the standard of road construction set by the Highway Commissioner was too high and too severe. It is quite evident that it is going to take time to educate the ratepayers of rural districts up to engineering standards, in this and other matters. There can surely be no standard too high in road construction. (It is worthy of note here that only one engineer was present at the convention as an accredited delegate.)

The resolution which raised the keenest interest and discussion and was passed unanimously, reads as follows: "That this Union of Manitoba Municipalities request the Provincial Government to devote the proceeds of the automobile licenses wholly to the maintenance of roads and the administration of the Motor Vehicle Act."

The municipality of Rockwood, which brought in the resolution, had had prepared a chart which showed in concise form how this question of distribution of revenue from motor vehicle licenses and fines is handled in every province in Canada and in every State in the Union. It showed clearly how far behind the times Manitoba and the majority of the other Canadian provinces are in this very important matter. Of the 49 States to the south of us, 40 (82%) spend this money for the maintenance of roads, while only two Canadian provinces (Nova Scotia and Quebec) do the same. About half of the 40 States returning the money to the roads spends the same under state engineers, while the other half returns the money to the various rural counties affected. While the citizens of the United States thus seem undecided as to who shall actually spend the money, the important point to note is that they do spend it on the roads and do not credit it to the general (or consolidated revenue) fund of the State for expenditure on some altogether foreign purpose. It is to be hoped that the government of Manitoba will realize and recognize the unanimity of public opinion as to the spending of this motor vehicle money and pass legislation as requested, thus leading the way again, as far as the western provinces are concerned, at least, in the matter of good roads.

NEW ELECTRIC RAILWAY—TORONTO TO GUELPH.

It was recently announced by Mr. H. T. Hazen, district engineer for Mackenzie and Mann, Limited, that the Toronto Suburban Railway would be in operation as far as Georgetown, Ont., by February, and throughout its entire length of 48 miles to Guelph by March 1st. Mr. Hazen has had charge of the construction of this new electric line, which will serve the towns and villages of Islington, Dixie, Cooksville, Meadowvale, Churchill, Huttonville, Norval, Georgetown, Limehouse, Acton, Blue Springs, Eden Mills, in addition to the rural municipalities en route between the two terminal cities, Toronto and Guelph. It will be a single-track line with an abundant siding trackage.

Steel is laid for the full 48 miles to Guelph, leaving only the overhead work to be done, and if the conclusions of the officials are correct there will be an hourly service between Toronto and Georgetown and a two-hour service to Guelph. The distance between Toronto and Guelph is expected to be covered in two hours. The route to Guelph will be known as the company's main line, with the Woodbridge line as a branch. The latter line has been in operation now over a year.

There are rumors still of negotiations pending between the company and the Hydro-Electric Power Commission of Ontario for the purchase of the new Toronto-Guelph line by the latter, to be operated as a part of the hydro radial system referred to in these columns recently.

The consumption of antimony in Canada and the United States is estimated to amount at present to 600 to 700 tons per month. Regular domestic consumption is now probably not over 50 per cent. of normal, owing to the high price of the metal. Imports of the metal and regulus for July, 1915, were 2,439,601 lbs., as against only 856,653 lbs. in July, 1914. Before the war about half the antimony was imported from Europe, but now it comes from Japan and China, indicating the tremendous expansion there. These countries are also exporting to England.

ECONOMIC POSSIBILITIES OF SLUDGE.

ONE of the subjects under experimental investigation last year at the experimental station of the Provincial Board of Health of Ontario, according to the recently issued report for the year 1915, was a study of the economic possibilities of the sludge from Emscher or modified Travis tanks. The experiments aimed to ascertain the fertilizer, fat and fuel value of the sludge. They were conducted by Mr. A. V. DeLaporte, B.A., Sc., who had charge of the experimental station last year and who submits, in the report already referred to, a summary of the results of the first series of experiments as follows:—

Fertilizer Value.—The analysis of Imhoff sludge from several sources, as shown in the tables, when considered together with the high grease content and felt-like character of the sludge, seemed to render unnecessary further investigation into its value as a fertilizer.

Comparison with the tabulated analysis would indicate that while Imhoff sludge compares favorably with a good loam, it has no commercial value as a fertilizer.

	Wet Sludge			Dry Sludge		
From—	Percentage matter	Solids	Ash	Organic matter	Nitrogen	Fats
Recklinghausen	79.34	20.66	44.8	45.2	1.56	6.4
Essen IV. W.	75.6	24.4	45.8	54.9	1.22	4.89
Bochum	75.8	24.12	54.9	40.5	1.102	5.73
Beckon, I. W.	77.6	22.4	64.0	36.0	1.34	2.61
Experimental Station, Toronto, shallow tank	83.9	16.1	33.0	47.0	1.5	1.40

An Average Analysis of Sludge of the Shallow Imhoff Tank at the Experimental Station of the Provincial Board of Health.

Wet Sludge.		Dry Sludge.	
Water	83.9%	Total nitrogen	0.2%
Ash	7.5%	Total phosphoric acid	0.5%
Volatile on heating	8.6%	Potash	0.1%
	100%		

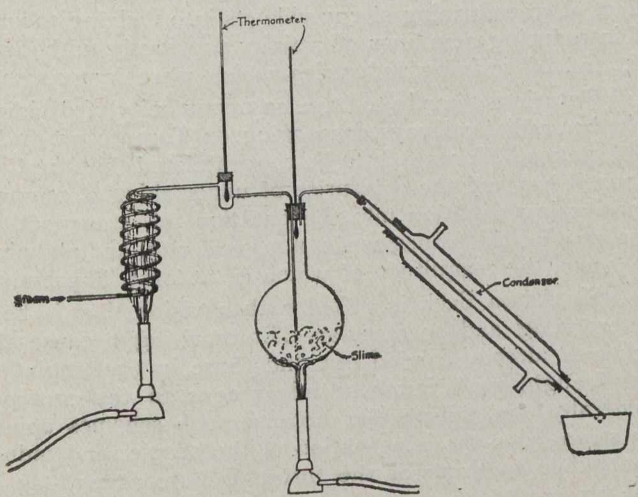
Analysis of an average Fertilizer.		Analysis of an average Loam.	
Nitrogen	4%	Nitrogen	0.642%
Phosphoric acid	8%	Phosphoric acid	0.15 %
Potash	5%	Potash	0.14 %

Fat Value.—The recovery of the grease content is theoretically possible by any one of the several well-known methods: (*a*) By extraction with solvents; (*b*) by distillation in superheated steam; (*c*) by destructive distillation; (*d*) by rendering—similar to the rendering of butchers' waste.

(1) Extraction was tried first and very satisfactory results were obtained by using different solvents. Ether, benzine, gasoline and carbon tetrachloride were used and comparable results obtained. Twenty-three per cent. grease was the highest obtained during the experiments. The average was fourteen per cent. Some samples were as low as six per cent.

To recover the maximum of grease from the sludge it is necessary to acidify the wet sludge with H_2SO_4 and then dry. The cost of this treatment, taken in conjunction with the low price and limited market for the product, is such as to render it unprofitable.

(2) Distillation in steam was carried out in the apparatus shown in Fig. 1. No results were obtained until the temperature of the steam entering was raised to 300° C. when a light yellow oil distilled which had a characteristic odor. No difference was observable between samples acidified with H_2SO_4 and those which had not. The average yield of oil was 4.5 per cent. by weight of the dried sludge. The liquor collected from the condenser had some ammonia, and also on evaporation a small amount of oil. This method was obviously of no commercial use,



DISTILLATION OF IMHOFF SLIME WITH SUPERHEATED STEAM

Fig. 1.

the quantity of steam required and the small yield of oil being the principal reason for no further investigation of this method.

(3) Destructive distillation of the sludge showed possibilities. The grease given off during the combustion was distinctly inflammable. A high yield of oil (20 per cent.) was obtained.

The gas was made up roughly of—

	By volume		
Carbon dioxide......	10%	Higher hydrocarbons	1.00%
Oxygen	trace	Methyne & hydrogen	50.00%
Carbon monoxide ...	25%	Nitrogen by difference	13.8%
			100%

and was of good illuminating quality, burning freely in a Bunsen burner.

A fractional distillation of the resultant oil gave the following factors:—

20 per cent. between 70° C.—85° C.—a light yellow oil.
6 per cent. between 85° C.—105° C.—
0—between 105° C.—110° C.—
20 per cent. between 110° C.—

The latter 20 per cent. was a white fat, which looked and smelt like lard. At 300° C. nothing was left but a black tar very similar to coal tar.

The results of distillation summarized as follows:—

Original dry sludge 100 grams	Residuum 60 grms.	Obtained 15 litres of gas
	Distilled 40 grms.	5 grms. of light oil
		5 " of heavy oil
		3.5 " of grease
		2. "
		0.2 " ammonia

A rough estimate of the sludge obtained in our Imhoff tank is 3 cubic yards per million gallons of sewage. That equals about 6,000 lbs. of sludge. The moisture content of this sludge per million gallons of sewage is 4,500 lbs. of water. In view of the fact that the moisture content of sludge varies considerably, it is convenient to consider only dried sludge as a basis of calculation. The amount of dried sludge obtained in a city of the size of Toronto would appear to be between 25 and 40 tons daily.

If the sludge were destructively distilled we should obtain approximately 1,280,000 cubic feet of illuminating gas worth between 25 and 50 cents a thousand cubic feet, therefore having a value of about $500; 4,000 lbs. of saponifiable grease worth about $100; 3,500 lbs. of tar and 4,000 lbs. of light oil and 15 tons of ash. Thus the value of this material wasted per day in a city the size of Toronto would be in the neighborhood of $700. The cost of recovery of this material is, however, impossible to estimate without the installation of a plant.

(4) Rendering. No investigation has been made into the possibility of rendering the sludge, no apparatus suitable for the purpose being at hand. The fuel value of the sludge was given scant consideration after two or three tests in a bomb calorimeter, the highest value obtained being 2,000 calories. The very low calorific value and high ash makes it useless as a fuel.

The results to date are as follows: (*a*) The sludge has practically no value as a fertilizer or a fuel. (*b*) Extraction for the recovery of the grease or distillation with superheated steam would not pay. (*c*) Destructive distillation designed to recover the grease, gas, ammonia, etc., might cover expenses. It is impossible to say without first running a small plant.

UNIT COSTS, SOOKE LAKE WATER SYSTEM.

An article appearing in *The Canadian Engineer* for November 18th, 1915, reviewed the construction of the Sooke Lake water supply system for Victoria, B.C., and presented some interesting figures of cost, relating to earth and rock excavation, concreting, etc., for the concrete pipe line, steel pressure line, Humpback reservoir, etc. Mr. C. H. Rust, M.Can.Soc.C.E., city engineer and water commissioner, has compiled some additional data, referring to the unit cost of the undertaking and we are indebted to him for the following figures. It will be remembered that the original contractors abandoned the work in April, 1914, after working slightly more than twelve months, and Mr. Rust then, as water commissioner, took charge of the work and completed a great deal of it by day labor.

The contract was divided into five schedules: Schedules "A" and "B" comprised the clearing of land, construction of roads and dam at Sooke Lake; Schedule "C," the concrete pipe line; Schedule "D," work in connection with Humpback reservoir, and Schedule "E," work on pressure pipe line from Humpback reservoir to the city.

Schedule "A."

	Contractor's figures.	Actual cost.
Earth excavation ....$	1.50 cu. yd.	$ .22 cu. yd.
Rock excavation	7.50 cu. yd.	4.67 cu. yd.
*Clearing land	150.00 per acre	246.10 per acre
Building wagon road.	1.50 cu. yd.	.89 cu. yd.

Schedule "B."

	Contractor's figures.	Actual cost.
Earth excavation ...$	.70 cu. yd.	$ .90 cu. yd.
*Rock excavation ...	4.75 cu. yd.	3.44 cu. yd.
†Concrete	11.00 cu. yd.	15.69 cu. yd.

Schedule "C."

	Contractor's figures.	Actual cost.
Clearing right-of-way	$2,400.00 per mi.	$1,456.00 per mi.
Earth excavation ...	.60 cu. yd.	.57 cu. yd.
Rock excavation ...	1.75 cu. yd.	1.79 cu. yd.
‡§Concrete pipe	2.53 lin. ft.	‖3.35 lin. ft.

‖This includes the construction of railway, concrete trestles and transportation. The pipe per foot under new contract was $2.29 laid and installed.

‡Telephone line	$280.00 per mile	$426.00 per mile

Schedule "D."

	Contractor's figures.	Actual cost.
*Earth excavation ...	$ .65 cu. yd.	$ 1.92 cu. yd.
*Rock excavation ...	4.00 cu. yd.	11.25 cu. yd.
Clearing	350.00 per acre	445.00 per acre
†Gravel on bottom of reservoir site	1.00 cu. yd.	3.28 cu. yd.
†Concrete, Class "A"	12.50 cu. yd.	Average cost
†Concrete, Class "B"	10.00 cu. yd.	of 3 classes,
†Concrete, Class "C"	9.25 cu. yd.	$9.04 cu. yd.

Schedule "E."

	Contractor's figures.	Actual cost.
†Earth excavation ..	$ .60 cu. yd.	$ 1.32 cu. yd.
†Rock excavation ...	3.00 cu. yd.	9.20 cu. yd.
†Backfilling	.15 cu. yd.	.55 cu. yd.
*Concrete	20.00 cu. yd.	19.58 cu. yd.
‡5/16-in. riveted pipe	5.25 lin. ft.	5.53 lin. ft.
‡3/8-in. riveted pipe .	6.25 lin. ft.	6.28 lin. ft.

* Work commenced by contractor and completed by city.
† Work carried out entirely by city.
‡ New contracts awarded.
§ Original contract provided for a pipe 40 ins. in diameter, but new contractor laid, without additional cost, a pipe 42 ins. in diameter.

Unskilled labor, 34½ cents per hour. Eight hours constituted a day's work.

PROTECTION OF ROAD SHOULDERS.

A novel and practical device is used in the State of Maryland to prevent the washing-out of road shoulders and gutters. These "breakers," as they are termed, answer their purpose so well that they will pay for themselves after two or three heavy storms, according to Mr. H. G. Shirley, chief engineer of the state roads commission. They are considerably cheaper than cobblestone gutters, give thorough protection to the shoulders of the road, and may be used on any type of highway, including farm lanes and driveways.

The breaker consists of a low concrete barrier extending from the edge of the road diagonally through the shoulder to the ditch. It is built flush with the surface of the road shoulder, and where the highways are patrolled and the shoulders kept in repair it is no objection to travel. Breakers are spaced as occasion may require, and are neither expensive nor difficult to build. The Maryland breakers are 12 inches wide and 18 inches deep. The spacing varies with the nature of the soil, grade, and amount of water they encounter. Thus it would probably be necessary to space them closer at the bottom of a hill than at the top. On 5 or 6 per cent. grades and medium soil they are spaced 25 to 30 feet apart. Where the soil is liable to wash and the grade is steeper they would be spaced much closer. The length as well as the grade of a hill would also influence spacing.

RADIAL RAILWAYS.

By R. O. Wynne-Roberts, Toronto.

Transportation and intercommunication between districts and communities constitute a very important factor in the problem of town planning because the development of districts and the prosperity of communities depend largely upon cheap and easy transport.

The advent of railways of different kinds had the effect of transforming sleepy villages into thriving towns; of introducing new lines of activity previously unthought of, and of reviving industries which were languishing.

Ontario is shortly to have an opportunity of deciding whether radial railways converging on Toronto are to be undertaken. Toronto is to be congratulated that the City Council has had the enterprise of undertaking a comprehensive investigation into the question of transport, in anticipating the future needs of a great city, and planning schemes, the magnitude of which is, at least, impressive.

Sir Adam Beck is gifted with a vision that is both enterprising and spectacular. Enterprising because the schemes already carried out and those in contemplation are fraught with immense advantages to the province generally, and spectacular because such schemes appeal so strongly to the imagination of the people, and induce the public to think of the future welfare as well as of the present.

Radial railways, however, are not local in their conception. Such means of communication are to be found in other countries, although the names applied to them are not the same. Radial railways are to be found in the United States. They are known in Britain as "light railways," in Belgium as "vicinal railways," and so on.

The writer had occasion some time ago to collect information concerning such railways, and it may be interesting to give some of the particulars.

It is somewhat anomalous that light railways have not been extensively adopted in Britain. England and Wales have a few small examples, such as the Glyn Valley, the Wisbech and the Wantage lines. The Festiniog to Port Madoc is probably the oldest narrow-gauge line in the world, having been constructed about half a century ago and operated successfully meanwhile. Its main use is to transport slate from the quarries to the harbor, and incidentally to convey passengers to the different villages en route. The Snowdon narrow-gauge line connects Carnarvon docks and the quarries inland. It also conveys passengers between the several villages. The Glyn Valley railway is nine miles long, of which five miles are laid on the side of a public road. The gauge is 2 ft. 4½ ins. and the railway has been operated since 1875, affording facilities to develop the mineral resources of the district. Stations are provided at the termini, but passengers can join the train at stopping places. The Wisbech railway is about eight miles long, 4¼ miles of which are laid on the roadside. This was constructed in 1883 and the materials carried are chiefly agricultural produce, fruit, oil cake, etc. The Wantage railway was started in 1874 and a part of this line also is on the side of a road.

The Kinver railway connects that town with Stourbridge and with the centre of Birmingham. The Middlesex electric railways, constructed and owned by the county council, pass through a large number of cities outside London. The municipally owned electric railways of Liverpool, Manchester, Leeds, Glasgow, etc., are all interconnected with neighboring towns.

Under the authority of the Light Railways Act, 1896, and the Development and Road Improvement Fund Act, 1909, certain inducements are given and regulations relaxed in connection with the construction of railways to rural districts.

There are 83¾ miles (1910) of light railways in Ireland, laid on public roads. Mr. Barrington stated that while the population of Ireland had diminished from 16 to 25 per cent. during the last quarter of a century, the gross receipts had increased on an average of about 51 per cent, although the railways were in the poorer parts of the country.

There are many reasons why light railways have not been more largely constructed in Britain, such as cost, transhipments and the opposition of large railway companies.

There are several narrow-gauge lines in France, Italy, Holland, Prussia, India, Cape Colony and other countries, but the most interesting examples of the value of radial lines are those in Belgium, known as *chemins de fer vicinaux*, or vicinal railways, which connect vicinities together.

Mons. C. de Burlet, the director-general, was good enough to furnish the writer with information, plans and drawings of the vicinal railways and rolling stock. He stated that private enterprise failed to provide vicinal railways adequate for the needs of the country. So the Belgium Act of 1885 was passed by the Parliament, giving powers to the Société Nationale des Chemins de Fer Vicinaux (National Society for Vicinal Railways) to investigate each proposed new vicinal railway and to report thereon to the Government. If the scheme commends itself and receives the approval of the Government, the National Society then proceeds to raise the capital by forming a limited liability company. Shares are taken up by the State, the provinces, parishes, townships and private persons. The State holds about 40 per cent. of the shares, the provinces and parishes, etc., each nearly 30 per cent., and the balance, if any, is held by private investors. Since 1885 the growth of the system of vicinal railways has been steady and great. The mileage in 1910 was about 2,020, the capital invested about $53,000,000, and the annual receipts about $3,800,000. These railways are almost entirely on the roadside, the track and two feet on either side being maintained by the companies. The traffic on the railways may be appreciated when it is stated that 1,000,000 tons of agricultural produce and materials, nearly 2,000,000 tons of merchandise, and 1,000,000 tons of miscellaneous goods were carried in 1908, while 53,500,000 journeys were made by passengers.

Mons. de Burlet stated that the cost of transporting gravel, macadam and setts was reduced to such an extent that the shippers saved from 60 cents to $2 per ton, according to the distance hauled.

There are about 400 sidings, 85 per cent. of which are to works, factories and quarries, and 15 per cent. to farms. Passengers and goods are taken on at any point and thus intermediate stations are unnecessary. So popular have these vicinal railways become that the demands for extensions taxes the resources of the Society and consequently the government, provincial and village authorities are often unable to pay for their share. They solved the difficulty by agreeing to pay in ninety annual instalments, together with 3½ per cent. interest and sinking fund charges, receiving in return a proportional share of the net annual income. In this manner the shareholding authorities gradually acquired a valuable property often at little or no cost to the ratepayers, because the dividends sometimes exceeded 3½ per cent.

The value of the vicinal railways from the commercial and social points of view, has been great. Mons. de Burlet stated that the transport facilities transformed insignificant and abandoned quarries into lucrative and important undertakings; agriculture was raised from a depressed condition to a prosperous one; dormant villages became centres of human activity; new markets were found for all produce; the finances and commerce were revived; the value of land and property was enhanced; the low rates for workmen extended their spheres of employment; cheap facilities for travel and transport stimulated a new and optimistic spirit, infused fresh energy, improved the economic conditions of the rural districts and produced an increasing national prosperity throughout Belgium.

In return for the State guarantees the mails are carried free and special facilities are given to voters, soldiers, workmen and school children.

The foregoing remarks, of course, apply to Belgium under normal peace conditions.

EXTERNAL CORROSION AND REPAIR OF WATER MAIN.

In the journal of the Boston Society of Civil Engineers Mr. Harrison P. Eddy, consulting Engineer, Boston, describes a rather unusual case of corrosion where a 20-inch cast-iron intake pipe crossed over a small vitrified pipe which conveyed drip and waste sulphuric acid from a mill. The vitrified pipe apparently was broken or clogged so that the acid escaped from it into the ground in the immediate vicinity of the main. An irregular hole about 2 in. by 1 in. was eaten through the cast-iron pipe. At the edge of the hole the thickness of the pipe was not over one-eighth of an inch, although this thickness gradually increased as the distance from the hole became greater. The effect of the acid on the outside of the pipe was noticeable for a distance of about three feet along its axis. The action of the acid upon the iron was greater in some places than others. There were several large bands of corrosion about the underside of the pipe, some of which were three or four inches wide, and apparently the pipe was being eaten into a depth of as much as three-eighths of an inch. The surface of the pipe, aside from the general irregularity of the bands and large areas eaten by the acid, was slightly rough but not materially different from the surface of ordinary cast-iron pipe. It was nowhere honeycombed, as might be expected.

The pipe was repaired by surrounding the portion affected by a split cast-iron sleeve four feet in length, packed with rubber gaskets and bolted together. The ends of the sleeve were leaded and calked in the usual way. At first the sleeve leaked at the joints, but these leaks stopped within twelve hours and the sleeve was entirely surrounded with Portland cement concrete well reinforced. The concrete sleeve was extended far enough in either direction to make certain that it protected the iron from any acid in the ground.

The vitrified acid pipe was diverted to a new location at some distance from the intake pipe. The soil in which the cast-iron pipe main and the vitrified pipe were laid was a mixture of sand and hardpan, fairly impervious to water, and not virgin soil, as there had been an old tannery in this location and various logs and timbers from the tannery were encountered in the excavation. Immediately below the vitrified pipe, a coarse water-bearing gravel was encountered. It is probable, however, that this stratum of gravel was fairly well cut off from the soil above by moderately impervious material.

THE FOREST PRODUCTS LABORATORIES OF CANADA.

A VALUABLE increment to the facilities in Canada for practical research is the Forest Products Laboratories of Canada, formally opened in Montreal on December 3rd. The institution has been established, as the name implies, for the carrying on of research work on forest products for the benefit of the Canadian public at large and the Canadian wood-using industries in particular. It was established in 1913 under the Forestry Bureau of the Department of the Interior and in conjunction with McGill University, a co-operative plan having been formulated whereby the University provides laboratory quarters while the government provides equipment and meets the cost of maintenance. The work of organization has been practically accomplished and the Laboratories are now proceeding with a series of systematic scientific investigations. These deal largely with the conservation of forest resources by proper utilization of raw material. They involve a study of the wood itself and of the processes and products of manufacture. The work is accordingly of a chemical, physical and engineering nature. The laboratories occupy a number of buildings on University Avenue, Montreal. Besides the administration building, which houses general and private offices, drafting room, chemical and photographic laboratories and the wood preservation laboratory, there is a building which is devoted entirely to an experimental paper mill, complete in every way and already in operation. In addition, there are seasoning sheds, woodworking shops, store houses, etc. The timber-testing facilities of the university laboratory are taken advantage of for strength tests, etc. The accompanying illustrations relate to the laboratory equipment in use. Fig. 1 is a view of the 30,000-lb. Olsen testing machine used in testing small, clear specimens in compression parallel to the grain of the wood. Fig. 2 is an illustration of the experimental paper machine. It is a special Fourdrinier machine and is about 75 feet in length and capable of turning out a sheet 30 inches wide. The machine is flexible in its adjustments and attachments and is designed to make practically all grades of paper. A single beater of 40 lbs. capacity and a double beater of 60 lbs. capacity have been installed with interchangeable basalt lava and steel rolls with individual motor drive to each roll. The remaining equipment, which is now in place, includes three stuff chests, riffler, screen, four pumps, five motors, two paper-testing instruments, Erfurt sizing system and a variety of small apparatus. Sulphite

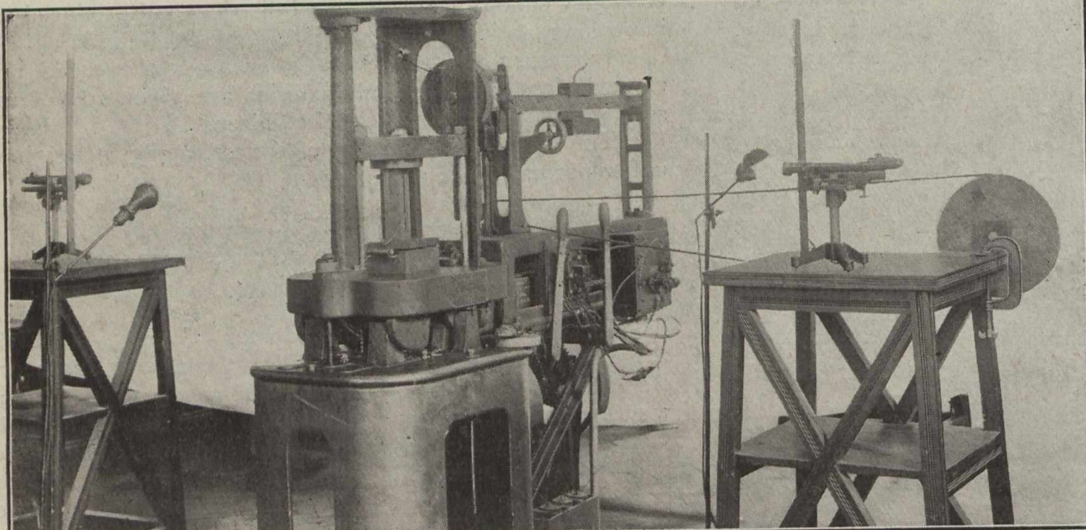


Fig. 1.—Olsen Machine Used in Testing Small Clear Specimens for Compression Parallel to Grain.

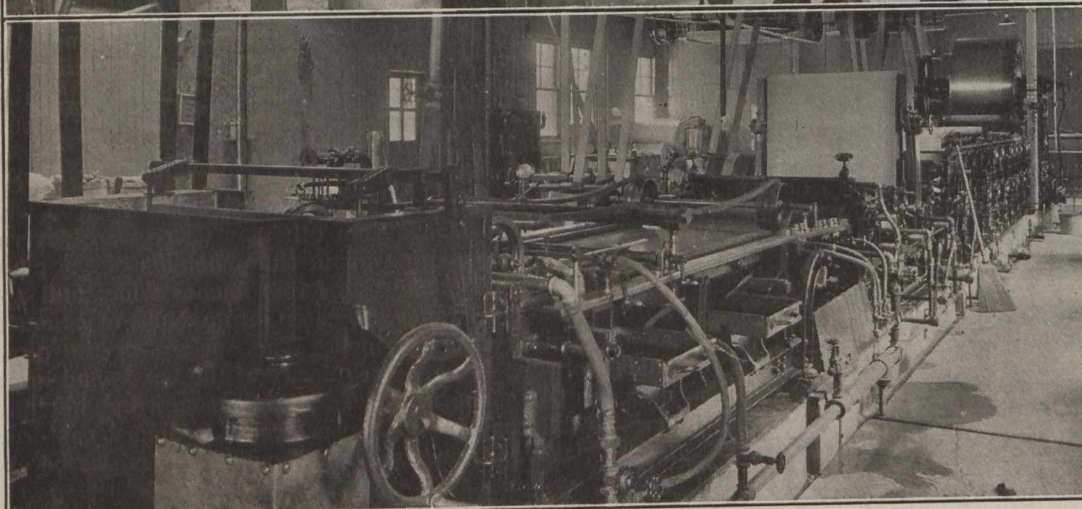


Fig. 2.—The Experimental Paper Machine.

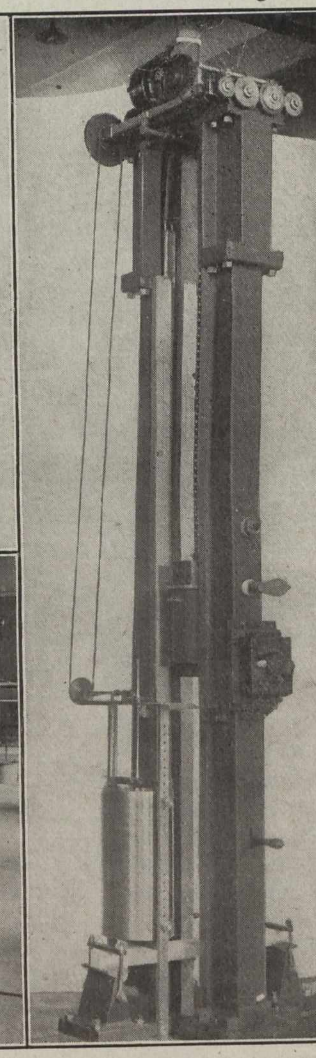


Fig. 3.—Hatt-Turner Machine Testing Small Clear Specimens in Impact Bending.

and soda digesters and other equipment will be installed in the near future for the manufacture of wood pulp by chemical processes on a satisfactory scale. Preliminary work has been done on several pulp and paper investigations. Queen's University has co-operated in research on the chemical composition of waste sulphite liquor, which is produced in such large quantities by our paper mills.

Fig. 3 is a view of the Hatt-Turner testing machine that is being used in tests for impact bending that are being performed on specimens of various Canadian woods as outlined later. Fig. 4 illustrates a 150,000-lb. Emery testing machine employed in mine prop investigations, and Fig. 5 shows a 200,000-lb. Wicksteed machine engaged on mine booms. A 60,000-lb. Riehle testing machine is also occasionally employed.

In the matter of timber tests two very important series of experiments have already been undertaken. The first relates to the mechanical and physical properties of Canadian woods, as determined by tests on small clear specimens. Its purpose is to establish the strength characteristics of the important Canadian wood species. The testing procedure includes eight strength tests—static bending, compression parallel to grain, compression perpendicular to grain, shear, tension, impact bending, cleavage and hardness. The first species under test is Douglas fir, obtained from Alberta and British Columbia. The results have shown that the fast-growing Douglas fir of the Pacific Coast has unusual strength and that the slower growing and smaller mountain types, although more affected by knots and other defects, are of very good quality. The tests confirm the fact that our Canadian Douglas fir is a first-class structural material.

An investigation of strength functions and physical properties of Nova Scotia mine timbers has been carried on in connection with a general investigation of Nova Scotia mine timbers instituted by McGill University in co-operation with the Forestry Branch. Over seven hundred representative pit props and booms were obtained from Nova Scotia, including five species—black spruce, balsam fir, white birch, yellow birch and jack pine. Most of these timbers have been tested in commercial sizes.

Studies in timber physics require considerable equipment, including microtome, microscopes, photomicrographic apparatus, projection lantern, cameras, electric ovens, autoclave, balances, etc. The work has to do largely with the determination of physical and structural properties of wood by the testing of moisture content, specific gravity, per cent. springwood, per cent. summerwood, per cent. sapwood, per cent. heartwood, fibre dimensions, cell structure, microscopic characteristics and fungus infection. There has been considerable study to learn the relation of microscopic structure of wood to penetration by preservatives and other liquids. General botanical studies are also made. All the photographic work is done by this division, including the making of microscopic slides, photomicrographs and lantern slides of wood sections and pulp fibres, as well as miscellaneous photographs, copies, enlargements, etc. Studies have been made to improve the methods of wood identification. Investigations are in progress on the relation of vapor pressure and shrinkage to the moisture content of wood.

A division of wood preservation was organized in October, 1914. The scope of this division includes the study of wood preservatives and methods of treating wood to prolong the life of railroad ties, paving blocks, telegraph poles, posts, piling, trestle timber, mine props and structural timber in general. A study of wood-destroying fungi has also been undertaken as well as methods of fireproofing wood. A certain amount of equipment in the form of retorts, pumps, motors, air compressor and so forth have been obtained for the carrying on of experimental work. Particular attention is being paid to the subject of railway ties in Canada.

The publications contributed to date by the laboratories are Forestry Branch Circular No. 8, "Forest Products Laboratories," Circular No. 9, "Chemical Methods for Utilizing Wood Wastes," and Bulletin No. 49, "Treated Wood Block Paving." A very interesting and

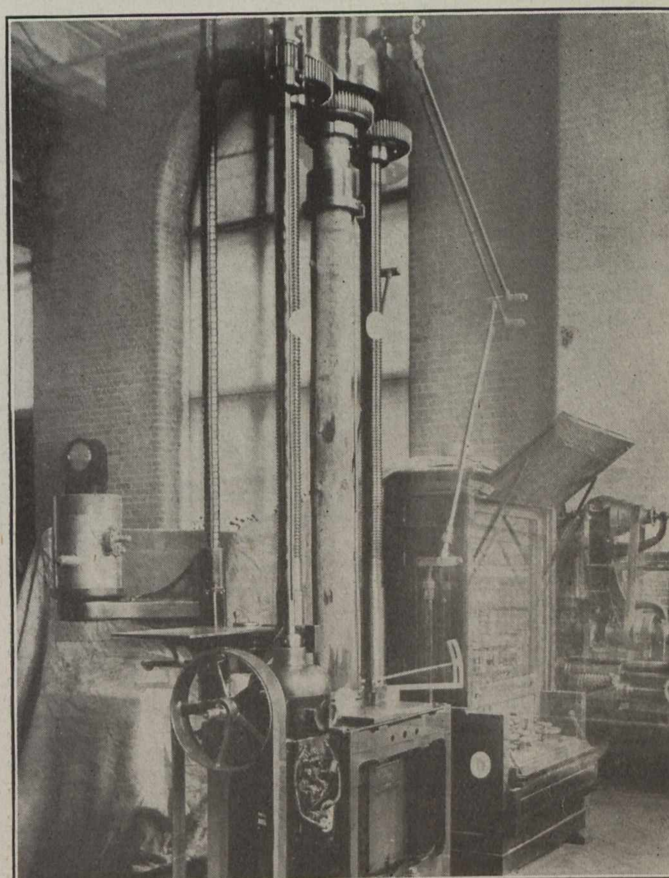


Fig. 4.—Emery Testing Machine Engaged on Mine Props.

complete description of the laboratories and equipment appeared in the Canadian Forestry Journal for July, 1915, and another in the Journal (for March 31, 1915) of the Canadian Section of the Society of Chemical Industry.

The organization of Forest Products Laboratories of Canada is as follows: Superintendent, J. S. Bates, Ph.D.; assistant superintendent, W. B. Campbell (on active service); division of timber physics, H. N. Lee, acting chief; division of timber tests, R. W. Sterns, chief; division of pulp and paper, O. F. Bryant, acting chief; division of wood preservation, W. G. Mitchell, chief.

At present the permanent staff numbers 30. Seven former members are now on active service, leaving 17 technical men at work in the laboratories and the balance in the division of administration. Two members resigned in the early fall to engage in ammunition work.

At the formal opening on December 3rd the guests assembled included the following representatives:—

Government—Hon. W. J. Roche, Minister of the Interior, Ottawa; R. H. Campbell, Director of Forestry, Department of the Interior, Ottawa; Dr. A. McGill, Chief Analyst, Department of Inland Revenue, Ottawa; Dr. C. G. Hewitt, D.Sc., Dominion Entomologist, Department of Agriculture, Ottawa; R. Grigg, Commissioner of Commerce, Department of Trade and Commerce, Ottawa; J. M. Macoun, C.M.G., Assistant Botanist, Geological Survey, Department of Mines, Ottawa.

Advisory Committee—F. Howard, care of J. C. Wilson, Limited, 61 St. Alexander Street, Montreal; J. A. DeCew, McGill Building, Montreal; Dr. R. F. Ruttan, Department of Chemistry, McGill University, Montreal; Carl Riordon, Riordon Pulp and Paper Co., Limited, No. 1 Beaver Hall Square, Montreal; Prof. H. M. Mackay, Department of Civil Engineering, McGill University, Montreal; R. O. Sweezey, Royal Military College, Kingston, Ont.; Dr. Frank D. Adams, McGill University, Montreal.

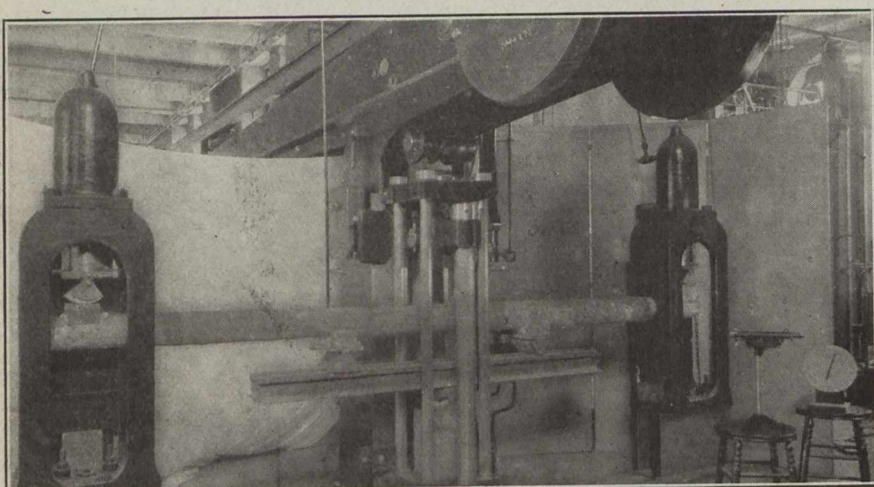


Fig. 5.—Wicksteed Testing Machine, Showing Method of Testing Mine Booms.

McGill University—Sir Wm. Peterson, K.C.M.G., McGill University, Montreal; Mr. Walter Vaughan, Secretary, McGill University, Montreal; Dr. H. T. Barnes, F.R.S., McGill University, Montreal; Dr. J. B. Porter, Prof. H. O. Keay, Prof. E. Brown, Prof. C. H. McLeod, Faculty of Applied Science, McGill University, Montreal; Dr. F. C. Harrison, Principal, Macdonald College, Ste. Anne de Bellevue, Que.; Dr. J. F. Snell, Macdonald College, Ste. Anne de Bellevue, Que.; Prof. Carrie M. Derick, McGill University, Montreal.

Foresters—Ellwood Wilson, Laurentide Co., Limited, Grand Mere, Que.; Clyde Leavitt, Forester, Commission of Conservation, Ottawa; E. J. Zavitz, Provincial Forester, Parliament Buildings, Toronto.

Canadian Forestry Association—Robson Black, Secretary Canadian Forestry Association, Ottawa.

Canadian Pulp and Paper Association—C. Howard Smith, Howard Smith Paper Mills, Limited, 138 McGill Street, Montreal.

Canadian Manufacturers' Association—J. H. Sherrard, President Canadian Manufacturers' Association (Alaska Feather and Down Co., Limited) 412 St. Ambroise Street, Montreal; George A. Slater, Vice-President Canadian Manufacturers' Association (Geo. A. Slater, Limited) Ontario, Mainsonneuve; Roy L. Campbell, Secretary Canadian Manufacturers' Association, Board of Trade Building, Montreal.

Canadian Society of Civil Engineers—R. A. Ross, Vice-President Canadian Society of Civil Engineers, 80 St. Francois Xavier Street, Montreal; Walter J. Francis, Chairman Canadian Society Civil Engineers, 232 St. James Street, Montreal; A. Surveyer, Councillor, Canadian Society of Civil Engineers, 56 Beaver Hall Hill, Montreal.

Society of Chemical Industry—T. H. Wardleworth, Chairman, Society of Chemical Industry, Montreal.

Canadian Railroads—M. G. Blaiklock, Chief Engineer, Maintenance of Way, G.T.R., Montreal; C. E. E. Ussher, Passenger Traffic Agent, C.P.R., Windsor Station, Montreal; B. M. Winegar, Forest Inspector, C.P.R., Windsor Station, Montreal.

Canadian Lumbermen's Association—Frank Hawkins, Secretary, Canadian Lumbermen's Association, 19 Castle Building, 53 Queens Street, Ottawa, Ont.

Miscellaneous—Hon. Sydney Fisher, Ottawa, Ont.; Howard Murray, Vice-President, Shawinigan Water and Power Company, 83 Craig Street West, Montreal; Smeaton White, 298 Stanley Street, Montreal; Capt. J. A. Weir Johnson, A.O.D., Ritz Carleton Hotel, Montreal; Mr. Wm. Kelly, Canadian Explosives Limited, Transportation Building, Montreal; J. B. Bell, Chief Chemist, Canadian Explosives Limited, Montreal; William Little, Westmount, Que.; T. L. Crossley, Laboratory of Dr. J. T. Donald; Dr. Hugh P. Baker, Syracuse University, Syracuse, N.Y.; Prof. S. J. Record, Forestry School, Yale University, New Haven, Conn.

The guests assembled in the laboratories and inspected the various divisions, much of the machinery and apparatus being in operation, including paper machine, pulp beaters, timber-testing machines, wood preservation retorts, etc. In the afternoon speeches were delivered by Hon. Dr. W. J. Roche, Sir Wm. Peterson, Hon. Sydney Fisher, T. H. Wardleworth, Dr. Hugh P. Baker, R. H. Campbell, and others.

STRENGTH OF CONCRETE BRIDGES.

The U.S. Office of Public Roads at Washington has begun a series of tests to determine the amount of load that can be sustained by concrete bridges of the type used in all parts of the country to span small streams.

An interesting test was made recently on a reinforced concrete bridge of this class. The platform of the bridge measures 16 feet wide and 32 feet long. It consisted of a solid slab of reinforced concrete 10 inches thick, and was supported by concrete abutments about four feet from the ground. The concrete slab was reinforced by ¾-inch iron rods about 8 inches apart, extending across it.

The load was applied to the slab by means of a hydraulic jack rigged above the bridge. It was brought to bear on a point in the centre of the platform. Previously experiments had been made to ascertain what the bridge would withstand when the load was distributed at four points. As the pressure was exerted any deflection in the slab was measured with instruments designed for that purpose.

It is not until the pressure had amounted to 90,000 pounds that the concrete slab cracked. A pressure of 84,000 pounds was exerted until the centre of the span had been depressed about 8 inches, and yet the platform did not entirely give way.

The test, it is claimed, demonstrates that the bridge could withstand the weight of two of the heaviest traction engines, even if applied at a single point in its centre.

Editorial

PUBLICITY IN ENGINEERING WORK.

As Henry Adams, president of the Concrete Institute of Great Britain, stated in a recent address, the time has gone by when engineers are justified in regarding their knowledge of how to do things as professional secrets. Looking at the matter strictly from the standpoint of individual selfish advantage, and not that of professional welfare, it is not desirable to have the same mistakes repeated. Engineers are not usually retained by other engineers, but by men without technical knowledge. These men, learning that certain kinds of work or certain classes of plants have not been successful, are naturally prejudiced against them, and look with suspicion on the advice of any engineer on such subjects. The best way to have the engineering profession strengthened is to prevent inferior or bad engineering work, and the best way to accomplish this is to tell freely what proves successful and what proves unsuccessful, so that everybody may profit, so far as in him lies, by the knowledge of all. No engineer will lose standing among his colleagues or be ranked any less competent by business men for frankly putting on record a statement of his non-successes. On the contrary, he will receive the approbation of all thinking men, for he will warn others away from a repetition of his unsuccessful work, which is a most desirable thing.

In view of the present predominance of steel as a material of construction, and the exceedingly satisfactory way in which it behaves in general, it is somewhat curious to look back and note the distrust with which it was regarded by engineers of the last generation. When Sir Henry Bessemer suggested the use of steel for rails, a prominent engineer remarked that those who wished might use steel, but that personally he was not desirous of being indicted for manslaughter. The good qualities of the material were, however, gradually recognized, but at the same time there were periodically expressions of alarm at certain mysterious failures, of which at the present time we hear little or nothing.

It has been pointed out that the quality of structural steel is really a function of three variables, *viz.*, its chemical composition, its structure, and its freedom from initial stresses. All of these variables may differ materially, even in bars rolled from a single ingot. Experiment shows that while the ingot is solidifying, the carbon, sulphur, and phosphorus tend to concentrate in the centre of the upper third of the ingot. Indeed, a content of phosphorus, on the average but 0.06 for the whole ingot, may, through segregation, be five times this figure in parts. The structure of a steel depends mainly on its treatment from the ingot up to the finished bar. Much light has been thrown on this matter by the microscopic examination of the polished and etched surfaces of the metal, whilst the knowledge of the properties of solutions worked out in other departments of science have permitted of some explanation being given for the peculiarities in the structure found.

Thus a knowledge of steel has been built up and the engineer is seldom much troubled about the quality of his materials, since most steel works can readily supply precisely what he requires.

Although we have taken steel as an example, by reason of the well-established nature of the information that has accumulated for the guidance and use of the engineer, other materials, concrete, for instance, or wood, might have been similarly considered. We are all well aware of the world-wide attention given to a study of the former in recent years, and the increased interest being taken now in the proper conservation of the latter. The principle of publicity as regards engineering knowledge and the results of the adoption of certain questions of design, materials and methods of construction, has been an all-important factor in all scientific progress.

IRON AND STEEL PRODUCTION, CANADA, 1915.

According to the report of John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics, Department of Mines, the Canadian iron and steel industry fell away in 1914, which, with a large falling off in imports, indicated a greatly diminished consumption. The quantities of iron and steel annually used is a fair measure of the nation's constructional activity, and Canada had already been experiencing a period of reaction when the outbreak of war caused an almost immediate collapse in an already declining industry. Before the close of the year, however, the demand for steel for munitions and war supplies enabled many of the steel companies to resume operations on a large scale, and the report of the Division for 1915 will no doubt tell an interesting tale of increased activities and heavy steel demand for these and other purposes.

The conditions under which the iron industry has been carried on, in so far as the general relationship of domestic ore supplies to furnace requirements is concerned, have remained practically the same for a number of years. Canadian furnaces are operated largely on imported ores and fuels, only about 12 per cent. of the ore consumption and 36 per cent. of the fuel used in 1914 being of domestic origin. The imports of iron and steel goods of all kinds has, during the past ten years, been considerably in excess of the domestic production.

Hitherto the exports of iron and steel which have been small compared with the imports, have consisted chiefly of machinery and manufactured goods. In 1914, however, there was some export of pig-iron and of steel rails. With the falling off in Canadian demand, the steel companies have sought new markets abroad, particularly for rails, while the Nova Scotia plants as a result of the war, have also developed an export trade in billets, wire rods, nails and wire.

MONETARY TIMES ANNUAL.

A wealth of material of interest to engineers and contractors will appear in The Monetary Times Annual, to be issued January 7th, 1916, by the publishers of *The Canadian Engineer*. It contains articles and statistics from which it is possible to gain an idea of likely conditions in 1916. There are several valuable articles on the iron and steel industry, railroad construction, and Canada's economic position. How to trade with Russia is the subject of a contribution by Canada's trade commissioner at Petrograd. Trade and commerce statistics are given in easy reference style, with facts and figures, also building permits, bank clearings, fire losses, etc.

THE LOCATING OF A NEW LINE.*

By David Wilson, B.A., Johannesburg, South Africa.

THE actual work and methods of locating a new railway are so much dependent upon the type of line which it is proposed to build, and this, in turn, is so much modified by the physical character of the country and by its industrial history and development, that it seems advisable to examine these matters at the outset.

South Africa is a plateau rising, as far as railway development has gone, to a height of 5,735 feet, that being the altitude of Johannesburg, the greatest industrial centre in the sub-continent. Lines from five ports concentrate at this point. Four of these ports are within the South African Union; the fifth, Delagoa Bay, being in Portuguese territory. All these lines of railway encounter rough and steep country at short distances from the coast. None of them, with the exception of perhaps the Delagoa Bay line, were planned as main lines to develop important inland mining and agricultural areas. They were designed to meet the requirements of small pastoral communities living at no great distance from these ports, and afterwards extended great distances inland on the discovery of diamonds and gold.

The main obstacles which the country presents to railway development were encountered in these short lines, and had to be dealt with at a time when neither the development nor the prospects of the country had made it possible or desirable to spend the capital necessary to carry out heavy works. The gauge of 3 ft. 6 in., to which all South African lines of importance are built, was decided on at this stage. This gauge was very suitable at that time, but if the pioneer lines had been built to be extended over long distances of comparatively easy country and to carry a large traffic, then it is possible that a wider gauge would have been justified. Large sums are being spent in reducing grades and in reducing and flattening curvature, but the question of a wider gauge has so far not been seriously raised. Sharp curves and steep grades were freely used on all the lines, and were necessary in order to negotiate the narrow kloofs and steep ascents. The Natal main line, for instance, on which alone is now carried over three and a half million tons per annum on a single line, has a minimum curvature of 300 ft. radius and a grade of 1 in 30. The grades are not compensated for curvature, and, as the limits of grade and curvature are freely used together, the virtual grade is not better than 1 in 25. The line rises to a height of 2,225 feet in the first 28 miles. It has on this section approximately 375 degrees of curvature to the mile. Sixty trains now pass over this line daily.

The principal problem to be faced by the locating engineer in South Africa is that of grades. There are problems on the coast belt, of lagoons, blown sand, corrosion and washaways; and inland, of waterless plains and great distances; but the question of grade has been the main consideration in the working of South African railways.

It will, therefore, be instructive to consider the various methods that have been adopted for overcoming heights. These methods have been, at the different stages of railway development, (1) steep grades, (2) reversing stations or zigzags, (3) artificial development, and (4) heavy work, with or without the assistance of artificial development.

*From a paper presented at the International Engineering Congress in San Francisco, Cal., September 20-25, 1915.

The early engineers had no option but to introduce steep grades, as the worst problems had to be solved in some way at a time when the resources of the country were undeveloped or undiscovered. The steepest grade adopted was 1 in 30, uncompensated, that being a grade which is practicable almost anywhere, although a rack section (which has since been replaced by a 1 in 50 grade) was introduced on the Delagoa Bay line, and reversing stations in conjunction with 1 in 30 grades were used in ascending van Reenen's Pass on the Drakensberg. Reversing stations were used as a means of getting a 1 in 50 grade on the northern section of the Natal main line. These are a cheap and ready method of getting over grade difficulties in the first instance, but are expensive to operate, and are a serious cause of delay if heavy traffic is afterwards developed. The question of replacing those referred to is under consideration, and even for unimportant branch lines, reversing stations are out of favor, and recent examples are not likely to be repeated.

The next stage in the development of the art of laying out easy grades on steeply rising country has been artificial development, and South Africa has many interesting and picturesque examples of this method. The engineer in difficulties is constantly on the look-out for a likely spot where he can go through a nek with a cutting and, circling round the shoulder of a hill, reverse his direction. Then he will probably find a point at the junction of two or more valleys, where, by crossing the tributary streams, and re-crossing the main stream by a high bridge, he regains his original direction at a much lower level. This method is still in use even for main line work, and although it necessarily introduces a large amount of curvature, it is difficult to see how some of the ascents can be gained otherwise. An extensive deviation of the Natal main line which is at present being constructed furnishes an interesting example of crossing a summit on a comparatively easy grade by means of artificial development, combined with heavy works. The deviation commences at Pietermaritzburg station yard, and the obstacle to be surmounted is a ridge 1,518 feet above the starting point. The only practicable point of crossing the ridge is less than six miles from the starting point, in a direct line. It was practicable to reduce the summit only 134 feet by means of a tunnel 902 yards long. Starting from the grade at the mouth of the proposed tunnel, natural development failed to reach the station yard by some 250 feet in elevation. The grade and the two ends of the line being fixed, either absolutely or by practical considerations, it was necessary to have recourse to artificial development. This was done on curves of 7½ chains radius (495 feet radius; or approximately 11.5°) at the cost of heavy work. There is no slack grade, except for crossing stations; the located line being 14¾ miles in length. In addition to tunneling, it is estimated that the earthwork will be in excess of 75,000 cubic yards per mile, for a single line. Artificial development in this case introduced at least 300 degrees of curvature, all on the limit grade. As at least 40 heavy trains per day will be run over this line, £30 per degree is quite a moderate amount to which to equate curvature. For this class of line the method adopted should be used only as a last resort. As the improvement of this particular part of the Natal main line has been under consideration for some 20 years, and as at least four routes have been carefully surveyed, it may be taken that a direct line was unobtainable.

While artificial development is exceptional and undesirable on main line work on account of the amount of curvature of necessarily small radius introduced, for branch lines it may be said to be the normal method of locating fairly flat grades, a grade of 1 in 40 being the steepest now favored for branch line work. For this class of work the limiting radius of curvature is 5 chains (330 feet; 100.6 metres). It is comparatively easy to develop length with this limit of curvature. The steepest grade now being used for the main lines is 1 in 50, but that is used only with the greatest reluctance; the standard which is aimed at being 1 in 66 as a maximum. For instance, surveys are now in progress to relocate the first section of the Natal main line from Durban, which, after various reverse grades, reaches the first step in the plateau at a height of 2,500 feet, and in a length of some 40 miles. The grade on the present line is 1 in 30, against both "up" and "down" traffic, uncompensated on curves of 300 feet radius, there being approximately 370 degrees of curvature per mile. The new location will be on a 1 in 66 grade compensated, with no reverse grades. Curvature will be reduced by about half, and the length will not be increased. Final estimates of the cost have not been completed, but it is not misleading to say that the cost will be approximately £20,000 per mile for a single line. This is a direct line, the gradient being attained without artificial development. Tunnels up to about half a mile in length, but mostly much shorter, are being introduced to cut through the sharp spurs, instead of the old system of going round on sharp curves.

The old line and the new location are instructive examples of the earliest and latest stages of the progress of railway location in South Africa.

Having, in the foregoing, glanced at the physical and economical conditions that have influenced the development of railway construction in South Africa, and having indicated the standard which has been attained in main and branch lines in the more difficult parts of the country, it is now proposed to examine the considerations by which the locating engineer is guided in the selection of a route and in deciding in detail questions of grade curvature, rise and fall, length, etc.

In these matters the principles laid down by Wellington in "The Economic Theory of Railway Location" are followed, with due regard to local conditions, and American engineers will find nothing new in South African practice.

Grades being the great difficulty in South Africa, the first consideration is to get the best practicable grade. In this respect, it is very easy to compare different schemes, the only difficulty being in anticipating the growth of traffic. South African railway managers have had many surprises in this respect in the past. A few years ago the problem in Natal was to carry imported goods to the gold mining areas, and grades against traffic moving inland were being improved to facilitate this work. Now the problem is to carry coal to the port, and empties back to the coal fields, the traffic to the mines being relatively unimportant, and it is found to be imperative to build practically a new line.

After grades, curvature is the greatest consideration. Curvature on the pioneer lines is extremely heavy, averaging as much as 370 degrees over the worst sections. As usually happens, the sharpest curves are associated with the heaviest grades. The difficulty of grades has been overcome to some extent by the introduction of exceptionally heavy engines, designed to run on curves of 300 feet radius (19 degrees) on the 3 ft. 6 in. gauge. The South African Railways Class 12 engines, which have proved most successful, weigh 91 tons 16 cwt. without the tender, and it has been claimed that they are the heaviest non-articulated engines working on such a narrow gauge. Under these circumstances, the difficulties arising from curvature, especially sharp curvature, on steep grades, become accentuated, and the wear on rails and ties becomes very great, in some situations an 80-lb. rail lasting only about six months. For new work where curves and grades are more favorable, it is considered that the expenditure due to curvature is about eight pence per degree per annum multiplied by the number of trains run over the section per day. The justifiable expenditure to avoid curvature is, on the most important lines, taken at as much as £25 per degree. The cost per train mile on the South African Government railways is approximately 5s. 11d.

In a country presenting the physical characteristics of South Africa the question of rise and fall is most important. This especially applies, however, to a comparison between two routes of considerable length, but it is seldom that the locating engineer has the luxury of selecting such a route on purely engineering principles. A great many other considerations have weight in this, as in other countries, and rightly so. It is, therefore, difficult to define South African practice with regard to rise and fall on a large scale. On any particular route, the question of saving rise and fall is seldom of relative importance, for the reason that so little can be done by heavy works to shorten the long inclines which are a feature of the country. For minor rise and fall the average practice is to allow 12s. per foot per daily train, but grades would not be broken up for the sake of strictly observing this rule.

The question of length is the only remaining consideration. In main line work, length is in every case sacrificed to grade, at least to the extent of getting a 1 in 66 grade on main lines and 1 in 40 on branch lines. An important deviation recently completed on the Natal line cuts out a section 21 miles in length having 1 in 30 uncompensated grades in each direction. On the new line the maximum grade is 1 in 65 compensated, but the length is 28 miles. Within the prescribed limits of grade, however, the question of length is most carefully studied and on important lines it has been considered justifiable to expend as much as £3 per foot to effect minor shortening. It sometimes happens, however, especially on a single line, such as practically all South African lines are, that circumstances do not justify expenditure proportionate to this. It is often difficult in broken country to locate crossing stations to suit the traffic. If heavy expenditure can be avoided by lengthening a section which is less than the average between crossing stations, the question should be carefully considered on its merits, as a considerable lengthening might be introduced without appreciably delaying the traffic.

The methods adopted in the field by the locating engineer do not present any novel features. In the settled districts, a map to the scale of one inch to the mile, showing farm boundaries and the principal streams, is generally obtainable. In the first reconnaissance, if the route is of any considerable length, an aneroid barometer is used to ascertain the altitude of tying points. The next step is to run between these points with an Abney level to ascertain whether the limit grade is practicable. The length can be roughly ascertained by sketching on the map and from local information. Should grade difficulties present themselves a rough tacheometer survey is run and plotted. This, with field notes, will enable the length, curvature, etc., to be roughly estimated; or some salient points may be fixed from each station, and a rough contour plan prepared. If satisfactory results are obtained, a detailed tacheometer survey is made and a contour plan prepared to convenient scale of, say, 200 feet to the inch in moderate country, and 100 feet to the inch in broken country. On this, trial lines are located and sections plotted, and the locating engineer carefully balances the elements of safety, cost, curvature, length, etc. It may be said that it has been found in South Africa, as elsewhere, that it is often not so much a question of balancing curvature against cost, as of eliminating a fair portion of it altogether by extra care and the help of a good contour plan.

When the route has been decided upon the line is staked out and a plan section and cross-sections plotted. Should the country be broken, the final location of the line is done from the cross-sections and the line is, where necessary, re-pegged. The 66-foot chain, divided into 100 links, is the unit of measurement in use over nearly all South African railways, and curves are defined in terms of the radius in chains, while grades are given in ratios. This necessitates the preparation and use of a great many tables and leads to many calculations that might be dispensed with by the use of a more rational system of units, but in practice the inconvenience is not so much felt as might be supposed. All curves are located with transition curves at the ends, generally three chains long, and grades are connected by vertical curves at least four chains long. Grades are compensated for curvature at the rate of from 0.035 to 0.05 per cent. per degree of curvature. A compensation of 0.04 is found, generally, to be sufficient, if not rather excessive, on new rails, but there is an impression that for long trains extending over perhaps more than one curve the resistance due to curvature increases. On sharp curves check railing adds to the resistence The condition of the rails and ties and the length of rigid wheel base are important elements. The tendency, therefore, is to increase the compensation to 0.05 where possible.

The foregoing refers to the practice of locating standard 3 ft. 6 in. gauge main and branch lines in the more difficult parts of the country. Although South Africa is not by any means a regular plateau, the difficulties decrease inland and there are extensive areas presenting no particular obstacles. On the other hand, there are parts near the coast which cannot be economically developed by means of a 3 ft. 6 in. gauge railway with a limiting radius of curvature of 300 feet (91.4 m.; 19°). A 2-foot gauge has, consequently, been introduced, with a minimum radius of curvature of 175 feet (53.3 m.; 32.75°). There are 474 miles of railway of this gauge within the Union, and in German Southwest Africa there is a line over 360 miles in length on a gauge of 23.6 inches (.6 metre), with a minimum radius of curvature of 38.26 metres. This line rises to a height of 5,370 feet. These lines serve their purpose, but owing to the delay and cost of transhipping they are not looked upon with favor.

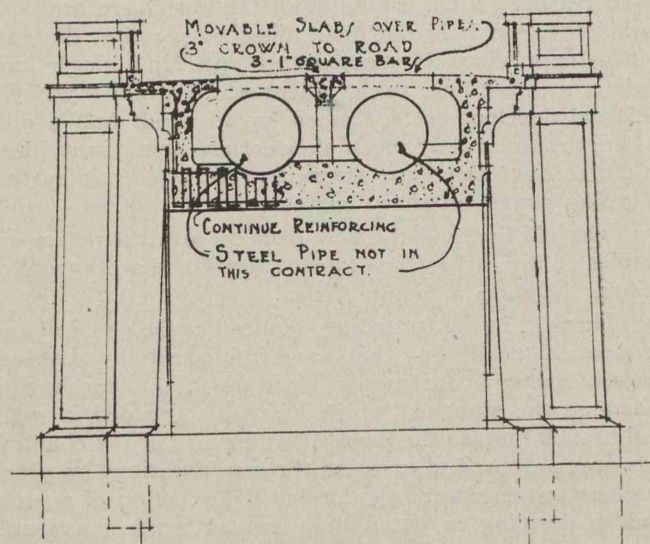
LEMIEUX ISLAND BRIDGE, OTTAWA.

By L. McLaren Hunter, C.E.,
City Engineer's Department, Ottawa.

THIS is a four-span reinforced concrete arch bridge, carrying two 51-inch water mains of the new overland fire pressure system, and a 20-foot roadway, over the portion of the Ottawa River between Lemieux Island and the Ontario shore.

All spans are identically the same, as are each of the four abutments, the latter differing only in the depth of footing below spring line. The first two spans carry the mains from Lemieux Island, where the pumping plant is located, to Bell Island, a small island about 100 feet across, on centre line of bridge. The second two spans are from Bell Island to the mainland.

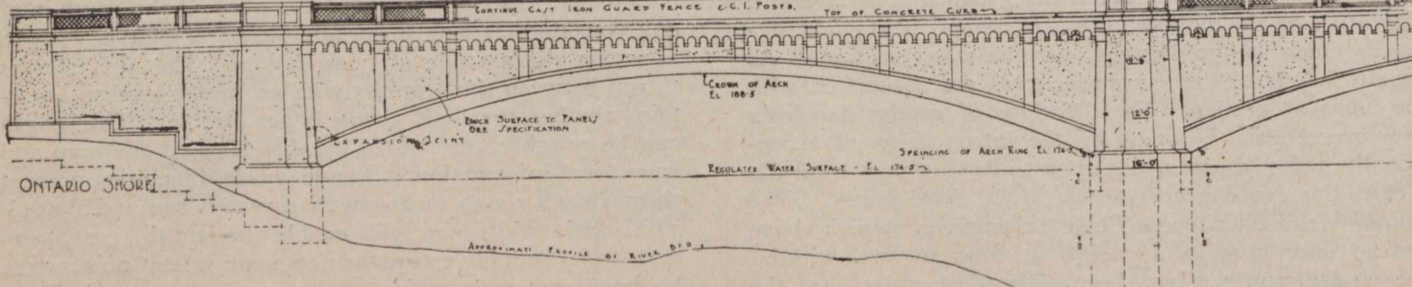
The bridge is, therefore, in reality two bridges, and



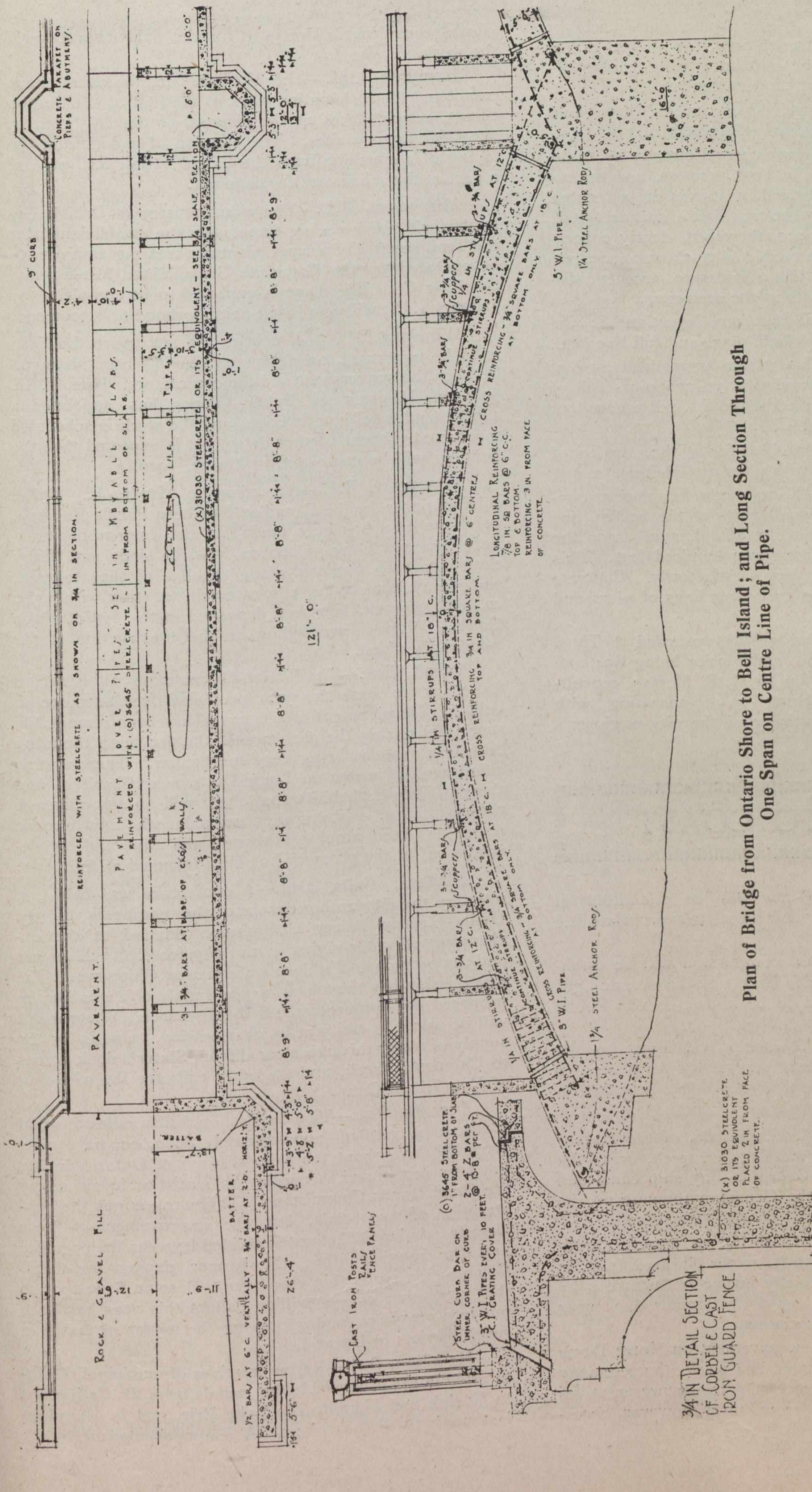
Cross-section at Centre of Arch.

it is proposed at some future time to connect the two abutments on Bell Island, with retaining walls, and to give access to the bridge from the island by a broad flight of steps on each side.

Each of the two piers is located in about eighteen to twenty feet of water. On account of the rock bottom, sheet piling could not be driven in to form an open cofferdam which might be pumped dry. Two temporary wooden cribs were therefore made, one on each side of the pier location, and were loaded with stone and sunk. These served a double purpose. First, when their two upstream ends were connected with framing and sheeting in a V shape to produce still water within the caisson area; and second, by reducing the span needing to be bridged for carrying the arch centering, as ordinary methods could



South Elevation of Bridge from Ontario Shore to Bell Island.



Plan of Bridge from Ontario Shore to Bell Island; and Long Section Through One Span on Centre Line of Pipe.

not be used on account of the impossibility of driving even temporary piling, and also on account of the considerable current and ice shove which occurs at this place.

Between the temporary piers just described and the abutments, two more temporary piers were made, one in the middle of each span, and sunk. Consequently, the clear span of 106 feet was reduced, by this method, to two spans of about 40 feet each, the temporary pier being made quite wide. Wooden trusses will be built upon these temporary piers, and the arch centering carried on them. The pier caissons consist of cribwork of 10-in. x 10-in. timber, framed to the outline of pier, weighted and sunk to position, and then sheeted by divers. This structure is held from spreading, when concrete is placed, by heavy transverse and longitudinal rods.

Concrete is being placed in piers through still water, and is deposited through a 15-inch pipe which can be moved over any part of the pier. The material is thereby conveyed where required without really being subject to any water action at all, and with a minimum disturbance of its ingredients, as the lower end of this pipe is kept within the freshly laid concrete, and the pipe is kept partly full.

The arches are of the solid slab type, crown thickness being 3 feet, and 5 feet at the haunches. They are segmental curves, having a rise of 12 feet from the springing line to intrados at crown. Radius of intrados is 123 feet; radius of extrados, 171.25 feet.

Longitudinal reinforcing is composed of ⅞-inch square bars, placed at 6-inch centres, three inches from face of extrados and intrados alike. Transverse reinforcement is obtained by the use of ¾-inch square bars placed at eighteen inches centre, intrados only, for a third of the distance from each end, the remaining third having ¾-inch bars top and bottom at six-inch centres.

Stirrups are used at twelve-inch centres, throughout the whole length of longitudinal reinforcement.

The two 51-inch mains are carried directly by transverse spandrel walls placed at 10-ft. centres, and the 20-ft. roadway slab is also carried by means of a central beam and short column to the transverse spandrel wall. All loads on the arch ring are, therefore, clearly concentrated by these walls, which enables a much more accurate solution to be made of the line of pressure, eccentric distances, and bending moments in the arch ring.

Three conditions of loading were investigated: the dead load, live load covering half span, and full live load.

Loads assumed for the design were dead load of arch ring, superstructure, and two 51-inch pipes full of water. Live load was assumed at 150 lbs. per square foot of road surface.

Expansion joints are provided for at the junction of longitudinal spandrel walls with piers and abutments.

A cableway system is being made for placing concrete and other materials in all parts of the bridge, one tower being placed on Lemieux Island, another on the mainland, a distance of some seven hundred feet. This system is found to operate very satisfactorily. Concrete is being laid this fall up to springing lines of piers and abutments only.

The contract for the bridge was awarded to Thos. McLaughlin, of Ottawa, the tender price being $54,000. The structure was designed by Mr. J. B. McRae, consulting engineer, Ottawa, working in co-operation with Robert Henham, bridge engineer of the city engineer's department, Ottawa.

COAST TO COAST

Windsor, Ont.—A by-law will be submitted in January as the result of a movement to expropriate the local gas plant.

Huntsville, Ont.—A new commission will be established early in January to have charge of the electric light and water departments and to be known as the Public Utilities Commission.

Toronto, Ont.—York Township will apply to the Ontario Legislature at its next session for permission to supply water throughout the township. It is proposed to secure the water supply from the city, if possible.

Montreal, Que.—Col. A. E. Labelle, of the Harbor Commission, speaking at a meeting last week, urged the speedy construction of the Georgian Bay ship canal and a considerable increase of the Canadian tonnage on the Great Lakes.

Vancouver, B.C.—The Clark Drive sewer outfall, which extends for over 1,550 ft. under Burrard Inlet, is now complete, and was officially inspected last week by Mr. A. D. Creer, chief engineer of the Greater Vancouver and Districts Sewerage Commission.

Montreal, Que.—The new pavement on Notre Dame Street was officially inaugurated last week, the ceremony being conducted in the presence of official representatives of the province and city. A snow storm, however, necessitated considerable sweeping for the final inspection of the work.

Hamilton, Ont.—The Harbor Commissioners have completed the reclamation work at the foot of Wellington Street, which places at the disposal of the city over 15 acres for factory sites. The erection of a dock and the laying of a spur line from the Grand Trunk Railway are a part of the scheme of development.

Vancouver, B.C.—The zinc industry in British Columbia will receive a big impetus in the establishment at the Trail smelter of a large plant for treating zinc ore, to be operated by the Canadian Consolidated Mining and Smelting Co. The plant is expected to be completed by January 1. It will cost in the neighborhood of $1,000,000.

Winnipeg, Man.—Work on the law courts building is to be continued, an agreement having been arranged between the government and the contractors. Hon. T. H. Johnson, Minister of Public Works, has appointed a superintendent of construction, and the work is scheduled to proceed without further delay. It is expected that the building will be completed in March, 1916.

Vancouver, B.C.—According to Mr. T. H. White, chief engineer for the Canadian Northern Pacific Railway, good progress has been made in the improvements at False Creek. Over 35,000 cu. yds. of shale and heavy clay have been removed along the line of the sea wall, and some 1,800,000 cu. yds. of earth, together with 7,500 cu. yds. of rock, has been deposited in the bed of False Creek. Work is proceeding on the construction of the company's wharf.

Cobalt, Ont.—The Tough-Oakes mine at Kirkland Lake has to date this year produced over $400,000 in bullion. Development underground has been remarkably successful during the past month, the ore being found on both vein systems being very spectacular. There is now a full head of water on Long Lake, near Charlton, and there is little probability that there will be any shortage before spring. For more than a month now electric power has been running both mill and mine and the development of the property has been resumed at full blast.

Niagara, Falls, Ont.—A conference was held last week by the city authorities and the engineers of the Hydro-Electric Power Commission relative to the exchanging of water rights in the city for electrical power and the providing of a deep waterway at Chippewa. The Commission has two plans for the supply of water for the proposed development which the Provincial Government will be asked to ratify at its next session. One is for the supply of water through a canal from Slater's dock across to Chippewa Creek, and the other calls for the widening of Hog Island Cut.

Toronto, Ont.—Two hundred and fifty miles of good roads, at a cost of approximately $800,000, have been provided throughout the older sections of Ontario during the year just ended, according to statistics furnished by the Good Roads Commission. This work is not the construction of new roads, but the improvement of those already existing. The cost is divided between the province and the municipalities, the former paying one-third. Colonization roads this year have cost some $220,000, so that altogether over a million dollars this year has been put into providing and improving the means of travel in rural districts in Ontario.

Hamilton, Ont.—Representatives of municipalities interested in the proposed hydro radials from St. Catharines to Guelph and Hamilton to Lake Erie, met in Hamilton last week to discuss plans. A common entrance in the

west end of the city was decided upon, together with a central station in the centre of the city. Under the existing agreement with the Street Railway Co., the city may use the street car lines, according to arbitration, for municipally owned railways. It was decided that a separate freight line should run through the northern section of the city. The direct route of the Hamilton to Lake Erie branch is to be settled by special committee.

PERSONAL.

J. M. McARTHUR has been appointed acting superintendent of the Lethbridge sub-division of the Canadian Pacific Railway, succeeding Mr. F. Walker, who has been granted leave of absence owing to ill health.

C. C. JOHNSON, B.A.Sc., has been appointed resident engineer at London, Ont., for Messrs. Chipman and Power, consulting engineers, Toronto. Mr. Johnson succeeds Mr. A. E. MacGregor, B.A.Sc., who has enlisted for active service.

MERVYN J. K. ALLEN, who has been for three years manager of Rocmac Roads, Limited, Toronto, has resigned to accept another position. Mr. Allen is a graduate in engineering of Trinity College, Dublin, and was for about nine years assistant engineer in the roadways section of the city of Toronto.

OBITUARY.

The death occurred in Toronto last week of Mr. Thomas J. Walsh, of the waterworks staff of the city. The deceased had been employed for the past fifteen years as chief operator at the high level pumping station.

We record the death of Mr. Abraham Knechtel, forester of the Parks Branch, Department of the Interior, Ottawa, who passed away on December 10th at the age of 58.

ROAD CONVENTION AT WORCESTER, MASS.

At the road congress held in Worcester last week Mr. W. A. McLean, provincial highway engineer of Ontario, officially represented the province. Mr. U. H. Dandurand, honorary president of the Canadian Good Roads Association, similarly represented the province of Quebec. The former read a paper on "The Development of Improved Roads in Canada and What it Means to the Dominion." Mr. Dandurand's paper touched upon the highway system of the province of Quebec and also upon the attractions the Dominion has for motorists.

OTTAWA BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

The third meeting for the season of the Ottawa Branch of the Canadian Society of Civil Engineers was held on December 16th, Mr. John Murphy, chairman, presiding. The speaker was Mr. S. Fortin, Mem.Am. Soc.C.E., structural engineer, Department of Public Works, Canada, who presented a paper entitled "Novel System of Foundations Used in Connection with the Federal Legislative Palace, Mexico City."

The paper described the method employed in designing the foundations: the assumption being that the resistance of the subsoil instead of being uniform as usually assumed is increasing from the centre towards the perimeter of the building as the co-ordinates of an ellipse. A good attendance of the Ottawa members was in evidence.

A. B. Lambe, who has acted as secretary-treasurer for the last three years, was presented with a very handsome silver loving cup as a token of appreciation. The presentation was made by the past chairman, Mr. St. Laurent, assistant deputy-minister, Department of Public Works.

REGINA BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

As will be noted in the personnel of the officials of the various branches of the Canadian Society of Civil Engineers, as presented in our page of "Technical and Municipal Societies," the officers of the Regina Branch are as follows: Chairman, O. W. Smith; secretary-treasurer, J. N. de Stein. The monthly meetings of the branch are held on the first Thursday of each month.

MONTREAL MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The December meeting of the Canadian Society of Civil Engineers was held on Thursday, the 16th instant. Dr. H. T. Barnes gave an informal talk, illustrated by lantern slides, on the "Development and Principles of Construction of the Submarine." An interesting discussion on structural details followed the instructive address.

COMING MEETINGS.

AMERICAN FORESTRY ASSOCIATION.—**Annual meeting to be held at Boston, Mass., January 17th and 18th, 1916. Secretary, P. S. Ridsdale, Washington, D.C.**

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—**Fourteenth annual convention to be held at Toronto January 18th to 20th, 1916. Secretary, G. C. Keith, 32 Colborne Street, Toronto.**

AMERICAN WOOD PRESERVERS' ASSOCIATION.—The Twelfth Annual Convention to be held in Chicago, January 18, 19 and 20, 1916. Chas. C. Schnatterbeck, chairman, Committee on Publicity and Promotion, American Wood Preservers' Association, Baltimore, Maryland.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—The Thirtieth Annual Meeting to be held in Montreal, January 25, 26 and 27, 1916. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—To be held in Chicago, Ill., February 4th, 1916. Joint dinner that evening with American Electric Railway Manufacturers' Association.

AMERICAN CONCRETE PIPE ASSOCIATION.—Annual Convention to be held in Chicago, February 17 and 18, 1916. Secretary, E. S. Hanson, 538 S. Clark Street, Chicago, Ill.

CANADIAN LUMBERMEN'S ASSOCIATION.—At Ottawa, February 18th, 19th and 20th, 1916, annual convention. Frank Hawkins, secretary, Ottawa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—At Sohmer Park, Montreal, March 6th to 10th, 1916. Geo. A. McNamee, secretary, New Birks Building, Montreal.