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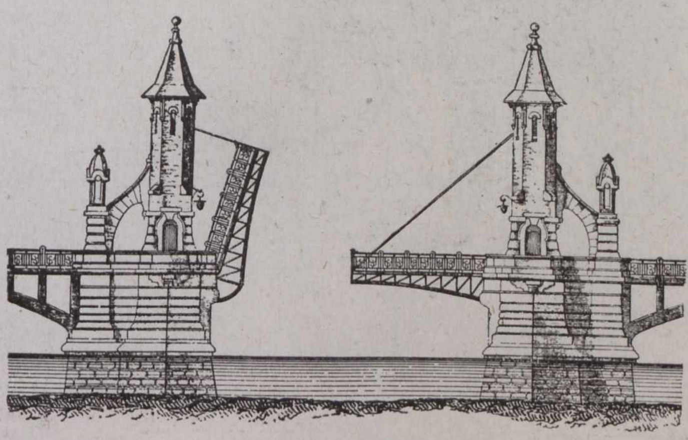
BASCULE BRIDGES

By H. G. TYRRELL.*

Early French Bascules.—The Belidor system of draw-bridges, invented by M. Belidor in 1816, consists of a leaf or platform hinged at one side of the waterway and supported at the outer end by chains or cables passing up over elevated sheaves on the shore structure, either castle wall or tower, and fastened to two separate rolling counterweights, one at each side of the roadway, moving on curved tracks of special form, the outline being called a "sinusoid." The essential idea of the invention is that the centre of gravity of all moving parts, including both leaf and counterweight, travel on a horizontal line. Instead of one large rolling weight at each side, two or more smaller ones connected together may be used.

A modification of the Belidor system was invented prior to 1820 by Captain Délille. who proposed joining the rollers with the outer end of the platform by a bar or stiff member instead of a flexible cable, and working them by an endless chain. When the drawbridge adjoined a building or walled enclosure, vertical grooves for the bars were left in the masonry at each side of the roadway, but, as in the Belidor design, the centre of gravity of all moving parts still travelled horizontally. Equipped in this way, the bridge was very easily worked by hand, and because of its simplicity came rapidly into favor. Exact methods for determining the outline of the "sinusoid" were evolved and the construction henceforth presented no difficulty. The two rolling counterweights were sometimes connected by a shaft or stiff member across the roadway, and in open situations apart from buildings the curved tracks were supported by timber framing.



Bascule in Spain.

A further modification of the methods of Belidor and Délille appeared prior to 1840, the invention of Colonel Bergére. The counterweight in this case described precisely the same curve as in the former methods, but the weight of leaf and balance is supported by a connecting bar or lever mounted at its centre on wheels which roll back and forth on a horizontal track, the principle being similar in this respect to a recent American patent. Another of Colonel Bergére's designs shows the connecting lever mounted on large wheels with their treads at the roadway level instead of smaller wheels on an elevated track.

Mr. J. C. Ardagh, of the Royal Engineers, devised a system somewhat similar to Belidor's, with the platform supported by chains passing over sheaves and connecting at the rear to counterweights which, instead of travelling on a rigid curved track of special form, were guided in their course by other cables, the ends of which were fastened in the proper positions, that the rolling sheaves would describe exactly the same curve as that followed in the Belidor and Délille systems. The bridge was balanced in all positions. Dobenheim's draw was counterweighted with blocks or bars on the chains, the weight being great enough to balance the platform when horizontal, but it was in complete equilibrium in only 3 positions. The Noggerath system was somewhat similar.

An opening span of the Belidor type was incorporated in a design proposed in 1885 by Ordish and Matheson for crossing the Thames at London, and since then several have appeared in America, one of the first being a railroad bridge over the Morris Canal, between Jersey City and Lafayette, completed in 1890. It was all framed in timber and was worked by hand power. The leaf was 25 feet long and the whole draw weighed only 3 tons. Counterweights were 3 feet in diameter.

Another bridge, completed in 1896, to carry four tracks of the Erie Railroad over Berry's Creek, on the Hackensack meadow near Rutherford, N.J., had a span of 32 feet and a clear opening of 24 feet, and at the time was the largest of its kind. It was 44 feet wide between outside girders, and had a total weight of 70 tons. Beside the moving span, it had two fixed plate girders 50 feet long. The counterweights were 6½ feet in diameter, each one weighing 51,000 pounds. They consisted of several circular parts fastened together with bolts, the heads of which at each side were countersunk into the casting. The four railroad tracks were 13 feet apart on centres and were each supported on a pair of deck plate girders. The bridge was operated by hand power by means of 9/16-inch wire ropes passing over 23-inch sheaves.

The longest bridge of the kind and the first important bascule in America was completed in 1897 over the river at Michigan Avenue, Buffalo, N.Y., the span being 153 feet between trunnions and 150 feet between piers. It has two

* Consulting Engineer, Evanston, Illinois.

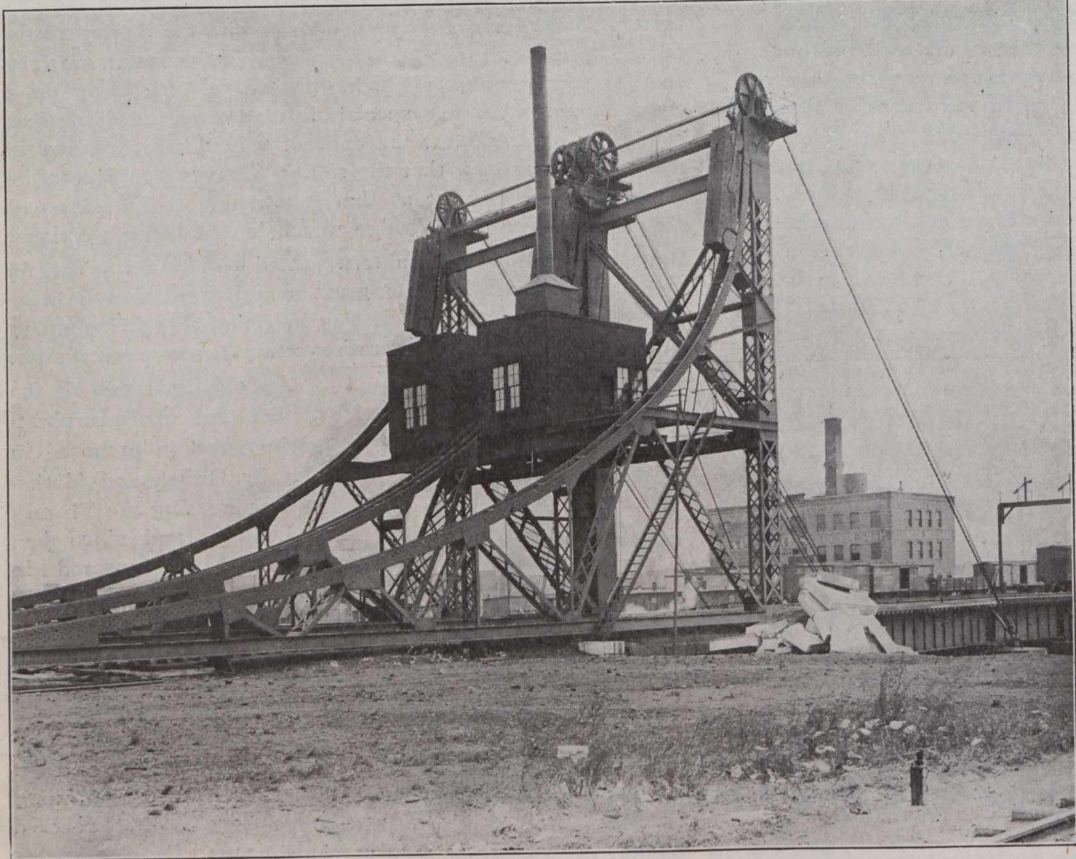
leaves with trusses 77 feet long and 9 feet deep, drawn up by ropes attached to shore towers 77 feet high. Each counterweight consists of ten castings 6½ feet diameter and six others 5½ feet diameter, mounted on a 6-inch shaft 8 feet long. The weights running on double rails are attached to the leaves by four 1½-inch crucible steel cables worked by steam power. At each side of the centre opening is an approach span. The dead weight of each leaf is 60 tons, and the total counterweight at each side is 70 tons. It has a central road 22 feet wide and a 6-foot walk outside each of the trusses. The superstructure cost $38,700, on which there was probably a considerable contractor's loss. It is opened forty to fifty times per day and can be operated by steam power in one minute by means of 6-inch screws 18 feet long, lying horizontally, and attached at one end to the trusses at the upper shore panel point. The screws have three threads ¾ inch square and 4½-inch pitch.

The bridge over the west fork of the south branch of the Chicago River for the Chicago Terminal Transfer Railroad has a clear span of 61 feet, with girders 70 feet long, and was completed in 1899 from plans by George S. Morison. Two ropes and one chain are attached to each of the counterweights, the chains having a rigid hold on the sheaves, while the ropes carry all or most of the load. Provision was made at first for two spans meeting on a centre pier, but the towers and lifting machinery were put in for one span only. The light centre pier gives rigid bearing to the girders and offers less obstruction in the channel than would the centre pier of a swing bridge. Since it was first built the bridge has been raised 4 to 5 feet with new masonry. It has four tracks with sixteen girders 70 feet long and eight girders 27 feet long. The part that is moved is underbalanced in its lower position and overbalanced in its upper position, thus requiring power to start it from either extremity. After its completion, the designer stated that if building another one he would have it underbalanced throughout, and would raise and lower it with a winding engine. The bridge is in two parts, each of which can be operated separately. The sheaves at the tower are six feet in diameter and each counterweight weighs 27 tons.

The Harway Avenue lift over Coney Island Creek, at Brooklyn, was completed in 1898 at a cost of $25,000. The clear span is 50 feet and it is worked by a five-horse-power electric motor, but has also hand power gearings. It is 31 feet wide between railings, and has three main girders 10 feet apart on centres. Each counterweight weighs 45,000 pounds and is supported by 1¾-inch ropes passing over sheaves at the top of towers which are 35 feet high.

A temporary bridge of this type was placed over the Passaic River a few years ago and was built complete in forty days. The clear opening is 40 feet, the hoisting towers being framed of timber, but the girders are of steel. Adjoining it is 280 feet of pile trestle, the total cost of the whole construction being $12,000.

A patent was recorded on March 4, 1899, in favor of Mr. Montgomery Waddell for a bascule bridge with trusses counterbalanced by weights attached to the upper panel points and rolling on curved tracks similar to the design invented by Belidor, but differing therefrom by having open web truss supports instead of simple beams.



A Belidor Bridge at Chicago.

One of the most recent of this type is that completed in 1908 at Tiverton, over Sakonet River. The original design was made by Mr. Augustus Smith, and was revised and approved by Mr. J. R. Worcester. The road is 32 feet wide with a 5-foot cantilever walk on each side, the central way being proportioned for 40-ton electric cars. The opening span is of the Délille system, with two leaves and a clear water width of 100 feet, and at each side of it is a 70-foot girder which supports the counterweight. There are also masonry approaches 581 and 439 feet long, with concrete arches and earth filling between the spandrel walls. The counterweights are rigidly attached by struts to the moving leaves and instead of separate circular rollers, as on the previous design, the counterweight in this case extends clear across the roadway, being mounted at each end on four-wheeled trucks. Motors are connected directly to the track wheels and ropes are not needed. The moving span is without tail pits and all parts are open for inspection. The steel superstructure weighs 430 tons and the total cost of the whole bridge was $250,000.

Tower Bascules With Vertical Moving Counterweights.—Three different methods of counterbalancing draw-bridge leaves were evolved in France during the first part of the eighteenth century by Messrs. Derché and Poncelet.

The Derché System.—In the Derché system, invented by Captain Derché about 1810, chains from the front end of the moving leaf passed over fixed pulleys on shore, and the counterweights were suspended over spiral sheaves. As the leaf rose and less weight was required to balance it, the spirals revolved to such a position that the counterweights hung over a smaller radius than when the leaf was down. Derché evolved easy methods for determining the exact form of these spirals, and on the spiral axes he placed sprocket wheels with hand chains, by means of which the leaf was operated. Overhead balance levers of the Dutch portal type were also installed in some cases, so the movement could be affected either by chain or lever. Movable hinged struts bracing back diagonally to the abutments, and revolving in against the shore as the platform was lifted, were sometimes placed beneath the leaves. This method of counterbalancing the leaves in all positions was so simple that it became quite popular in France and other parts of Europe.

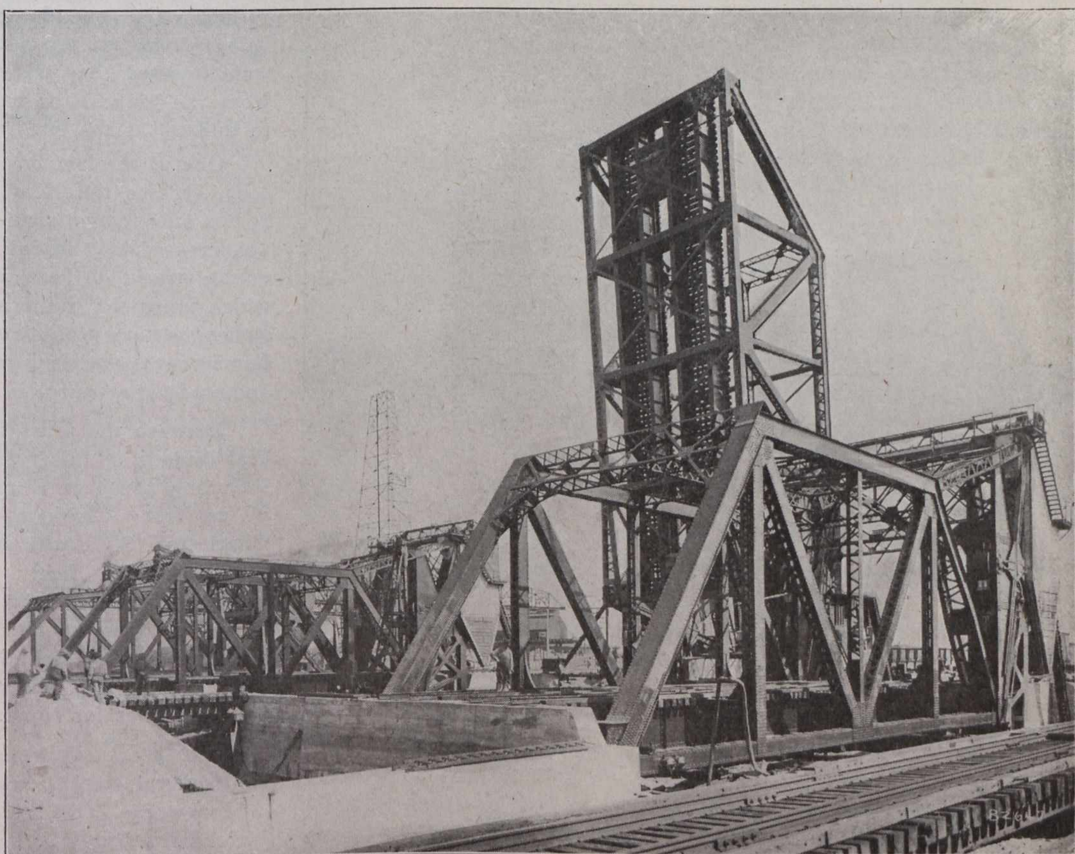
A bridge with varying counterweights had previously been proposed by Colonel Bergére, who intended using weights immersed in water, but his method was not greatly favored.

A modification of the Derché type was used some years ago in San Domingo. At the foot of the shore tower was a conical drum, to the small end of which was attached the balance chain from the outer end of the platform, while to the larger end of the drum was fastened the chain from the counterweight. Two applications of the Derché principle have recently appeared in America, the first of them being proposed in 1901 for the 95th Street bridge at Chicago. The plans showed a double leaf bridge with a clear opening of 140 feet. The leaves act as a three-hinged arch when closed, and are united by centre locks driven by a five-horse-power electric motor. The arch ribs are drawn up by cables passing over two 24-foot drums at the tops of towers, which are 80 feet high, and between these drums and on the same axle are spirals from which the counterweights are suspended. The spiral radius decreases from 12 to 3 feet. The total weight of each leaf is 120 tons.

Another design involving the Derché principle was invented and patented in 1904 by Mr. Wilbur J. Watson. In this design the cables are attached to fixed points on the trusses, and pass around sheaves of the proper diameter to which they are securely fastened, and on which they wind up upon themselves as the bridge rises. The counterweights are carried by chains built up of steel plates and pins. These chains pass around, and are wound from spiral sheaves mounted upon the same shafts as the first-mentioned ones. Chains are used instead of cables for hanging the counterweights because chains can be wound around drums of a smaller diameter. The counterweights are claimed to be less than half of those ordinarily used on bascule bridges, and the stresses in the structure, machinery and foundations are proportionately reduced.

The Poncelet System.—The other two types of bridges with compensating counterweights were invented in France by Poncelet prior to 1840. In one case, the leaves are supported by cables passing over fixed pulleys on shore, and over sheaves behind them, from which counterweights of heavy chain links are suspended, the lower ends of the chains being fastened to the shore structure. As the leaf rises and the chain links descend a greater part of the chain weight is transferred to the lower support, and less to the cables which pass over the sheaves to the bridge. The counterweight is self-acting and extremely simple, and it has, therefore, been extensively used. Small bridges thus equipped can be worked by a sprocket chain and wheel. The principle has been used to some extent in recent moving bridges of other types, as on the Halsted Street vertical lift bridge at Chicago.

A design for counterweight which is a modification of that described above, appeared in 1896 in the competition for a bridge over Newton Creek, the work of J. D. Wilkins and



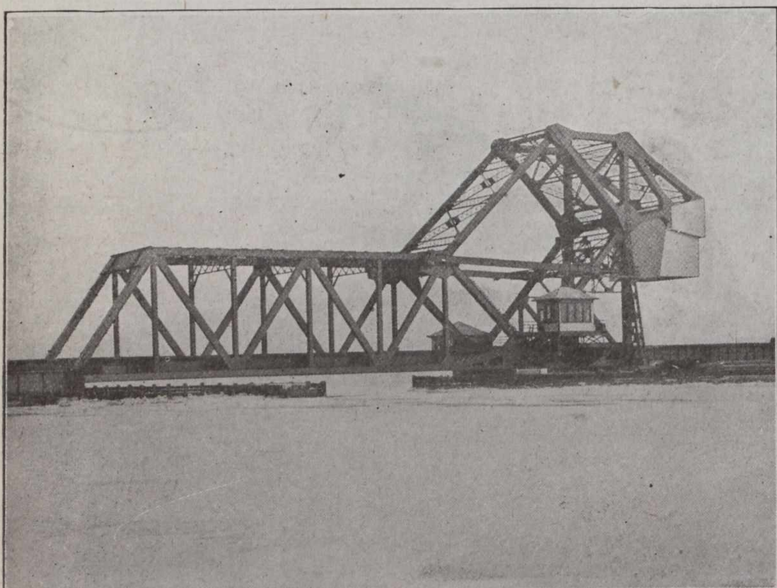
Bridges at Indiana Harbor, Michigan.

R. W. Creuzbaur. The clear opening of 100 feet was crossed by a single leaf which was drawn up by ropes passing over sheaves on a symmetrical tower on one shore, and it was balanced by a metal box 21 feet long filled with pig iron, and compensated with chain, the whole being described as "the Wilkins system of counterweight." A somewhat similar regulating system was, as previously stated, used on the Halsted Street bridge.

Revolving Arch With Bascule Floor.—An unusual design for a bascule bridge appeared at the Newton Creek competition, the work of Mr. W. H. Breithaupt, a Toronto engineer, a patent for which was recorded July 3, 1896. It consisted of movable ribs meeting when closed above the channel centre and forming a three-hinged arch with suspended bascule floor leaves beneath. It was somewhat similar to a bridge previously erected at Liverpool, where the lower bascule leaves are suspended from double swing spans on each shore, the deck of which is at a higher level. The chief merit of Mr. Breithaupt's design is that, for tugs and small craft the bascule floor only need be raised without opening the arch. The arches and bascule floor had separate counterweights consisting of chains, each link of which weighed two tons.

A patent was granted to Mr. Montgomery Waddell and filed April 6, 1897, for a somewhat similar type of bridge with lenticular or cigar-shaped arch ribs meeting at the centre when closed. The platform, instead of being suspended, as in Mr. Breithaupt's design, was in this case hinged to the arch ribs. Another patent granted to Mr. Waddell at the same time shows double bascule trusses hinged at the foot of the shore towers and supported underneath by diagonal struts bracing back to the abutments.

Suspended Series of Falling Counterweights.—Another system of compensating counterweights was invented by William Burdon and described in the Scientific Canadian of February, 1879. The lifting was accomplished by ropes



Strauss Trunnion Bascule Bridge, Hackensack River, Erie Railroad.

from hydraulic pistons, and the leaves were balanced by cables from their outer end passing over sheaves at the top of shore towers in which a series of weights were suspended, which came to a bearing on the ground as the leaf ascended. A somewhat similar type of small bridge was used many years ago at the Liverpool docks, the chains going down inside the shore columns to the hydraulic machinery below. In 1892, a plan on a larger scale was proposed by Mr. Charles Steiner, of Minneapolis, in which double leaves, each 25 feet long, were used over a 250-foot channel, the leaves being supported by chains passing over pulleys on shore towers and fastened to hydraulic rams. Another bridge at Birkenhead, over the Great Passage at Granaries, carried two tracks of railroad on double leaves over a 30-foot opening. When in their lowered position, the girders were strengthened by hinged struts supported by chains which guided the ends of the struts into sockets on the abutment faces. The bridge was raised by chains passing over pulleys on vertical pillars 10 feet high, set 8½ feet back from the abutment face. It was very light, had no tail end or balance and occupied a very small dock space.

Bridges of this type were brought into active use in America in 1890, when one over the Harlem River was completed for the New York Central Railway, near 135th Street and 4th Avenue. It was designed by Mr. G. H. Thomson, assisted by Mr. J. D. Wilkins. The principle involved is identically the same as that which is so commonly used in crossing gates, which, when open, fold up at each side of the street against their weight cases. The bridge was 106 feet long and 32 feet wide, with four tracks, the two outer ones curving in at the bridge and making it possible for only two trains to cross at one time, notwithstanding the heavy travel of more than five hundred trains daily. Switches were not used. The sheaves at the tower tops were quite unusual, being made of old locomotive driving wheels, 6 feet 10 inches diameter grooved out for the cables. Three years after its completion the bridge was removed and re-erected over the Harlem at Spuyten Duyvil. In 1897 there was a similar one on the Wisconsin Central Railway at Manitowoc, Wis., and another was proposed about the same time by Mr. C. E. Bidell for crossing Newton Creek. The clear opening in the latter case was 150 feet, and towers 112 feet high on each shore support 9-foot drums, over which the cables pass, holding the 65 tons of counterweight in several separate blocks. It was provided with a 36-foot road and 11-foot walks outside the trusses, the whole bridge being supported on cylinder piers. When the leaves were lowered they were to be supported by eye bars from the towers, the bars being hinged at the centre to fold up as the leaf was raised.

One of the last bridges of this kind, completed in 1905, crosses the New Basin Canal at New Orleans. It has an effective span of 70 feet over a 63-foot channel, crossed by through plate girders 9 feet deep, for double track. Towers are 104 feet high, inside of which hang the counterweights in successive blocks weighing 3,000 pounds each. It is operated by a 35-horse-power electric motor, but also has an auxiliary 10-horse-power gasoline engine.

Between the years 1897 and 1900, designs for several bridges of this type were made by I. G. Tyrrell, including those at Elizabeth City, N.C., with a span of 24 feet; Chatham, Mass, with span of 25 feet; Charleston, S.C., with span of 60 feet, and Kennebunk with span of 81 feet. A small one for single track, designed by the writer in December, 1899, had a 21-foot clear opening, and was founded on piles. It was proportioned for light locomotives equal to Cooper's specification E.30, and had hand machinery only. The estimated quantities for superstructure only, without foundation or floor, are:—

Structural steel	20,000 lbs.
Machinery	3,000 lbs.
Counterweight	16,000 lbs.
Total	39,000 lbs.

If the clear opening were increased to 30 feet, the estimated quantities would then be:—

Structural steel	30,000 lbs.
Machinery	3,500 lbs.
Counterweight	24,000 lbs.
Total	57,500 lbs.

A patent was filed February, 1908, in favor of Louis H. Shoemaker, of Sewickley, Pa., for a counterbalanced lift bridge, in which the pull on the cables from the bridge and fixed counterweight is equalized. As the bridge rises, the angle of the cable changes, making a nearly constant pull in the cables from the girders at all times.

Poncelet Bascule System.—This was evolved by M. Poncelet, in France, prior to 1840, and is a modification of the Derché draw. It was revived in 1896 during the Newton

Creek competition by Mr. T. E. Brown, for a double leaf bridge with a clear span of 150 feet. Mr. Brown, four years earlier, submitted a plan for crossing the canal at Duluth, which is said to have been the first important bascule design in America. It had no counterweight, and the estimated cost was $125,000. The towers of the Newton Creek design, standing on each side of the water, were 74 feet high and unsymmetrical, the width of road being 30 feet, with a 9-foot walk outside the trusses at each side, making a total width of 50 feet. The six cables at each side, passing over two 10-foot sheaves made of riveted steel plate, support a permanent counterweight hanging inside the towers, and each span is operated by eight hydraulic rams, the leaves being pushed open by struts connected to the heels of the trusses which swing on trunnions fixed in the tower legs. An unusual feature of the design is, that swinging hinged bents attached to the ends of the leaves gave them a centre bearing under live loads. These bents were to rest on the cast iron caps of submerged piers which could be cleaned of sediment or silt by water pressure from pipes especially laid for this purpose beneath the river bed. Mr. Brown also proposed an alternate plan for disposing of the bents and supporting the leaves by cables from the towers. The estimated cost was:—

Superstructure and machinery	$105,000
Foundations	105,000
Total	$210,000

In this design, the tower height could be fixed by the required vertical movement of the counterweight without special reference to the inclination of the lifting cables. But the design with its unsymmetrical towers was complicated. Referring to the various plans which appeared at this time, the Engineering Record, in commenting thereon, rather harshly declared that "the Newton Creek competition has produced an exhibition of more structural ugliness and awkwardness than any other event of its kind in this country." A design somewhat similar to Mr. Brown's was prepared in 1900 for another place, by a structural company in Milwaukee.

The first bridge of the kind completed is at Ohio Street, Buffalo, finished in 1906, with a single leaf 166 feet long and lattice trusses 21 feet deep, over a channel 140 feet wide. One leaf was evidently more economical than two, since it required only one tower, one set of machinery, and one operating house. It replaced an old swing bridge, which was removed when the channel was deepened from 19 to 23 feet. The roadway, 30 feet wide, carries two car tracks, and 7-foot walks project out at each side, making a total width of 44 feet. The span is balanced by twelve plough-steel wire ropes, 2¼-inch diameter, passing over 10-foot cast-steel sheaves (cast in halves) at the top of tower, the two counterweights, each containing 180 tons of cast-iron, moving vertically between guides. The lifting is controlled by hydraulic power from a tank in the tower, under which are girders 52 feet long, and the approach span at the opposite end is 100 feet. Its total cost was:—

Superstructure (including plans and royalties)	$117,700
Foundations	59,300
Total	$177,000

The cables have a heavy bending stress, due to winding over their sheaves, and the breaking load of each one is 190 tons.

The Burel drawbridge, invented prior to 1840, is a modification of that by Poncelet. The counterweight is placed at the extreme end of a 90-degree revolving segment, over which the cables pass when the bridge is in motion. The system has been recently revived and a patent thereon granted February, 1900, to Elmore D. Cummings, of St.

Cambell Avenue Bridge, Chicago.

Paul. It is described as "having a counterweight pivoted to a separate approach framework and connected to the moving leaf by chains which pass under the counterweight framing and over the top chords of the trusses in such a manner that equilibrium is maintained in all positions. The operation is by a rack and pinion on the top chord."

REPORT ON FORESTS.

At the fourth annual meeting of the Commission of Conservation, held at Ottawa January 21st and 22nd, the report of the Committee on Forests was approved, covering recommendations with regard to the following points:

Approving the plan of co-operation in effect between the Board of Railway Commissioners and the Dominion and Provincial Governments for the enforcement of the fire regulations of the board; urging the establishment of a fire-protective service along the Intercolonial and National Transcontinental Railways similar to that provided for in the fire regulations of the Railway Commission; urging the governments of New Brunswick and Nova Scotia to organize separate branches devoted especially to forest fire work and to appoint technically educated provincial foresters as has been done in British Columbia, Ontario, and Quebec; calling attention to the necessity of considering the requirements of brush disposal in the issuance of new licenses and the renewal of old licenses by Dominion and Provincial Governments; approving the organization of co-operative associations of limit holders and the principle of contribution by the Dominion of Provincial Government in proportion to the benefits received; urging the Dominion and Provincial Governments to begin a systematic study of the extent and character of forest resources; emphasizing the necessity for the collection of complete fire statistics; approving co-operation with the government of Ontario in an examination of forest conditions west of Sudbury and south of the Clay Belt; approving the proposed extension of the Dominion Forest Reserves and the establishment of a game preserve in the southern portion of the Rocky Mountains Forest Reserve and in southeastern British Columbia adjoining the Glacier National Park; urging that all appointments in the forest services of the Dominion and Provincial Governments should be based solely on capability and experience; urging the government of Ontario to undertake a systematic classification in the Clay Belt in advance of settlement to the end that settlement may be properly directed, and that non-agricultural lands may be reserved from settlement and entry.

REPAIR AND MAINTENANCE OF ROADS.*

By Dr. L. I. Hewes.†

The primary defect in road repair and maintenance to-day is lack of business management. The management of road construction is slowly improving, but repair and maintenance continue neglected. There is a certain enthusiasm and interest about new work which is entirely lacking for repair and maintenance operations. It is now well recognized, however, that no system of roads will remain a good system unless continuously cared for.

It is necessary to distinguish between repair and maintenance. When a road is finished, traffic and the elements act continuously to deteriorate it, and will ultimately destroy it. To oppose such deterioration, maintenance equally continuous is required. If maintenance is neglected the best roads will very soon require repair and longer neglect will even require reconstruction. It has been customary for a long time to classify repair as maintenance. It is a natural mistake in view of the fact that, generally speaking, roads on this continent have not been continuously maintained and therefore if maintenance is referred to, it necessarily signifies repair.

Under the organization which prevails throughout Canada and the United States, town and county roads are largely in charge of local officials elected at short intervals. Road management constitutes, as a rule, only a part of a miscellaneous list of duties. Consequently local officials are not elected because of their skill in road making. The typical road official has abundant confidence in his ability and usually proceeds to try out his ideas at the expense of the community. He has his own definition of gravel, crown, grade, etc., and usually has spent considerable money before he is willing to seek advice; and then it is time for electing a new man. Now, any system in business where an executive officer was dismissed as fast as he learned his duties would be unhesitatingly condemned. Why do we continue to use such a system on our highways.

The difficulty is largely because the local civil unit for highway purposes is too small. Too small because the annual appropriations for highways do not warrant the employment of skilled supervision; too small because with the permanent practice of rotation in office the annual appropriation is handled by each official as *his* appropriation, without reference to what has preceded or what is to follow. Too small because the experience in road construction and maintenance does not cover a wide enough range to supply information which already exists beyond the borders of the local community. The remedy for this condition, which so universally prevails, is co-operation in some of its various forms. A possible form of co-operation is for townships to collectively organize road districts and hire a salaried road engineer. Another possible form is to delegate more authority over local roads to county officials and to require a high-class county engineer. A still more effective form is to invite co-operation from the state or province, even in the matters of township roads, as well as in county roads and inter-county roads. It has been done in the State of New York.

You will observe that all of these methods suggested involve more centralization in the matter of roads. If there is objection to such centralization, the answer must be that there must then continue a "road problem," for an actual study of the scant records that have been kept on the cost and method of earth road work always reveals the startling fact that enormous sums of money have already been spent under the old system without visible improvement in the roads. I do not hesitate to condemn the use of statute labor upon highways. It has never proved effective. There are several fundamental objections to its use. First, under the statute labor system, work upon the roads cannot be, in any sense, continuous. Neither can it be applied "in point of time." Second, the attitude of freemen toward such work is careless and indifferent, and the days of working out the taxes are too often regarded as more or less of a jollification period. Statute labor is not economy even for those who advocate is strongly. For those who advocate it strongly are the residents who see in the custom an opportunity to avoid cash payments and to discharge a duty to the community with a minimum of effort. Now, the dwellers along the road are the ones to use the roads, and in proportion as the repair and maintenance of their roads is poor, so is the transportation burden per ton mile of useful produce increased. Those who advocate statute labor in preference to cash taxes simply shift the payment of a road tax to the payment of a mud tax. The road tax is a definite sum of cash, the mud tax has the never-ending invisible burden on the cost of hauling.

Let us consider, then, the repair and maintenance of a typical well organized county road system. In the first place, there should be a map of the county showing plainly all the roads within its borders. These roads should be classified. A possible classification is market roads, through roads and neighborhood roads. Necessarily many market roads will also be through roads and usually every through road is in part a market road. When the roads have been classified according to their service, there should be indicated the nature of construction on the already improved portions in each class. By consulting records, the average annual appropriations for all road and bridge purposes for a series of years may be determined. It will usually be found that some of this money has been spent for the new work, but that a large percentage of it must go for annual repairs. The county highway engineer or other highway engineer in charge of the road system must then adopt a financial plan, not for one or two years, but such a plan as will, within a series of years, result in a general betterment of the highways under his jurisdiction. A certain large percentage of the roads will receive a minimum of expenditure proportioned according to their importance. These roads will, many of them, be neighborhood roads which serve, in many instances, but one or two families. A plan of improvement system established for all improved roads and especially for the important roads which must wait for improvement.

The order of improvement to the relatively small percentage of most used roads should be definitely determined, and the type of improvement should be carefully planned. In making such plans, it must be understood that the first mile of any highway radiating from a market centre receives an annual traffic many times greater than a mile of the same road which is six or seven miles away from the market. Therefore, the type of improved surface adopted near the town must necessarily be more expensive than that adopted on the outlying mileage. A great deal of permanent improvement may be brought about on earth roads by the expenditure of the money which is usually classified under annual repairs. The engineer should first determine the existing profile of such roads and establish a grade line toward which some work may be done each season. The necessary improvement of the culverts, such as replacing wooden and other cheap construction by more durable construction such as concrete, should be planned so that some permanent

* Paper presented to Ontario Good Roads Association meeting, Toronto, February, 1913.

† Director, Maintenance Division, U.S. Office of Public Roads, Washington, D.C.

piece of work may be done each year and the whole effort should be to produce ultimately a road which may be adapted to this service, and which shall require low annual repair and maintenance charge. You must see that no such scheme of work can be planned and carried out by any road official who sees only the expenditures of one year ahead.

To get a little nearer to details, there must be begun a systematic set of highway accounts. All operations of repair and maintenance, as well as construction, should be classified as grading, ditching, repairing culverts, dragging, etc., and the unit costs of the various items must be obtainable from the records. To accomplish such a result, distributing tables may be printed on the backs of warrants and vouchers for labor paid. A great defect in maintenance and in repair has been the unintelligent management of materials and machinery. If a macadam road is to be maintained, there must be a supply of No. 2 stone stacked in considerable quantity at intervals along the road. The hauling of this material should be done at the most economical season of the year, and it should be continuously available for small repairs. The same applies to gravel. A great many roads may be constructed successfully and maintained as gravel roads with good results. For this purpose the location of the sources of supply of gravel and gravel pits should be plotted on the road map and a record of the quantity in each pit kept. Very frequently gravel is hauled necessarily great distances for various insufficient reasons. Too often the owner of the gravel pit is also managing some of the roads and may prefer to haul a mile or two from his pit when there exists a supply of good gravel within a quarter of a mile of his job. There is frequently, however, good gravel handy to work, but which has never been discovered or developed. It will pay to make a most careful investigation of the source of gravel supply along every road.

With reference to the repair of earth roads, the custom of scraping sod and refuse of all kinds into the road centre with a scraping grader cannot be too severely condemned. It is a universal cause of bad roads and waste of highway funds. In repairing an earth road with a scraping grader, the sod may first be scraped off and carted away or the sod may be raked off or picked out with forks and carted away, but never should sod or rotten leaves or manure or any organic substance be placed on the road. The operations of the road grader have been positively damaging in some cases. Many country roads have gutters that are too far from the travelled way and the road supervisor runs the scraping grader a little outside of the wheel tracks to form a new gutter which wanders in and out and up and down and has no outlet. The cost of operating a scraping grader with from two to eight horses attached is very great, and unless very effectively managed is a source of tremendous waste. Where new gutters must be formed, lines must be run before work is commenced, and broad shallow outlets should be constructed through the turf at all low points and all intermediate points on hillsides. Frequently the repair operations with a road grader can best be accomplished by scraping old material off the road toward the gutter and carting it entirely away. A great defect in most country roads is a high shoulder just outside the wheel track. The road grader can be used effectively to lower the shoulder by beginning at the wheel track and working in successive trips toward the gutter. The earth can then be moved to the centre of the road more quickly and without moving a constantly increasing mass. Very frequently the blade of the road scraper is run too deep at the gutter and not deep enough upon the shoulder.

When an earth road has been put in repair, it can be maintained by the road drag. The original form of the road drag was a split-log drag made from the split halves of a six to eight-foot log, six to eight inches in diameter. The two halves of the log are placed face forward and are set two and a half feet apart and at an angle of 45 degrees to the axis of the road. They are suitably braced and supplied with double-trees. In using the split-log drag, two horses are usually needed. Dragging begins at the outside edge or the gutter line of the earth road and proceeds toward the centre. The effect of the drag is to pair off ruts and move a small quantity of earth toward the centre of the road. It also has the capacity to puddle the surface material and form more or less impervious layers which prevent moisture from soaking into the roadbed. To drag a road twenty-four feet wide will require three round trips. A team of horses can draw a drag in ten hours about twenty-four miles, so that with three round trips, about four miles of road can be dragged in a day. This is probably the maximum. On steep grades or with unfavorable conditions, such as irregular gutters or stones in the road, the performance will be less. The minimum cost, figured on a four-mile basis, depends on the price of a man and team; at $4 a day, a complete dragging for three round trips is $1 per mile. In the experimental work by the United States Office of Public Roads in Alexandria County, Virginia, the cost of dragging has been about $1.25 per mile of three round trips.

The first year of dragging an earth road will require a greater number of trips than in subsequent years. Possibly 24 draggings will be required. As the road gets harder under continued dragging and traffic, fewer trips are needed. Important problems to determine immediately are how to establish the dragging system. Probably the best way will be, for the present, for road officials to contract with men who live along roads to drag sections from two to four miles in length. The dragging should be done after every rain and the section men may be required to fill out and forward to the supervisor a post card for each day of dragging. As time goes on, it may be possible for many communities to combine the road patrol and dragging system. This will require the continuous employment of men for probably seven months in the year. If they are paid $45 per month with the understanding that they are to do all dragging, when necessary, the annual cost will be $31.50 per mile on a ten-mile section. This is not an excessive cost per mile. It would no doubt pay to establish such a system in those counties which are spending around $40 per mile on any considerable mileage in the community. The presence of the patrolman during storms to prevent erosion and keep drainage in working order is a great permanent benefit to the road. In the experiment by the United States Office of Public Roads, as above referred to, about 43 per cent. of the patrolman's time was devoted to repairing, cleaning and improving ditches and under-drains and 23 per cent. to dragging. Whatever system of dragging or continuous maintenance is adopted, and the continuous maintenance is the best system, there must be competent inspection and daily reports to the inspector.

On the continent of Europe, the road men are frequently supplied with written instructions covering the slightest detail of their work. There is no reason why such a system could not be adopted on this continent. There is need for written instructions covering a great variety of details; for example, the care of the road at driveway entrances, particularly on hill-sides, is extremely imperative to prevent wash from adjacent lands. This is also true of road intersections.

With reference to the method of maintenance of macadam, gravel and bituminous macadam roads, there is much to be said. Written instructions should be issued covering all such points as the selection of stone, the preparation of worn holes and ruts to receive repair material, sweeping, scouring and picking up of the old road, etc. Wherever a roller is present there should be instructions to roll all macadam roads in the spring as soon as the frost is out. The management of the hauling of gravel and broken stone, the balancing of men and teams, offers a great opportunity for economy and detailed instructions on such matters are not superfluous.

It is scarcely necessary to add to what has been said above that the repair and maintenance of our highways is a business which requires trained men for its management and skilled workmen for its performance. There is no need to argue and waste oratory over the road question longer. We know it needs business management and we know that it costs an excessive amount of money under the old system. Furthermore, we know that the roads do continue poor. Happily, it has been found that all road work responds amazingly to organization and skilled supervision, nor is it necessary for a general election or overhauling of official positions to make a beginning in the improvement of repair and maintenance operations upon our highways.

FIRE CLAY TESTS.*

The term "fire clay" as it is generally interpreted has a very indefinite and elastic meaning. Usually it is applied to any clay which may be made up into wares that will withstand high temperature. This might mean any degree of heat from that attained in an open fire-place to that reached in a furnace for ore smelting. Obviously a clay suitable under the first set of conditions would not, in all probabilities, be suitable under the second. Fire-clays are frequently found associated with coal seams and in consequence miners invariably call any clay so associated a fire clay. In general this is far from the truth. The clay worker, at least, must have a more definite conception of the meaning of the term.

It is commonly accepted that the dividing line between refractory and non-refractory clays, as regards their temperatures of fusion, lies at or near 1,650 degrees centigrade, although this cannot be taken as a safe criterion for classifying refractories. It can be safely said, however, that very few No. 1 fire brick are made from clays fusing below this point. Since a high tension fusion point is the prime essential, its determination might well be made the first preliminary test.

The clay to be tested is moulded into a small "trial" the size and shape of a Seger cone (a tetrahedron or triangular pyramid about two inches high and measuring about half an inch at the base. This is placed in a vertical position on a fireclay slab, lowered into a suitable furnace, and the temperature gradually raised until fusion has proceeded to such an extent that the sharp edges of the cone have assumed a rounded appearance and the tip has fallen over until it touches the base. The temperature at this point is recorded as the temperature of fusion.

At first this might appear as a very reliable index to the character of a clay, but upon carefully considering the facts this is found not to be the case. Clays, being mixtures of minerals rather than definite chemical compounds, have no well defined melting points. The change from the solid to the viscous state is very gradual, often extending over a period of several hundred degrees. If two clays are taken whose cones show the same temperature of fusion, it may occur that if an appreciable load be applied to each at temperatures approaching their fusion points, great difference will be noted in their failure temperatures. This is due to the difference in their periods of softening; the one having the longer softening period failing first.

To this end, a test of fire brick under load at high temperatures has been devised by Bleininger and Brown at the Pittsburg Testing Laboratory. The furnace used for this work was of special design and is described by them in detail in Vol. XII. transactions A. C. S. It is fired by means of natural gas and compressed air and it is possible to bring the temperature up to 1,350 degrees Centigrade in about five hours. The load is applied to the brick by a lever outside the furnace and is carried to the brick through a high-grade fire clay bar acting as a column. The lever is fitted with adjusting bolts by means of which it can at all times be kept in a horizontal position. The movement of the lever can be observed by the operator and is an index to the action of the brick under test. Their final recommendation is that the brick be placed on end under a load of 50 pounds per sq. in., and subjected to a temperature of 1,350 degrees Centigrade for one hour. They further recommend that a one-pound fire brick should show no other marked deformation than a shortening of not to exceed one inch in the total original length of nine inches.

Some objections might be raised to this test on the ground that the time factor at high temperature figures prominently in the failure of fire brick and that in this case the specimen is held at the maximum temperature for only one hour. On the whole, however, the test relatively approximates actual conditions of use and gives such consistent results that it is likely to become, in time, a standard test for fire brick.

The furnace used for making the actual fusions are of several different types. The "Carbon Resistance Furnace" is probably the most convenient and satisfactory of those in use. It is described by Coggeshall and Bleininger in Vol. X. Trans. A. C. S. The casing is made from a high-grade fire clay and is supported on a wrought iron plate. A wrought iron ring and the crucible complete the list of parts. An annular space between the crucible and casing is packed with carbon; a grade known commercially as "Electric Furnace Carbon." The electrical connections are made through a supporting plate below and a ring above. The heat is generated by the resistance of the carbon to the flow of current. The current from the power line is stepped down through a suitable transformer so that it is available at five volt intervals from twenty to seventy volts. With this apparatus it is possible to get sufficiently high temperatures to fuse almost any clay. With the one in use in the Ceramics Laboratory of the Iowa State College, temperatures of over 3,200 degrees Fahr. have been obtained and this limit was determined only by the failure of the crucible by melting.

Methods for the testing of fire clays and fire clay products have not yet been standardized but considering the progress that is being made in Ceramics work, it should not be long before methods for systematic examination are available.

* From the Iowa Engineer, by M. F. Beecher, B.S., assistant in Ceramics, Engineering Experiment Station, Ames, Iowa.

DOMINION STEEL CORPORATION.

The nail plant of the Dominion Steel Corporation at Sydney is being steadily enlarged and although the company has been making nails on a commercial scale only a few months it is already becoming a large factor in the market.

A galvanizing plant of modern type is in operation. The only thing needed to complete it is the installation of the permanent power

The company's wire mill is equipped not only to provide wire for the nail mill and galvanizing plant, but wire for sale as well, including wire already drawn to be made into nails. The new annealing department to supply that part of the wire market is being rapidly pushed forward to completion.

WATER FRICTION IN WROUGHT IRON PIPE.*

Due to widely varying tables that appear in different handbooks and the necessity of elaborate interpolation to make them usable, a great deal of time is generally wasted in solving problems in which friction of water in pipes is a factor. Ira N. Evans (Power, July 9, 1912), has taken six of the best formulas for the friction of water in commercial wrought-iron pipe, together with the results of several tests, and compared them in tabular form.

The following were the principal formulas used by Mr. Evans in obtaining his average:

(1) Williams & Hazen formula:

$$V = cr^{0.63} \left(\frac{h}{l}\right)^{0.54} 0.001^{-0.04}$$

V = Velocity in feet per second;
c = Constant varying with condition of the pipe;
r = Hydraulic radius = $\frac{d}{4}$ in feet;
h = Friction head;
l = Length of pipe in feet.

The constant 120 gave results for most of the sizes higher than the average, while the factor 125 would give results checking closely with the average.

(2) Darcy's formula:

$$h = 0.003732\, l V^2 \frac{D + 1}{D^2}$$

D = Diameter in inches.

This formula gives values higher than the average.

(3) Meier's formula:

$$h = 0.0038\, l \frac{V^{1.86}}{D^{1.25}}$$

D = Diameter in feet.

(4) Harrison's formula:

$$h = 0.00375\, l \frac{V^2}{D}$$

D = Diameter in inches.

The results from this formula are below the average for pipe up to 6 in. in diameter.

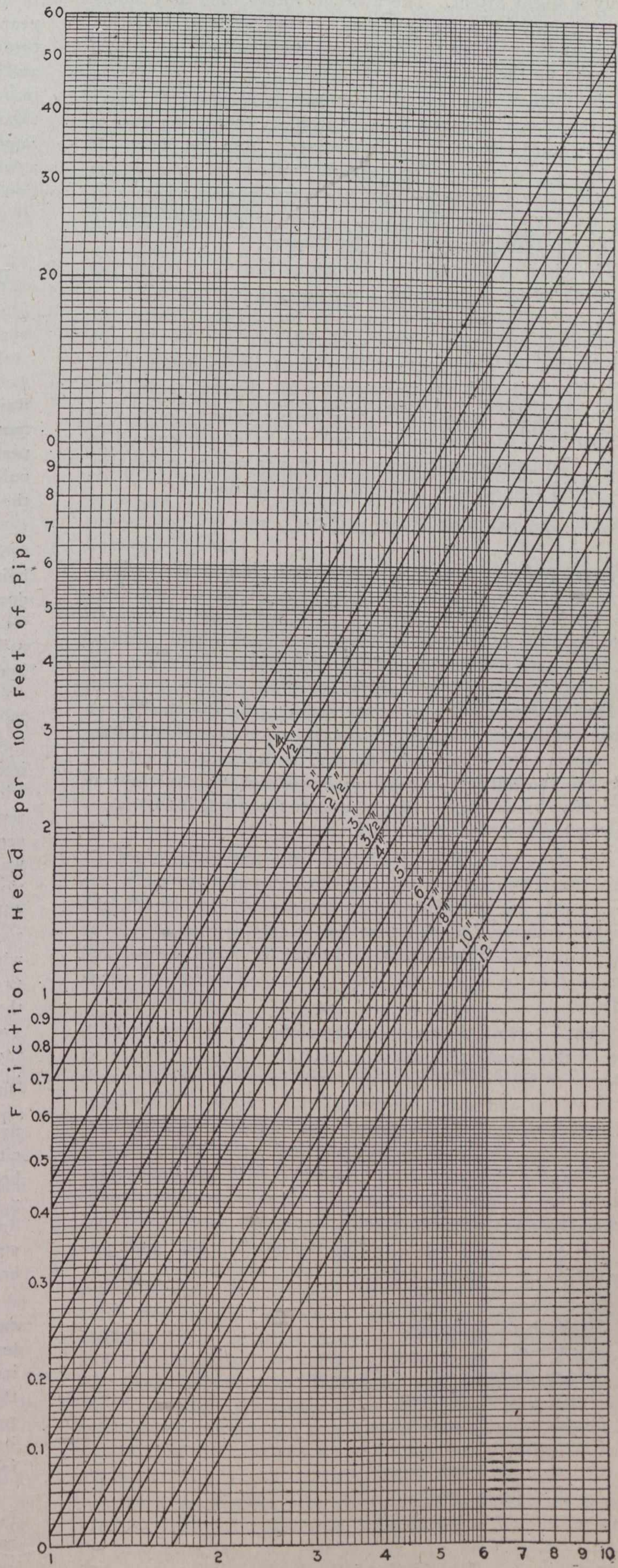
(5) Fanning's formula:

$$h = f \frac{l V^2}{d\, 2\, g}$$

The constant f varies for each change in size and velocity. This formula follows the average closely and gives results more consistent than the others except that of Williams & Hazen.

(6) Serginsky's formula, compiled from the latest German authorities, was also used. It gives results above the average for small sizes and below the average for large sizes.

The average values derived by Mr. Evans, mainly by the foregoing formulas, have been plotted by W. L. Durand, on logarithmic paper, as shown in the accompanying curves (Power, Oct. 29, 1912). All equations of the general form y = B x^n will plot at straight lines. Several of the formulas are



FRICTION HEAD IN PIPES 1 TO 12 IN. IN DIAMETER

* Taken from Engineering and Mining Journal, Vol. 94, No. 23.

of this form, and those that are not vary from a straight line to only a slight extent. The average values then may safely be represented by a straight line, as the greatest variation will be much less than the difference between any two values that make up the average.

The method of using these curves is self-evident, there being three variables and in any problem containing two of them the third can be found immediately from the chart. If only one variable is known, several values of one of the other two may be assumed and the corresponding values of the third found from the chart. The values that seem to best fit the problem may then be chosen.

The chart is plotted with velocities from 1 to 10 ft. per sec. as abscissas and friction head per 100 ft. from 0.1 ft. to 100 ft. as ordinates. Each curve is for a definite pipe size as indicated, and with a little variation, all the way through for velocities of 1 ft. per sec., the chart shows values practically identical with the averages in Mr. Evans' table.

For example, take a 3-in. pipe with a velocity of flow of 6 ft. per sec., the friction head per 100 ft. of pipe would be 5.45 ft. To produce a drop in head of 2 ft. in 100 ft. of 5-in. pipe would require a velocity of 4.7 per second.

ROAD CONSTRUCTION COURSE AT UNIVERSITY OF TORONTO.*

By A. T. Laing, B.A.Sc.†

Mr. Chairman,—I appreciate very highly the time given on your programme in order to make a statement regarding the attitude of the University toward the movement for better roads, and to tell you of what we are attempting in the way of training men for the duties and responsibilities of highway engineers.

For some years Dean Galbraith, who has given practically his whole life to the training of young men to meet the varied needs and ever increasing demands of this rapidly developing country, has felt that something special should be done to promote this important branch of engineering, and I am glad to be able to tell you that a beginning has been made.

That a technical course of instruction is of great importance in this connection must be admitted by all. There is perhaps no line of engineering work in which the demands are so varied and which require a wider range of knowledge and experience. Called upon as the highway engineer is to deal with constantly changing physical conditions and a varied supply of materials of construction, it is highly important that he should be thoroughly familiar with the fundamental sciences and their application.

He should know how to make surveys, plans and profiles,

Hydraulics.
Strength of materials.
Machinery.
Bridge design.
Masonry and concrete.
Geology.
Chemistry.
Structure of earth crest.
Laboratory methods.
Interpretation of reports.

Now, it is not the intention to establish a four-year course in highway engineering, but to make it a part of the final year in civil engineering. We have started by giving a lecture course in roads, pavements, maintenance, construction; and a laboratory course in the examination of materials, both in road metals and bituminous materials. But we do not expect by this means alone to turn out highway engineers. Superadded to all the instruction that can be given must be a wide experience, and here is where, I trust, this Association and the University may be able to co-operate.

*Address to Ontario Good Roads Association held Feb. 27th, 1913.

†Secretary University of Toronto.

DEFECTIVE CULVERT RECONSTRUCTION.*

By Mr. W. H. Mills.

A defective culvert at Killyman, on the Great Northern Railway, Ireland, was about 160 feet long and was surmounted by an embankment 50 feet in height. It was properly placed in the lowest point in a ravine, and afforded the only outlet for streams and surface water which gathers on the higher side of the railroad.

After carefully considering the many difficulties which arose, a cast-iron tubular culvert was decided on, the system being somewhat similar to the "Two Penny Tube" in London, only it was cut through compact earth, whereas in the Killyman tube the excavation was through loose ground of a railway embankment 50 feet high, consisting of tipped clay, boulders, roots of trees, etc.

The cast-iron tubular culvert was circular in section, with an internal diameter of 10 feet, the outer shell being 1⅛ inches in thickness. There were 91 rings, making a total length of 159 feet 3 inches. Each ring was 1 foot 9 inches wide, and consisted of six large segments, and one small segment, or key-piece, 10 inches long, at the top. These segments were all bolted together with ⅞-inch bolts and washers, placed at about 9-inch centres in the vertical direction, and at about 6½-inch centres in the horizontal direction. All butting surfaces of the castings, both vertical and horizontal, were machined perfectly true, and were thickly coated with white lead as they were bolted together during the progress of the work. To guard against any compression at the crown, which might be caused by the loose or made ground of the embankment overhead, transverse tie rods, ⅞-inch in diameter, and about 7 feet 5 inches long, were bolted to the upper joints of every third ring.

When the 159 feet 3 inches length of cast-iron tube was fixed in position, and bolted together, the lower half of the circumference was lined for the entire length with a half brick (4½ inches) lining of hard brick laid in cement. For 7 feet in length at each end of the culvert the half brick lining was continued all round the inside circumference. A strong masonry face wall and wing walls were built at each end, with large pitching stone invert between the wing walls.

It is interesting to note the comparison of weights. The cast-iron culvert, when taken full of water, weighs 137 tons less than the mass of earthwork which it replaced, and so, instead of an increased weight on the soft surface ground, there is a very considerable diminution. And we must also remember that the culvert, which weighs 511 tons when at its fullest capacity, is never more than one-third full when in its normal condition.

The total cost of the work was $8,500, and proved a perfect success, as work was carried on without hampering the railroad schedule in the least.

* Given in an address before the Institute of Civil Engineers, Ireland.

REPORT TO CITY OF OTTAWA ON SOURCE OF WATER SUPPLY.

The city of Ottawa lately engaged Sir Alexander Binnie and Dr. C. A. Houston as the most capable experts on water supply in Great Britain, to examine into and report to the city on a suitable water supply. The preliminary report of these engineers has lately come to hand and is published herewith. A feature of the report, outside their condemnation of the Ottawa River as the best source of supply, is their calculation that about seventy-five per cent. of the water at present pumped for the city is wasted.

"1. The Ottawa River, in our opinion, is unfit for domestic use in its present unpurified state. Moving the intake higher up the river might improve matters, but would not alter our settled conviction that this source of supply is unsafe in the absence of an approved process of purification. We are convinced that the up-river population is likely to increase rather than to decrease and despite all arguments to the contrary, we remain unconvinced that any rules and regulations can so control pollution in the future as to render the Ottawa River safe for domestic use in its unpurified state. To eliminate the chief risks of these pollutions would entail the construction of intercepting sewers on both banks of the river for many miles above the town at an enormous cost, nor would the fulfilment of this project completely remove our objections to this source of supply.

Must Use Chemicals.

"2. Apart from its liability to sudden accidental pollution of a specific sort, the Ottawa River water is highly colored and it would be a physical impossibility to render such a supply satisfactory without the aid of chemicals. Apart from the merits of the question we recognize that the use of chemicals is repugnant to a large proportion of the citizens of Ottawa.

Waste of Water.

"3. Our difficulties in pronouncing on a permanent source of supply have been greatly increased owing to the apparent consumption of water per head of the population being vastly in excess of all reasonable requirements. The system of distribution obviously requires a thorough investigation and the gross wastage of water not attributable to the consumer should receive immediate attention. At present the wastage would appear to amount to 75 per cent. of the total quantity pumped. In addition, we are strongly of the opinion that the climatic or other local conditions afford an insufficient excuse for any reckless waste of water on the part of consumers. It is essential to recognize that the supply of water per head of the population, hugely in excess of actual requirements, may involve the rejection on financial grounds of new schemes of water supply which otherwise appear to be eminently well suited for the needs of the city.

Lake Water Sources.

"4. In considering schemes for a permanent supply we have ruled out unpurified river water altogether and have contrasted the lake sources of supply with Ottawa River water after efficient purification.

"5. We have arrived at the conclusion that there is a bountiful supply of clear and wholesome lake water available for the needs of Ottawa for many years to come.

"6. Subject to the engineering difficulties of bringing lake water to Ottawa not proving financially too onerous a burden to be borne, and assuming that the drainage area chosen for the purpose would be protected from all sources of human pollution. We have finally decided to recommend the ultimate abandonment of the Ottawa River as a source of supply and to advocate the choice of a virgin lake water.

"7. It is absolutely impossible for us at this stage to discuss ways and means or the precise localization of the northern lake or lakes at present contemplated for waterworks use and so we have contented ourselves with dealing with general principles. We propose, however, to institute such further inquiries as will enable us to make specific recommendations as soon as is reasonably practicable.

"8. We consider that the present is a golden opportunity for securing for the Capital of the Dominion an unimpeachable source of water supply and of providing for the city without any form of treatment a water neither too hard nor unduly soft and of a bright, clear and transparent appearance.

Temporary Precautions.

"9. Until this great work can be accomplished it is necessary to adopt certain remedial measures and we suggest:—

"(a) That the water in the pipe line between the intake and pumping station should be kept uniformly under pressure.

"(b) That a sedimentation basin should be constructed at a cost which we estimate should not exceed $17,000 by connecting the piers at the intake with the high land on Lemieux Island.

"(c) That the double chlorination treatment now in operation should be stopped and a single treatment of the water as it enters the basin substituted for it. This, in our opinion, would enable the present dose to be reduced or, if the same dose were retained, the treatment would be rendered much more satisfactory than is the case at present.

"(d) That steps should at once be taken to reduce the extravagant rate of consumption per head of the population.

"10. We desire to point out that it is not our function to deal with health matters in the city, but it is obvious that provision of a pure water supply is only one of the steps necessary to secure the safety of the people of Ottawa from undue incidence of preventable diseases.

"In conclusion, we desire to place on record our appreciation of the courteous manner in which the mayor, his colleagues and various officers of the corporation have assisted us in our investigation. (Signed) ALEX. R. BINNIE, A. C. HOUSTON.

"February 10, 1913.

ONTARIO'S PIG IRON PRODUCTION

Ontario's iron and steel industries have received considerable attention since the intention of the United States Steel Corporation to build a plant to cost $20,000,000 at Sandwich, Ontario, was made public. It is probable that the corporation will erect a number of blast furnaces in addition to wire, rail, structural and bar mills.

At present there are nine blast furnaces in Ontario for the production of pig iron. The Algoma Steel Company, at Sault Ste. Marie, has three, the Canada Iron Corporation, Midland, two; the Steel Company of Canada, Hamilton, two, and the Atikokan Iron Company, Port Arthur, and the Standard Chemical Company, Deseronto, one each, reports Mr. T. W. Gibson, deputy minister of mines in the 21st annual report of the bureau of mines. In all, these plants turned out 526,610 tons of pig iron, valued at $7,716,314, an average of $14.65 per ton.

Much the greater part of the steel output of the Algoma Steel Company is rolled into "standard tee" rails, of which the production last year was 243,703 tons, the remainder, 24,617 tons, being in the form of merchant bars, tie plates, angle splice bars, light rails, bolts and nuts.

RAILWAY STATISTICS.

Statistics of steam railways, prepared by the Deputy Minister of Railways and Canals, have lately come to hand and are published below.

Railway Capital.

During the year ended June 30th last, $21,251,664 was added to the stock liability of railways, and $38,996,661 on account of funded debt—representing a total addition of $60,248,325. This increase over 1911 brought the total capital liability up to $1,588,937,526.

The facts with respect to capital liability in 1911 and 1912, for purposes of comparison, are as follows:—

Capital.	1911.	1912.	Increase.
Stocks	$ 749,207,687	$ 770,459,351	$21,251,664
Funded debt	779,481,514	818,478,175	38,996,661
Total	$1,528,689,201	$1,588,937,526	$60,248,325

It will be observed that, with double the operating mileage added in 1912, the amount of capital liability was slightly more than half the increase for 1911. This is explained by (1) market conditions, and (2) the issue of stocks and bonds prior to the completion of line mileage. In other words, the obligation is incurred before track mileage can be officially recorded.

The funded debt of railways was, in 1910, 1911 and 1912, distributed under the following heads:—

Funded debt.	1910.	1911.	1912.
Bonds	$696,677,305	$732,693,760	$772,532,108
Miscellaneous obligations	8,365,077	13,079,015	12,608,718
Income bonds	5,036,546	20,036,546	17,119,466
Equipment trust obligations	12,661,372	13,672,193	16,217,883
Total	$722,740,300	$779,481,514	$818,478,175

If the total capital liability of $1,588,937,526, as given above be divided by the 26,727 miles of operating line shown on a preceding page, the result would be $59,454 per mile of line. It would be quite misleading, however, to make such a calculation. Neither the divisor nor the dividend is correct. The mileage, for example, includes Government-owned and operated lines, to which no capital liability attaches. On the other hand, the capital figures embrace the liability of unfinished lines, such as the Grand Trunk Pacific, which do not appear in the mileage column. The deductions under this head amount to $134,321,020. Then there is considerable duplication. It has not been practicable to ascertain the exact amount thereof, created chiefly by the issue of stocks and bonds for the purchase or control of smaller roads by the larger, but it is known to be not less than $210,000,000. Joining these two sums, and subtracting the total from the $1,588,937,526 already indicated, the remainder is $1,244,-616,506. For immediate statistical purposes that might be regarded as the proper capital liability of Canadian railways.

The elimination of Government-owned lines, and such other lines as should not figure in the mileage column, reduces the total to 24,485. Using these factors, it will be seen that the capital liability of railways in Canada amounts to $50,832 per mile. This is a relatively low figure

The mileage, capital cost, and cost per mile of Government-owned and operated railways are given in the following table:—

Government lines.	Miles of line.	Capital cost.	Cost per mile.
Intercolonial	1,463	$94,746,391	$64,761
Prince Edward Island	269	8,687,727	32,296
Temiskaming and Northern Ontario	302	17,665,500	58,495
New Brunswick Coal and Railway	58	1,936,600	33,398

Following is a table showing the facts with respect to the capital liability of Canadian railways since 1910:—

Year.	Stocks.	Funded debt.	Total.
1910	$687,557,387	$722,740,300	$1,410,297,687
1911	749,207,687	779,481,514	1,528,689,201
1912	770,459,351	818,478,175	1,588,937,526

The relationship of dividends and net earnings to share capital during the past three years is shown in the following tables:—

Year.	Dividends paid.	Share capital.	Per cent.
1910	$21,747,914	$687,557,387	3.16
1911	30,577,740	749,207,687	4.08
1912	31,164,791	770,459,351	4.04

Year.	Net earnings.	Share capital.	Per cent.
1910	$53,550,777	$687,557,387	7.78
1911	57,698,709	749,207,687	7.70
1912	68,677,213	770,459,351	8.91

Of the foregoing payment of dividends, $18,487,000 was paid in common stock, and $12,677,791.31 on preferred stock.

Aid to Railways.

During the year $5,892,818.34 was given in cash as aid to railways. This sum includes $4,994,416.34 paid to the Grand Trunk Pacific under the Implement Clause of the agreement between the Dominion Government and that company. That clause provides that Government shall make up the difference between the amount realized on certain bonds and their par value. This is not exactly a subsidy; but there can be no question as to the propriety of classifying such a payment as aid. The whole amount of aid in cash for the year was made up as follows:—

By the Dominion	$5,858,163.34
By the Province	26,155.00
By municipalities	8,500.00
Total	$5,892,818.34

A discrepancy appears as between the aid given by Provinces in the table next succeeding and the table on a later page. It has arisen through defective records between the years 1875 and 1890, which cannot now be corrected; so both statements are published.

Following is an analysis of the cash subsidies paid by the various Provinces since 1910:—

Year.	Ontario.	Quebec.	Nova Scotia.	New Brunswick.
1910	$9,198,616.04	$12,328,196.52	$6,384,299.75	$4,851,486.71
1911	9,204,616.04	12,333,196.52	6,384,299.75	4,907,486.71
1912	9,204,616.04	12,333,196.52	6,440,454.75	4,907,486.71

Year.	British Columbia.	Manitoba.	Totals.
1910	$792,209.00	$2,878,887.02	$36,424,395.04
1911	798,209.00	2,878,887.02	36,506,695.04
1912	804,209.00	2,878,887.02	36,532,850.04

Following is an analysis of the various forms in which cash aid has been given to railways by the Dominion, by the Provinces and by Municipalities:—

Dominion.

Cash subsidies	$ 80,558,911.30
Loans	25,576,533.33
Cost of lines handed over to C.P.R.	37,785,319.97
Paid to Quebec Government	5,160,053.83
Implement Clause, G.T.P. agreement	4,994,416.66
Total	$154,075,235.09

The Dominion Government is also constructing the Eastern Division of the National Transcontinental Railway, on which an expenditure of $116,533,768.53 had taken place up to March 31st, 1912.

Provinces.

Cash subsidies	$ 32,895,485.16
Loans	2,750,030.00
Subsriptions to shares	300,000.00
Total	$ 35,945,515.16

Municipalities.

Cash subsidies	$ 12,807,324.98
Loans	2,404,498.62
Subscriptions to shares	2,839,500.00
Total	$ 18,051,323.60

Land Grants.

Following have been the land grants to railway:—

	Acres.
By the Dominion	31,864,074
By the Province of Quebec	13,625,949
By the Province of British Columbia	8,119,221
By the Province of New Brunswick	1,647,772
By the Province of Nova Scotia	160,000
By the Province of Ontario	635,039
Total	56,052,055

Summarizing the guarantees by the Dominion and Provinces, the result is as follows:—

	1911.	1912.
Dominion	$ 52,439,865	$ 91,983,553
Manitoba	20,899,660	20,899,660
Alberta	25,743,000	45,489,000
Saskatchewan	11,999,000	32,500,000
Ontario	7,860,000	7,860,000
Nova Scotia	5,022,000	5,022,000
British Columbia	23,196,832	38,946,832
New Brunswick	700,000	1,893,000
Quebec	476,000	476,000
Total	$148,336,357	$245,070,045

The above total of guarantees represents an increase for 1912 over 1911 of $96,733,688.

Public Service of Railway.

The public service of railways in 1912 was represented in the carrying of 41,124,181 passengers and 89,444,331 tons of freight.

In passengers carried there was an increase over 1911 of 4,026,463, and in freight hauled of 9,560,049 tons.

Passenger Traffic.

The number of passengers carried in 1912 was 41,124,181—an increase of 4,026,463, or 10.8 per cent. over 1911.

The number of passengers carried one mile was 2,910,251,636, which was 304,282,712 more than in 1911.

The number of passengers carried one mile per mile of line was 108,888, as compared with 102,597 in 1911. This represented an increase of 6,291 in passenger density.

The number of passengers carried per mile of line was 1,539—an increase of 79 for the year.

The average revenue per passenger per mile was 1.943 cents, which was .001 below the figures for 1911.

The aggregate earnings from passenger service—which included express, mails, baggage, etc.—was $65,048,186.66. This represented a gain over the preceding year of $6,730,188.21.

The earnings directly from ticket sales to passengers were $56,543,663.60, or $5,976,769.62 more than in 1911.

The average number of passengers per train was 62, as compared with 60 in 1911.

The average passenger journey was 71 miles—a gain of one mile over the preceding year.

The average receipts per passenger, using only the revenue from ticket sales as the chief factor, were $1.375—a betterment of .015 as compared with 1911.

The mileage of passenger trains was 40,440,393, and of mixed trains 6,473,882—an increase of 3,454,482 miles in the former and of 196,414 in the latter. In preceding calculations these two mileages were combined and used as the total passenger train mileage.

The earnings from passenger train service per passenger train mile—which includes express, mails, baggage, etc.—was $1.387. This was an increase of .039 over 1911.

Freight Traffic.

The volume of freight traffic was 89,444,331 tons, which, as compared with the preceding year, showed an increase of of 9,560,049 tons, or 11.9 per cent. This was the largest increase in the history of Canadian railways.

The number of tons hauled one mile was 19,558,190,527—a gain of 3,509,712,232 ton miles as against the figures for 1911.

The number of tons hauled one mile per mile of line was 731,776, which represented a betterment in the density of freight traffic, as compared with 1911, of 99,947.

The average revenue from freight per ton per mile was .757 cent, as compared with .777 in 1911.

Revenue from freight proper amounted to $148,030,898.60, a betterment of $23,287,883.29 over the preceding year.

The aggregate revenue from freight service for the year was $149,961,140.13, which represented an increase of $23,390,606.61 over 1911.

The gross earnings from freight were equal to $5,610.85 per mile of line—an advance of $626.76 over 1911.

Per ton, gross earnings from freight amounted to $1,655, or .094 better than in 1911.

The average number of loaded cars per freight train was 18.19, or .16 better than for the preceding year.

The average number of empty freight cars per freight train in 1912 was 5.17. The number in 1911 was 5.94.

The average number of tons per loaded freight car was 17.87, showing a gain over 1911 of .96.

The average freight haul was 218 miles, as against 200 miles in 1911—a gain of 18 miles.

The mileage of revenue freight trains was 60,126,023, which included mixed train mileage. This total represented an increase, as compared with 1911, of 6,627,157.

The mileage of loaded freight cars was 1,102,719,543, as against 946,946,917 in 1911.

Following is an analysis of the commodities which are placed in classes that constituted the freight traffic since 1910:—

	1910. Tons.	1911. Tons.	1921. Tons.
Products of agriculture	12,891,351	13,809,536	17,300,945
Products of animals	2,765,006	3,190,702	3,159,280
Products of mines	26,152,022	28,652,236	31,467,799
Products of forest	13,068,940	13,238,347	14,152,721
Manufactures	10,014,279	13,573,987	16,241,081
Merchandise	2,518,190	2,438,089	2,711,963
Miscellaneous	7,073,078	4,981,385	4,410,542
Totals	74,482,866	79,884,282	89,444,331

Of the total freight tonnage of 89,444,331, 63,186,732 tons were returned as "originating on this road." The tonnage so returned in 1911 was 55,152,430.

Earnings and Operating Expenses.

The gross earnings for 1912 were $219,403,752.79 as compared with $188,733,493.81 in 1911. The increment was $30,670,258.98, or equal to 16.2 per cent.

Operating expenses for the year were $150,726,539.87—an increase of $19,691,754.92, or 15.0 per cent.

The ratio of operating expenses to gross earnings was 68.7 per cent.—a decrease of .7 as compared with 1911.

The following table gives the gross earnings and operating expenses, with the ratio borne by the latter to the former, since 1910:—

Year.	Earnings.	Operating expenses.	Percentage of operating expenses to earnings.
1910	173,956,217	120,405,440	69.2
1911	188,733,494	131,033,785	69.4
1912	219,403,753	150,726,540	68.7

Earnings.

The difference between gross earnings and operating expenses was $68,677,212.92, as compared with $57,698,708.86 in 1911. These are popularly regarded as net earnings; but correct accounting methods require that certain deductions, such as interest on funded debt, taxes, rents, etc., shall be made before the real net corporate income is declared Table No. 9, in the body of the subjoined report, deals with the revenues of railway companies in this way.

The balance actually carried forward to profit and loss for the year according to the method followed in the preparation of Table No. 9, was $20,146,869.29, as against $14,150,464.67 in 1911.

The revenue during the year from outside operations amounted to $21,221,774.67, and operating expenses attached thereto, $15,333,617.50. The net revenue from this source in 1912 was $5,888,157.17, or $593,728.35 more than in 1911.

DECREASED PRODUCTION OF IRON ORE

An interesting white paper was recently issued by the British Government, containing statistics of the production and consumption of iron ore and pig-iron and the production of steel in the United Kingdom and the principal foreign countries in recent years, with additionally the imports and exports of certain classes of iron and steel manufactures. It states that the combined output of iron ore in the ten principal countries dealt with exceeded in 1910 139 million tons, and if the output of the minor countries be added it is probable that the world's total production during that year was about 145 million tons. Complete statistics are not yet available for 1911, but the provincial figures show that the world's total output is unlikely to reach more than 120,000,000 tons, the United Kingdom's production figures, however, showing a slight increase.

The total quantity of pig iron produced in the world during 1911 is estimated at about 63,000,000 tons, the principal producing countries being the United States, Germany, and the United Kingdom, which between them account for about seven-ninths of the world's output. Particulars for the first half of 1912 show that the output of pig iron for the five principal producing countries during that period was about 29,400,000 tons, which compares with 27,600,000 tons during the second half-year of 1911. For the second half of 1912 the United States produced about 15,600,000 tons of pig iron, Germany 9,277,000 tons and Belgium about 1,203,000 tons.

EARTH AND GRAVEL ROADS.*

By Robert C. Terrell.†

I feel a delicacy in discussing this very important problem of earth and gravel roads. As this class of roads comprises more than ninety per cent. of the total mileage of roads in the United States, and since there are more than 2,150,000 miles of road, you can readily see how important it is to have the earth and gravel road maintained in good condition for travel.

Earth and gravel roads—as is the case with most of our roads, it matters not of what material they may be constructed—have two natural enemies—water and politics—and the latter point is not to be overlooked. Water, however, is the subject that attracts the greatest attention in the road maintenance; and, since water and politics do not mix very readily, we will discuss the former.

Thorough drainage is the most important problem that confronts the engineer or road builder. Earth roads must be well drained and properly crowned, in order to be serviceable at all times. The maintenance of a road thus constructed is comparatively easy and not very expensive if the work is done at the proper time, but good drainage is very costly, if not altogether impossible, unless the road is properly located.

A road, in order to be properly drained, must have the proper longitudinal grade; a minimum grade of 0.5 per cent., with a maximum grade of 5.0 per cent., which may be increased, depending upon the amount of traffic and the obstacles met in locating. The minimum grade is necessary in order to give the side ditches the proper amount of fall to carry the water quickly and rapidly along and away from the road. The side ditches should be built of a sufficient width to successfully carry all of the water coming into them, having side slopes of 1½ to 1, or 1½ horizontal to 1 foot vertical, which will prevent the earth from the side caving in either from excessive wet weather, or from freezing and thawing. Side ditches should never be made deep and narrow. If extra drainage is necessary, they should be underdrained by use of tile or by excavating a deep ditch, filling with large stones, or making stone boxes and covering these stones with smaller ones and finally covering with sod, the sod side down, or hay, straw, or shavings from a planing mill, to prevent dirt from washing into the inside drain, leaving a shallow ditch on top. Deep, narrow ditches are dangerous to travel and otherwise objectionable, in that they catch trash and cause clogging, thus forming pools along the side of the road, permitting the water to seep into the foundation of the road and soften it. Where roads are located along sidehills a ditch on the upper side sufficient to take all the water coming down the hill is necessary and if it cannot be constructed immediately along the side of the road, there should be an additional ditch constructed above the road and parallel to it, intercepting the water from the hill and carrying it along the same general direction with a sufficiently small grade to prevent washing or gullying of the ditch. Where the grade exceeds 5 per cent., the ditch should be paved with stone and the water should be carried under the road from the upper side at short intervals and disposed of without permitting it to collect in sufficient quantities to damage the side of the road or break across it.

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* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati.

† Commissioner of Public Roads of Kentucky.

NOTE.—Space allowed only a short abstract of this paper in an earlier number. On account of the number and importance of earth and gravel roads in the Dominion, it has been deemed advisable to publish the paper in full.

Under, or subsoil, drainage is frequently necessary where roads are located on low or marshy soil and should be secured by a line of farm drain tile on either side, or by placing the tile immediately under the road. This farm or porous tile placed 34 to 36 ins. deep, and with a grade of ½ to 1 per cent. longitudinally, will keep the foundation of the road free from water, thus leaving the road hard and compact at all times.

Earth and gravel roads should have more care given to their location than roads surfaced with more permanent material, and probably receive less attention. In locating roads attention should be paid to the character of the surface of the soil over which the road is to pass. Clays form very poor surfaces and even among the clay soils there is as much variation of the fitness of the material for forming road surfaces as there is in variation of soils for farming purposes. These poor soils require more careful study and can withstand the effect due to bad location less than any other materials used for road building purposes. However, in many instances the roads have already been located with little or no prospects of change and to relocate a road means, in many instances, the purchase of expensive rights of way, and the changing of routes often causes trouble, because of the improved property along the old right of way.

For the clay soils, roads should be located where the sun has free access to the surface—preferably having a southern or western exposure and having a small amount of shade from trees and shrubbery. Where sandy or gravelly soil is available, it makes a better location for a road than the softer and less durable soils. As a sandy or gravelly soil sheds water very readily, being more porous, permitting the water to seep down and out; it requires less attention for drainage and shade. Sand makes a better surface for roads when damp.

If the road has been properly located and properly drained, probably the point of most importance is the crown or cross grade. There are several forms of cross section, but the parabola form, in my judgment, is the best, having a centre elevation equal to 1/24 of the width of the road. This form permits the more general use of the entire width of the road, as wagons getting across the middle of the road do not slide immediately into the side ditch. However, the parabola form is more costly, as it requires more care in construction. The uniform slope may be used to an advantage on account of the cheapness of constructing the uniform grade by means of the scraping grader, and probably is just as effective. If the uniform slope is used, ½ to 1 in. to the foot will be sufficient, and if traffic is not permitted to concentrate at the centre of the road and form ruts, the water will be carried quickly and effectively to the side ditches.

Mud holes have no place in roads well crowned, properly located, and properly ditched, and ordinarily they will not occur. However, the surface will become soft by constant pressure of water from underneath and can only be maintained in good condition for travel by putting in the subsoil or porous tile drains. Other frequent causes of mud holes are the unevenness in the texture of the soil and the combining of vegetable matter with the soil while working the roads; this vegetable matter holds water, thus damaging the surface. In no case should stone be piled into a mud hole, as it only forms a rough and unsatisfactory surface and permits the formation of mud holes at either end from the impact of loaded vehicles dropping from the harder surface of stones to the soil surface beyond. The road, however, can be successfully repaired by the removing of the softer soils, or soils containing vegetable matters and replacing with clay, or soil of the same consistency as the remaining portions of the road, and by removing the shade, so that the sun may have free access to that portion of the road.

An earth road, like all farm land, should have its principal working in the spring of the year when the soils will work most readily and will have time to become consolidated before the fall rains begin. A scraping grader drawn by a traction engine will do excellent work in giving a road sufficient crown, and the side ditches may also be opened by the use of the scraping grader. The earth removed from side ditches should not be thrown into the centre of the road but should be thrown out to the opposite side or left in such condition that it could be easily removed from the surface of the road entirely and should never be placed where it could be carried back into the ditches by reason of water falling on the surface.

In crowning a road in early spring with a road machine care should be taken that no second or shoulder ditch be left between the centre and the edge of the ditch supposed to carry the drainage, as such a ditch only tends to hold water falling on the surface and soften the subgrade rather than offering an opportunity for the water to be carried away. After the road is properly crowned in the early spring, it will need only slight care during the summer and fall months and in most instances this work can be effectively accomplished by the use of the split log drag. A light drag is preferable, which can be easily drawn by two horses.

It is not necessary for me to go into detail with reference to the construction of one of these excellent pieces of road machinery, as everyone who is interested in road building knows perfectly well the advantages to be gained by the use of a drag.

The amount of road improved by gravel more than equals the amount of road constructed by the use of other materials—probably next to earth roads is the most important—because of the quantity of road surfaced with this material and its low cost and easy method of construction. The same care should be given to the location and drainage as is given to the earth road. In the construction of the gravel road, beginning with the subgrade, it is probably best to open the trench to receive the gravel, giving it the same crown or cross section as the finished roadbed should have, which should be a parabola, with the centre height equal to 1/40 of the width of the road. The subgrade should be properly rolled, beginning at the edges and rolling toward the centre, as you would the finished road, and where soft places or uneven surfaces appear, they should be filled and shaped and the rolling continued until the surface is entirely smooth. The gravel should not be dumped in piles as it forms a wavelike appearance after the road becomes thoroughly consolidated, but should be dumped on boards or shoveled out of the wagon and to the roadbed, spreading evenly and in layers of from 4 to 6 ins.

Gravels containing clay or sand, or even loam, not exceeding 20 per cent. of the entire quantity, make excellent road material and will bind or compact very readily. After the gravel has been properly placed on the subgrade it should be thoroughly sprinkled and rolled, the rolling beginning at the edge of the ditch and rolling the shoulder in the same manner as the gravel, so as to have an even surface for the water to shed from the centre to the side ditch.

In many instances, however, it is not possible to secure a roller for consolidating the gravel. In that case the gravel can be properly shaped and thrown open to travel, care being taken to fill wheel ruts by moving the loose stones in with a rake until the road has been consolidated to an even surface and having proper cross section. If this care is not given to the gravel when first placed and unrolled, ruts will form on either side by the constant rolling of vehicles in the same tracks and will prevent the water from reaching the side ditches and form channels in which the water will collect and cause much damage.

In western Kentucky our gravel roads cost approximately $1,000 per mile, while in eastern Kentucky, where the country is more hilly and less attention has been paid in the past to the proper maintenance of earth roads, which are being converted into gravel roads, the cost is slightly higher.

In my opinion the maintenance of earth and gravel roads will never be effectively accomplished until we receive government aid for all post-roads and until every road becomes a post-road. I do not mean, however, by "government aid" that the government shall bear the entire or major portion of the expense of constructing or maintaining any road or roads in the Union, but that the government will merely assist in the construction and maintenance of roads to such an extent as will enable the government to direct the local authorities how the work must be done before the federal aid is available, and then that these roads be put under direct government inspection by making each and every rural mail carrier the inspector of his route, reporting deficiencies in the road as they occur to the local authorities and to make reports to the federal government once each month as to the condition of the road.

THE CONSTRUCTION OF REINFORCED CONCRETE SYPHONS OF THE CHENAB IRRIGATION CANAL.

The Chenab Canal, Punjab, India, is the most advanced of what is called the triple canal project now under construction, and with which Mr. Scott, who gave this description at the Institute of Civil Engineers, Ireland, is connected. It obtains its supply from a weir that is thrown across the river just below the point of the offtake of the canal, about 40 miles from the point where the river emerges from the Himalayan Mountains. It has a bed width of 240 feet and a full supply depth of 12 feet, with a discharge of 12,000 cubic feet per second.

The first 26 miles of the main line of the canal passes through a fertile district which has a plentiful rainfall, therefore, no irrigation will take place within its reach, but owing to its proximity to the hills the alignments had to be carried across several drainage lines which, during the rainy season, carry high supplies, therefore, in order to pass the storm water safely under the canal it was necessary to construct several syphons in the upper portions of the head reach.

Of the twelve syphons used eleven were of reinforced concrete, which is an experiment in India, and especially in the Punjab, owing to the extremes of temperature that the concrete will be exposed to, and will be an experience as to how it stands the test. The syphons are cheaper to build and will stand the pressure better than would massive deep foundations of brick masonry, these being more or less submerged, will offer a great protection for the concrete.

The dimensions of the largest of these syphons is as follows:—

Estimated discharge	2,550 cusecs
Number of barrels	8
Length of the barrels	342 feet
Diameter of the barrels	6.5 "
Thickness under canal bed	6½ inches
Thickness under canal banks	7½ "
Head of internal hydraulic pressure	15.00 feet
Depth of foundation below spring level	12.00 "
Design of foundation—slab of concrete	2 ft. thick

The Portland cement concrete used in the barrels of the syphons was made up in the following proportions:—

Portland cement	60 lbs.
Sand	100 lbs.
Ballast	160 lbs.
Water	22 lbs.

The Portland cement was obtained from England by indent of the secretary of state of India, and complied with the specifications of the India office. The aggregate consisted of broken quartzite boulders obtained from the bed of the Chenab River and broken in a Baxter stone-breaker to a size that each piece should pass through a ring of half-inch diameter. The sand consisted of the same material crushed to a much finer degree. A block of this concrete, tested after one month, gave a resistence to crushing of 1,380 lbs. per square inch.

The exact proportions of the concrete used in the foundation are as follows:—

Brick ballast	120 cubic feet
Kankar lime	30 "
White lime	10 "
Crushed brick or Surkhi	10 "

It was hand-mixed on brick platforms, carried in baskets to the work, and rammed in 6-inch layers which formed a very hard concrete and was also hydraulic. This syphon will cost in the neighborhood of $50,000 (£10,333).

Nearly every person who has not travelled to India are generally under the erroneous impression that work is done in a leasurely fashion. With only two European engineers to supervise the work of the reinforcement, centrings and laying of the concrete, what would be a simple operation in this country assumed large proportions in India, as the work was new to the men and the staff and coolies had to be trained up to the work, which was done under awnings to protect the concrete from the heat of the sun. But, despite all this, and with the temperature nearly always in the neighborhood of 90 degrees Fahr., the work was completed well within the anticipated time.

UNION FREIGHT STATIONS.

Union freight stations will in time be established in all large commercial centres, says L. C. Fritch, chief engineer of the Chicago Great Western Railroad.

A plan for consolidating the passenger and freight terminals in Chicago has recently been proposed. The plan is commendable, although to bring it about certain railroads would have to give up valuable vantage points in the interests of economy and improved service for all. The union terminal should, Mr. Fritch believes, be operated by a terminal company, equal service being rendered to all lines. This undertaking, tremendous at first thought, is nevertheless feasible and is simplified by the fact that Chicago is the terminus of all the lines entering the city, so that only small portions of the ends of main lines would be out of the hands of the individual railroad companies.

A step toward such a plan would be the aquisition of all belt lines now existing in the Chicago district. They should be owned jointly by all the railroads entering the city, and should afford all such railroads equal access to all facilities and industries located on them. There are four or five principal belt lines in the district, and in some cases lines badly congested are paralleled by lines little used. Common ownership would make it possible to balance the traffic on the different lines, would eliminate the necessity for increased facilities on the lines now congested, and would enable each road entering the city to get its belt line service at actual cost.

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CONTENTS OF THIS ISSUE.

A COURSE IN HIGHWAY ENGINEERING.

In an address given before the recent Ontario Good Roads Association meeting, Mr A. T. Laing, the secretary of the Faculty of Engineering, University of Toronto, outlined the plans of that institution to meet the present-day requirements of trained highway engineers. Dean Galbraith, as the head of the Faculty of Engineering, is again to be congratulated on his continued putting into force of those lectures and courses which improve the value and opportunities of his graduating students. In their final year they are to be given besides lectures on roads, pavements, maintenance, etc., a laboratory course in the examination of road metals and bituminous materials.

Modern highway engineering cannot be properly carried on without the employment of technically trained men. With the present-day movement towards good roads throughout the country, every school of engineering should make provision for special lectures in that branch of work. Some of the state road associations across the border make special provision for keeping young men working with them on practical work in the summer and attending schools and lectures on highway engineering in the winter. No doubt some such arrangement will be arrived at in this country as the demand for such men increases.

Students spending their summers on practical road work of different types, obtaining in the winter supplementary technical information on the subject, ought to be in a position to be of considerable service when they graduate. The schools of engineering and road associations in all parts of Canada should work together to this end. The full text of Mr. Laing's address on this subject is given on another page.

ELECTRIFICATION OF RAILWAYS.

The Chicago, Milwaukee and Puget Sound Railway is preparing to operate electrically through part of Montana and Idaho, and has signed a contract for the electric energy needed. In so far as many Canadians expect to see some of our steam railways finally forced through economy of operation to electrify in many localities, it is of interest to note the terms of the contract made for power by the railway in question.

The railway is not to be liable for interruption to its consumption of energy due to causes beyond their control, such as strikes, fires, etc. Neither is the power company liable for interruption to supply due to the same causes. Two years' notice to commence delivery of energy must be given the power company, and the railway must electrify its line before 1918. The railway agrees to buy energy at the rate of 10,000 kilowatt for a full period of ninety-nine years. It has options to buy more power from the power company up to a maximum of 25,000 kilowatt. The permissible call for additional energy from the power company is scaled both as regards amounts and necessary time notice beforehand. These additional amounts once called for will be delivered for the entire remaining time of the contract. The power company in making delivery of energy, is to provide energy at either 50,000 volts or 100,000 volts, three-phase, sixty cycle, and is not to be called on to deliver at more than five stations; the railway company to be responsible for distribution. The railway is also forbidden to sell to others any of the energy purchased.

In an endeavor to avoid any misunderstandings, provision has been made for a board of arbitrators to settle disputes of any nature between the companies interested. This board is to consist of three parties, one representative from each company and the third party selected by the first two.

Such a board is to be commended, and ought to facilitate the efficient operation of such big contracts where it is almost impossible to cover all the details of construction and operation beforehand. The more general adoption of such a board of arbitrators in connection with contracts of this character should rather be encouraged.

The power company pays the federal government a tax of five mills per 1,000 kilowatt hours for energy crossing domains. The rate paid the power company by the railway for energy is 5.36 mills per kilowatt hour. This is subject to a minimum bill of 60 per cent. of all the energy contracted for by the railway. It will be seen that this provision of a minimum charge makes it incumbent upon the railway to operate so efficiently that 60 per cent. of the energy supplied is under use. Otherwise, they will not benefit by the low rate.

UTILIZATION OF TIDAL ACTION.

Readers will remember a few years ago that the newspapers had considerable in their columns regarding a scheme for utilizing tidal action for developing electricity. The Bay of Fundy has a tidal movement of 50 or 70 feet, and was spoken of as the locality where electric development by this means would be immediately started. A site was spoken of, but it is our impression that no construction work was ever started. Apropos of the above comes word of plans for development in Europe of 5,000 horse-power by this means at Husum on the North Sea.

A reservoir of 4,000 acres is to be constructed by means of two embankments running from an island to the mainland. The reservoir is to be further subdivided into an upper and lower tank by another embankment. The assumptions for operation are as follows: When the water in the sea is higher than in the lower reservoir or tank, it will flow in through turbines, the flow starting sometime after high tide and stopping after the beginning of low tide. If the water in the sea be lower than in this tank, then through sluices it is to flow into the sea. In the upper reservoir, when the sea is higher than the tank, it will be filled through sluices, and when lower the water will flow off through turbines. A uniform tidal amplitude of three meters is counted upon and a difference of level of one and a half meters between the sea and the tank actually in operation. The cost of producing electricity by this means is estimated at 20 to 25 mills per kilowatt hour. No necessary expense for accumulators is expected, and the cost of construction is placed at about $1,000,000.

The scheme has been very severely criticized in a German technical paper by Mr. L. Benjamin. While it is not our purpose to pay any attention to his criticisms of the estimated expense of the project, we think criticism of the practical operation of such a plant worth considering and interesting. If it is a feasible and practical plant at all, with a tidal amplitude of only three meters, it ought to mean wonderful possibilities for electrical development in Canada in the Bay of Fundy. In the criticism of the practical operation of such a scheme by the German paper before mentioned, the objections are principally on the following points:—

After making allowance for back pressure and the head necessary to bring the water from the remoter parts of the reservoir to the turbines, the maximum head available would only amount to one meter, and falls to zero in a working period. In the most favorable case the dynamos would only work for a period of about four hours, followed by a standstill of two hours. The energy would have to be stored for distribution to consumers, and expensive accumulators would become necessary. Turbines suitable for one meter head are not suitable for less than one-half meter, and consequently more turbines become necessary.

Summing up the criticism, it amounts to the fact that the final cost of electric energy delivered to the consumer by this plan would be prohibitive and far beyond a properly designed steam plant.

The affair, as far as a proposed plant at Husum is concerned, savors of wild-catting and stock promotion. The market for the distribution of energy is at considerable distance from the proposed site, and in every way it would appear to be a very expensive and impractical plant.

In Canada it is probable that the inland water powers are sufficient, and can be more economically developed for the use of the people of New Brunswick and Nova Scotia than any possible present harnessing of the high tides on the shores of the Bay of Fundy. It is interesting, however, in looking forward, to see a tremendous field for electric development as above in Eastern Canada. The Bay of Fundy is the locality of the greatest tidal amplitude of movement in the world. It will be strange, indeed, if the first works to put the scheme to practical test are not located there. Any urgent demand or necessity for power in that region will probably lead to an attempt to develop electric energy by the above means.

EDITORIAL COMMENT.

Oil production in Canada, as shown in the statistics published on another page, is steadily decreasing. This is probably the only product of Canada's wealth or natural resources, the production of which has steadily declined in the last five years. We are of the opinion that this movement is only temporary. There are yet tremendous and promising tracts of land to be properly prospected for oil. It is to be hoped the engineer and geologist will soon locate it in abundance. It would be unfortunate, indeed, if, as a country, we were lacking in such a product, so largely used in the arts and manufactures.

STORM WATER DISCHARGE.

R. O. Wynne-Roberts * and T. Brockmann.†

(Continued from page 375).

Before proceeding to explain the method of constructing flow areas and curves, it will be necessary to submit the following formulæ:—

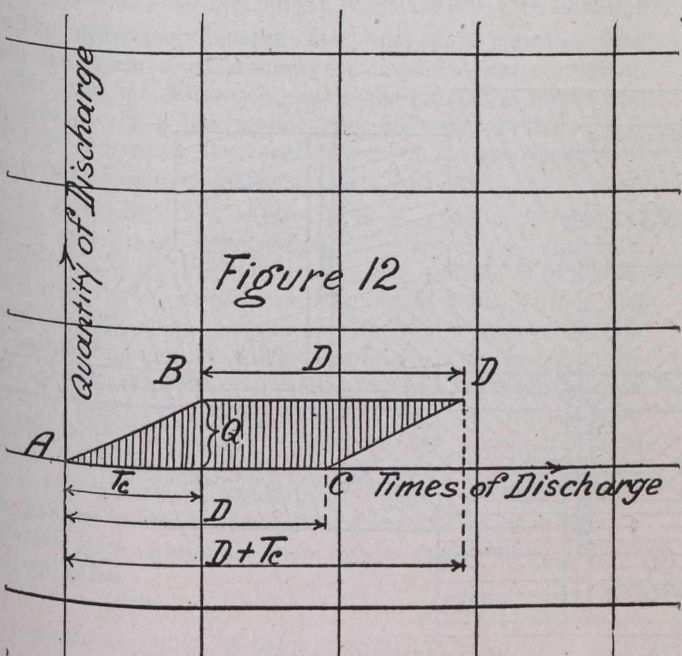
Let Q = Volume of storm water discharged in cubic feet per second, when the whole of the drainage area is contributory.

Qt = Volume of storm water discharging at any time during or after a storm, in cubic feet per second.

P = Coefficient of impermeability, taken from diagram or table.

R = Quantity of rain, reduced to cubic feet per second per acre.

I = Coefficient of rainfall intensity, see table or diagram.



A = Drainage area, in acres.

Tc = Time required for storm water to concentrate at the lower end on the sewer of "L" length, in minutes.

L = Length of sewer, in feet.

V = Mean velocity of flow in sewer, in feet per second.

D = Duration of storm, in minutes.

T = Any time, in minutes.

$$\text{Then (1) } Tc = \frac{L}{V}$$

$$\text{and (2) } Q = P \times I \times R \times A.$$

In the preliminary design of a sewerage system the length of any particular section is known, and the velocity of flow may be assumed at, say, three feet per second, when running half-full or full, so that the time Tc required for the storm water under such condition to flow from point to point can be easily ascertained by formula (1).

The duration of a storm is "D," and the ordinates representing the volume of storm water "Qt" for any time "T" will be as follows:—

If "T" is greater than zero and less than "Tc," then

$$Qt = \frac{T}{Tc} \times Q.$$

If "T" is greater than Tc and less than D, then Qt = Q.

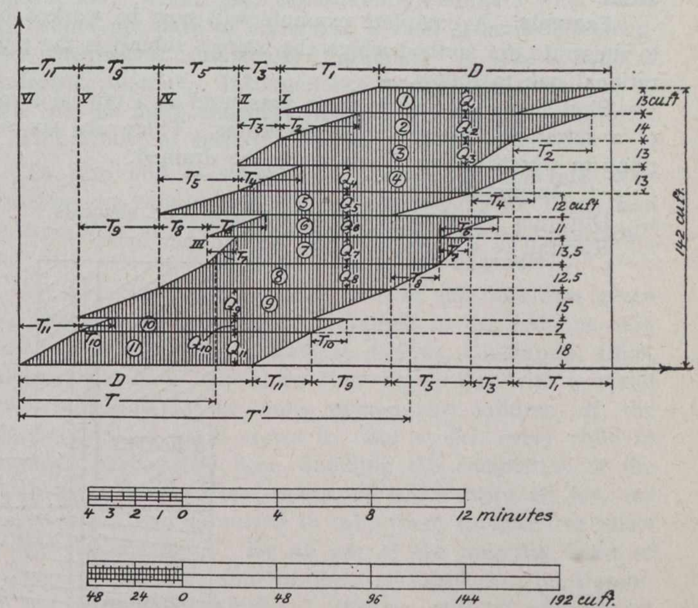


Fig. 14.

If T is greater than D and less than D + Tc, then

$$Qt = \frac{(Tc\ D) - T}{Tc} \times Q.$$

If (D + Tc) is less than T, then Q = O.

(See Figure 12.)

The left-hand slope A-B (of Figure 12) of the flow-area is parallel to the right-hand slope C-D.

The volume of storm water run-off is represented by the flow area, having the shape of the rhomboid A-B-D-C, and the period of concentration, as well as the quantity discharged at any time at the lower end of any sewer having "L" length, and during any storm of "D" duration is clearly indicated in the diagram (Figure 12). It may be explained that in this case the direction of the flow is from the right

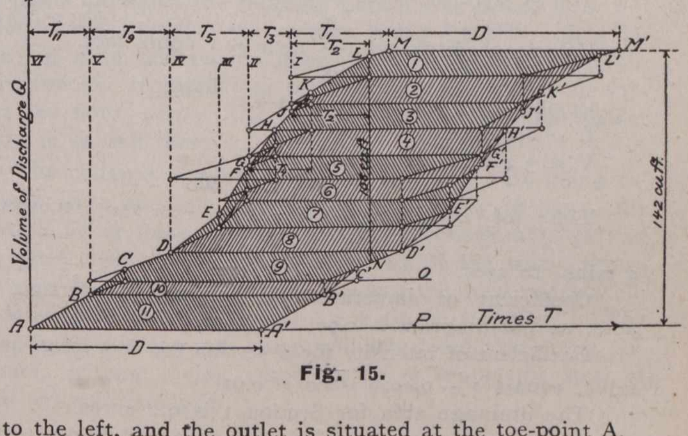


Fig. 15.

to the left, and the outlet is situated at the toe-point A.

Recapitulation.—It is to be hoped that what has already been stated regarding the problem of calculating the quantity of storm water, to be dealt with in any district, has been expressed in explicit terms, and that it will be recognized that, having regard to the variable factors which have to be considered, the best way of arriving at a satisfactory solution will be by drawing flow-areas.

* M. Inst. C.E., F. R. San. Inst., Consulting Engineer, Regina.

† Dipl. Ing. (Berlin), Civil Engineer, Regina.

The engineer will, therefore, have first to

1. Assume the intensity of the rainfall.
2. To ascertain if retardation takes place.
3. If retardation does not take place, then use formula.
4. If retardation does take place, then to draw flow-areas.

Example.—A complete example will now be worked out to illustrate the method which the writers submit is the more rational one to follow.

Plan shown in Figure 13 is presented as a typical layout of a sewerage system for storm water. There are six sections to which eleven areas are to be drained.

Assumptions—

Duration of storm = 10 minutes, or 600 seconds.

Rainfall = 2 cubic feet per second per acre.

The volumes of discharge for the other ten areas can be arrived at by analogous calculations and the following results will be obtained:—

Section 1	13	cubic feet per second.
" 2	14	" " "
" 3	13	" " "
" 4	13	" " "
" 5	12	" " "
" 6	11	" " "
" 7	13.5	" " "
" 8	12.5	" " "
" 9	15	" " "
" 10	7	" " "
" 11	18	" " "
Total	142	cubic feet per second.

So that the total discharge at manhole VI. amounts to 142 cubic feet per second.

Figure 14 shows the floor area for each section and drainage area illustrated in Figure 13.

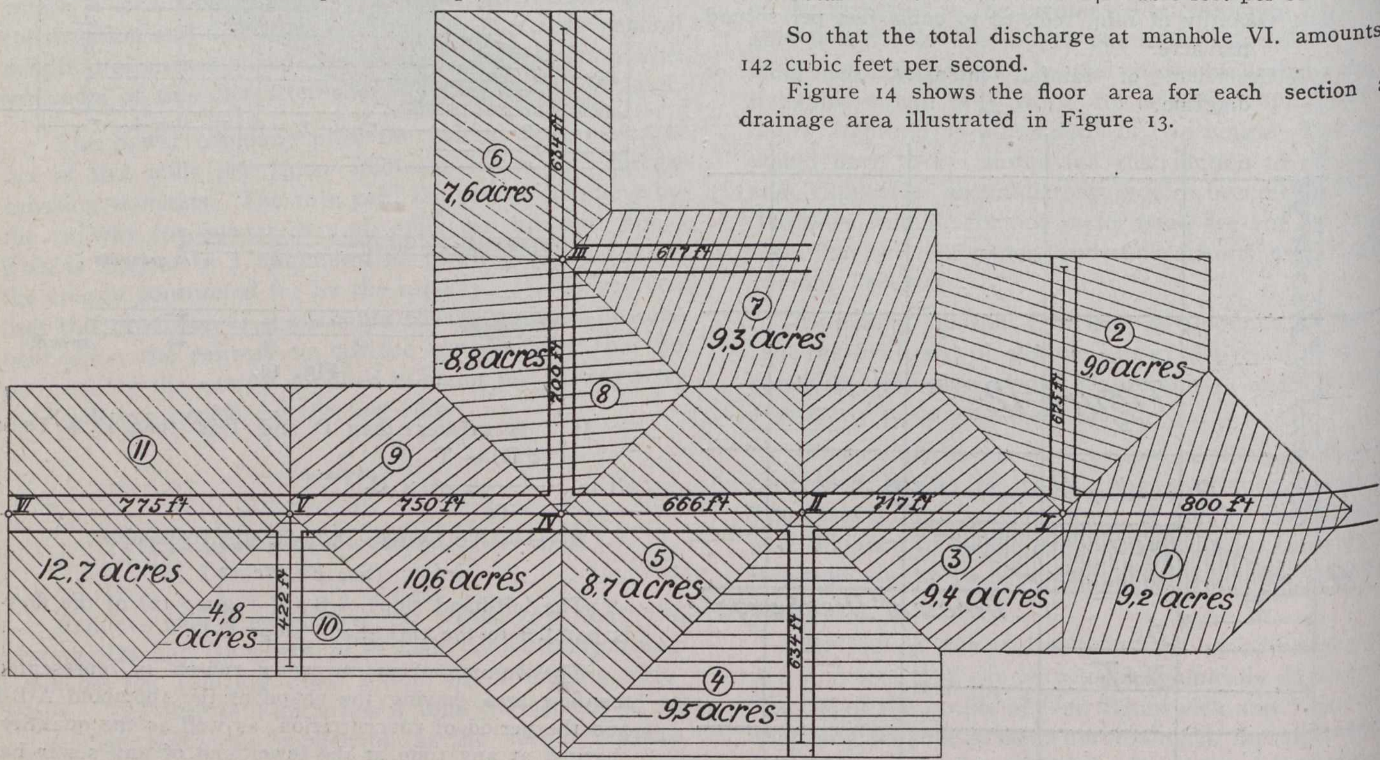


Fig. 13.

Scales of the flow-areas are—

Time one inch = four minutes.

Volume of discharge, $\frac{1}{48}$ inch = 1 cubic foot.

Commencing with Section 1—

L = 800 feet.

V = 3.2 feet per second.

Time of concentration $= \frac{L}{V} = \frac{800}{3.2} = 250$ seconds, or 4 mins. 10 secs.

Coefficient of impermeability for, say, 70 persons per acre, as per diagram = 0.77.

Coefficient of intensity for a section 800 feet long, as per table, equals $1 - 0.0028\sqrt{800} = 0.92$.

The drainage area for Section 1 is 9.2 acres.

Accordingly the volume of discharge will be:—

Q = Area × rainfall × coeff. of impermeability × coeff. of intensity.

$Q = A \times R \times P \times I = 9.2 \times 2 \times 0.77 \times 0.92$.

Q = 13 cubic feet per second.

Having ascertained the time of concentration and the volume of discharge as above, the flow-area is plotted in the top right-hand portion of the diagram (Figure 14).

Those who wish to draw similar charts may be guided by the following simple rules:—

1. Start by drawing the flow-area of the section of sewer lying near the remote limits of a district, that is, the farthest from the point of outlet, and then proceed, section by section, downwards, in the direction of the flow.

2. Flow-areas of sewers which meet at a manhole have the same abscissæ; i.e., the toe-points of their ascending slopes are located perpendicularly above each other.

3. The flow-area of a sewer section located between two manholes is to be drawn beneath those of the upper sections, the toe-point being moved leftwards a distance corresponding to the time of concentration for that particular sewer.

4. Secondary collecting sewers joining the main sewers will have to be dealt with in a similar manner.

The chart illustrated in Figure 14 has been constructed in accordance with the foregoing rules.

The volume of discharge passing through manhole VI. at the time "T" is represented by an ordinate erected at "T," and cutting the flow-areas 11-5. The parts of the erected ordinate which signify discharge are those which lie within the shaded areas. The flow-areas 4-1 are not passed through by the ordinate, which shows that they are not yet contributing, whereas, at the time "T¹" the sections represented by the flow-areas 8-1 are discharging into manhole VI., while the water from sections represented by flow-areas 11-9 has already run off.

Figure 15 has been prepared by depressing the projecting points on the left and elevating those on the right to the area next to them, and so a flow-curve is obtained which is characteristic for the volume of storm water discharge at any time from the whole drainage area under discussion.

It will suffice to construct only the ascending curves A-B-C, etc., because the descending curves M′-L′-K′, etc., are parallel to them.

The largest ordinate of the total flow-area will give the maximum rate of flow on which the calculations of the sewer dimensions are to be based.

In the present example the ordinate L-N shows this maximum rate of flow to amount to 106 cubic feet per second, and this is the volume of storm water that must be provided for in Sections 9, 10 and 11.

The difference between M-P and L-N indicates how much the storm water discharge is modified by retardation. In this case the difference equals 142-106, or 36 cubic feet per second. In a like manner the difference between M-O and L-N represents the modification of the aggregate flow due to retardation in Sections 1 to 9 inclusive.

In conclusion, the writers have to urge upon city engineers and others the desirability of installing automatic recording rain gauges so as to obtain reliable information concerning the quantity of rain falling in short periods and in different districts, for without this data it is possible that the assumptions which will be made when designing storm water sewers may be erroneous and lead to inadequate or excessive provision for storm water. In each city the rainfall should be automatically recorded for those having a duration of 2 to 120 minutes, and such data plotted as shown in Figure 1, illustrating the intensity of rainfall. The rain gauges required for this purpose are to be had at a moderate price, whilst the information thus secured will be of great value.

NOTE:—The issue of The Canadian Engineer, Feb. 20th 1913, page 344, containing a preceding article by R. O. Wynne-Roberts and T. Brockmann on Storm Water Discharge, did not, unfortunately in printing, bring out many of the symbols r belonging to q. The part of the page needing correction is here reprinted together with more distinct $\sqrt{}$ signs and the omission of a dash over an x.

The corrected page should read :—

Line 22 — $\frac{q}{2}$ correct to "$\frac{q_r}{2}$".

Top of right hand column same page should read :

Let "A" be the zero point, then the parameter "p" is found from $10{,}000 \times p = \left(\frac{q_r}{2}\right)^2$ or "p" equals $\frac{q_r^2}{40{,}000}$; the equation of the parabola will be "y^2" $= \frac{q_r^2 \times x}{40{,}000}$.

The circumference described by the centre of gravity in revolving is $2 \times 0.6\, x \times x$, therefore the content of the solid of revolution corresponding to the shaded area (cylinder minus parabola) is $x^2 \pi\, q_r - \frac{2}{3}\, x\, y\, 1.2\, x\, \pi = x^2 \pi\, (q_r - 0.\ 8\ y)$ and "I" $= \frac{x^2 \pi\, (q_r - 0,\ 8\ y)}{x^2 \pi\, q_r} = 1 - 0.\ 8\, \frac{y}{q_r}$.

As $\frac{y}{q_r} = \sqrt{\frac{x}{40{,}000}}$, "I" $= 1 - \frac{0.\ 8\sqrt{x}}{\sqrt{40{,}000}}$.

FAULTY CEMENT WORK.

So simple does it seem to mix cement, sand, stone, and water, and embed therein steel rods, that the ordinary mind untrained in the refinements of technical calculation is apt to overlook the fact that a complicated theory underlies the construction. There are, consequently, builders who, while they would not dare to undertake a steel structure, yet consider themselves sufficiently "practical" to take a hand at reinforced concrete. Incompetence is thus too often set on high, and no more vengeful Juggernaut was ever enthroned to exact tribute of suffering and death.

To plan and to superintend reinforced concrete construction—we cannot repeat it too often—calls for more than the experience and common-sense of the so-called "practical" man; it is eminently work for the trained engineer.

No more emphatic demonstration of this was ever given than the example of failure presented in the remains of a motion picture theatre on Eastern Avenue, Cincinnati, Ohio, which was to have opened on New Year's day with a grand free-for-all show for as many women and children of the neighborhood as could crowd it. For weeks, every child in the neighborhood had been watching the completion of the new picture theatre; and many of them were all joy, for their mothers had promised to take them to that free show on New Year's day. By an act of the merciful hand of Providence, however, none of them attended, for, on December 10, the nearly completed theatre, without preliminary warning long enough to give the unsuspecting workmen a chance to escape, collapsed to the ground, carrying with it the ten workers who happened to be in the structure, instead of that happy throng of women and children. Had the structure stood until that opening day, it is conceded by all that it would have been the death trap for two hundred or more mothers and their children. As it is now, the story is three dead, six seriously injured, and one bruised.

The building was a reinforced concrete substructure of columns, beams, and slabs, with brick side and end walls forming the theatre proper. The concrete work was originally designed by an engineer employed by the architect; but it appears that the owner, on account of the high bids received, engaged a "practical" builder, who prepared his own plans, modifying the work of both the architect and the engineer, and agreeing to do the work for much less than the amount of the lowest bid. Neither architect nor engineer had anything to do with the supervision of the erection. Even the plans on which the building permit was issued were not followed out exactly, one column being omitted, thus increasing span between columns; and though the building commissioner required that the details of the girder to support the floor across this span be submitted, the builder failed to submit them.

The collapse occurred while the forms were being removed. The concrete had been in place only 18 days, the weather being generally cold and for a considerable part of the time below freezing. The folly of the whole thing, however, is strikingly shown in the way the steel was placed, no intelligent care whatsoever having been exercised. The rods in the girders were simply bunched together along the bottom, without being spaced so as to enable the steel to have any effective grip.

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*Cement World.

Mr. J. G. Sullivan, chief engineer of Western lines of the Canadian Pacific Railroad, has stated that tenders are being called, to close April 15, for a great tunnel 28,000 feet long to cut through the Roger's Pass Hill.

REPORT OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

(Continued from last week).

Thursday, January 30th, 1913

Morning Session

THE PRESIDENT said they would continue the discussion re British Columbia Branches.

MR. ROBINSON said it appeared to him that this question was too large for a snap judgment. The matter needed thorough consideration over an extended time, so that whatever action they might see fit to take in this matter should be well weighed and their judgment mature.

He moved that the Council be instructed to take this matter under advisement and thoroughly thresh it out, with a view to proposing any amendment to the by-laws which may be necessary to accomplishing this which we are asking for.

He hoped that the matter would not take the form of action which would in any way weaken either the interests of the parent society or of the branches. They hoped that whatever action was taken would tend to increase the strength of both, thereby making a stronger and more vigorous society in every respect. In the discussion after the meeting yesterday afternoon informally, it was brought to his attention that some of the members considered it unnecessary to seek incorporation from the Provincial Government of British Columbia, and that the only thing necessary in the circumstances would be to register this society, which had a charter from the Federal Government, as an extra provincial organization doing business in British Columbia. His opinion at the present time was that that would accomplish the objects which they had asked for fully as well as to secure an independent charter. If the council saw fit to take such action, he would like to have this meeting give the council such authority as might be necessary to secure this act. Possibly that could be done before the end of the year. He would like to have that discussed. He would make it as a motion.

THE PRESIDENT understood the motion to be, that the question of establishing a British Columbia branch be referred to the incoming Council.

MR. ROBINSON assented, adding "with power to act."

MR. LeGRAND seconded that motion.

MR. MOUNTAIN said the whole matter of the British Columbia section had been laid before them by Mr. Robinson in a very fair-minded spirit. The tone of his speech was conciliatory and temperate and admirably adapted to the subject. He made this motion that it be turned over to the Council to suggest amendments in the by-laws, if necessary, and then he said that he hoped action would be taken before the end of the year. Of course, that was a long period, but at the same time could amendments be put through between now and the next meeting?

THE PRESIDENT stated the only thing that could be done would be to have them ready for the next meeting.

The motion was then put and carried.

MR. ROBINSON had just one more matter to bring before the meeting.

There was a tendency on the part of politicians in all countries to use the prerogative of appointments as spoils of political battle. He thought that the citizenship of the country at large would approve if the society discouraged that attitude on the part of politicians. If there was anything within the power of the Council that they could do to discourage that attitude it would be probably conferring a boon upon all the citizens of the country, and especially upon engineers who are in the employ of the government.

MR. ROBINSON said in the absence of another to propose his motion he would like to place it in the form of a resolution:—

Resolved, that we, the Canadian Society of Civil Engineers, do heartily endorse the attitude taken by many of the officials of our government towards the matter of separating party politics from the engineering interests of the government, and anything we can do to further such attitude we will enter into with all zest.

MR. JAMIESON was pleased to second that.

MR. DUGGAN was in sympathy with that motion, but he did not think the form in which it was couched was felicitous. The same object was being achieved in another way, by asking the government to create a strong permanent corps. He thought they could eliminate all questions of politics. That had been carefully omitted all through in connection with that matter.

THE PRESIDENT asked if it would not be well to write out that resolution.

MR. ROBINSON thought the sentiment expressed in the resolution met entirely the views of the members, and they could safely trust to the Council or secretary to put it in diplomatic form.

THE PRESIDENT said the resolution would be worded by the secretary.

The motion then carried unanimously.

Proposed Committee on Reinforced Concrete Construction

THE PRESIDENT said there was some correspondence at hand from Mr. Almonte asking that the society form a committee on reinforced concrete construction.

MR. ALMONTE begged to propose that the society appoint a committee to work out specifications for reinforced concrete structures. Canada was one of the countries where reinforced concrete is very largely used. Most European countries and the United States years ago deemed it advisable to get out such specifications containing general rules to ensure safe construction. There was only one public body here in Canada which had issued such a specification, and that was the city of Toronto.

He thought it would be a great benefit to the Dominion if this society took this matter up, and if it were to do so the probability is that its recommendations would be adopted by all public bodies. It would not only ensure safe construction, but avoid the endless multiplicity of specifications which now prevail in the United States. And it would be a credit to the society to take this matter up now.

MR. MOUNTAIN proposed that it be referred to the incoming Council.

Carried.

Transportation Route Committee

MR. KENNEDY here said that they would all remember about the formation of the General Committee on Transportation. It was sub-divided into committees, of which several have been mentioned, and amongst others was one on transportation routes. It was erected some two years ago in Winnipeg into an independent committee.

Now, the Transportation Committee as a whole has really done almost nothing. The first chairman was Mr. McNab, who resigned after a time, then Mr. Mountain followed, and the president after him, and then he (Mr. Kennedy) was appointed some time ago. The subject seemed to him to be tremendously large when he sat down to consider it and try to do something about it. The president had written an important paper on four transportation routes between Fort William and Montreal, and Mr. Jamieson had also done a good deal personally in the same way. Mr. Coutlee had also done something, but as a committee they had not been able to get together and do much.

Looking over the subject as it stands, transportation routes take in everything from Hudson Straits down to Lake Erie and from Cape Breton to Vancouver Island, and that would be connected again on the Pacific side with the Panama Canal and Liverpool, and the same on this side. Then there is railway transportation as well as water transportation. It comes to be a tremendous subject unless it is more particularly defined than it is now.

Although they got permission from the Council to engage an expert, yet he confessed he hardly saw how the committee, as a volunteer committee, unless there was somebody engaged who would be at it all the time, could make a report which would be worthy of the society and have any weight.

He had grave doubts as to the usefulness of continuing the committee, and if it is continued possibly the constitution of it could be looked over to make it more concentrated. He was not prepared to make a definite recommendation in the matter, but he put it before the meeting so it might be considered.

MR. JAMIESON said, as a member of that Committee on Transportation, he confessed to a great deal of disappointment that they did not succeed in accomplishing what they had set out to do. It was a very difficult matter to deal with, and they have had a great many changes of chairmen, and some members, no doubt, had not been able to give the time and attention to it that was expected. He knew that their president, who was chairman of that committee, devoted a lot of time to it and got out quite an extensive report on the railway end, and some on vessels as well. For himself, he certainly did devote a very large amount of time and considerable expense to it. Month after month he had worked on it from time to time, and he had got his data in such complete shape as would make it very valuable on this question. And yet, to-day they had practically, as a committee, produced nothing.

THE PRESIDENT, after some discussion, suggested that Mr. Jamieson, after going to all the trouble he had, should write a paper for the society.

MR. MOUNTAIN moved that the Committee on Transportation Routes be disbanded.

He thought if the members who had worked on it would present their information in the shape of a paper it would be a valuable addition to the transactions. If they so desired, they could say the paper was presented more for discussion than as their firm conviction.

The motion to discontinue the committee then carried.

Re Committee on Portland Cement and Concrete

MR. JAMIESON wished to say a word or two in connection with the Committee on Portland Cement and Concrete. Unfortunately, they were not able to report for this meeting. It was something like the question of transportation routes, it covered a great deal of ground and required a great deal of data to be accumulated, and while they had got that very fully, yet, it was a matter of a good deal of work, and will take a good deal of time formulating a report. He had been considering the question of dealing with it in a paper or a lecture to bring out the information they had collected on the question of the effect of sea-water on cement and concrete. That will bring out the matter much more fully than can be done in a report, and then they could make a short report at a later date based on that.

Report of the Gzowski Medal Committee

THE PRESIDENT said he had a report by wire from the different members of the Gzowski Committee. The chairman of that branch was away ill, so that they had to get the views of the different members by wire. They were unanimous in recommending that Mr. R. F. Uniacke be given the Gzowski medal for his paper on "The Little Salmon River Viaduct."

This was confirmed by the meeting unanimously.

Report of Scrutineers

The next business was the report of the scrutineers.

BALLOT FOR SPECIFICATIONS.

The secretary read the report for the ballot for specifitions.

THE PRESIDENT presumed this meeting should instruct the Council that these specifications be printed and distributed.

Carried.

BALLOT FOR AMENDMENT TO BY-LAWS.

The secretary read the report as follows:—

By-law 23.—Ayes, 306.	Nays, 126.	By-law carried.
By-law 24.—Ayes, 339.	Nays, 76.	By-law carried.
By-law 51.—Ayes, 306.	Nays, 47.	By-law carried.
By-law 55.—Ayes, 355.	Nays, 39.	By-law carried.
By-law 20.—Ayes, 325.	Nays, 74.	By-law carried.

BALLOT FOR ELECTION OF OFFICERS AND MEMBERS OF COUNCIL.

The secretary read the report as follows:—

President—Phelps Johnston.

Vice-President—F. C. Gamble.

Councillors—District No. 1.—J. M. Fairbairn, W. J. Francis, R. J. Durly.

District No. 2.—F. A. Bowman.

District No. 3.—W. D. Baillairge.

District No. 4.—S. J. Chapleau.

District No. 5.—H. E. T. Haultain.

District No. 6.—W. A. Duff.

District No. 7.—T. H. White.

THE PRESIDENT then declared the foregoing gentlemen elected.

NEW BUSINESS

MR. HARKOM moved that the Council be requested to consider the advisability of forming a Montreal branch to operate on the same lines as other branches already formed.

MR. CROMPTON said, in seconding that motion as an out-of-town member, that it seemed to him there was a feeling, particularly among the out-of-town members, that they were not getting value.

THE PRESIDENT said he understood the motion was that the Council shall give its serious consideration to the question of starting here a Montreal branch.

MR. KENNEDY, in discussing the motion, said he noticed this resolution was put forward by gentlemen who were not members resident in Montreal, and not members of any other branch, and have had no real experience in this matter. He thought it would tend to worse confusion if they were to try to make a Montreal branch here. For the society to legislate at this point that Montreal should erect itself into a branch would be very much the same as if the Quebec Legislature ordered the city of Montreal to widen a street which the city knows much better about itself.

This matter of papers which seemed to be behind the motion, he thought, possibly they had a wrong idea about. They must remember that at the present time the whole country is flooded with technical journals. They had English, French, and above all, American journals, and the members had their own "Canadian Engineer," which was becoming a good engineering paper. (Hear, hear). So, it was practically impossible for a busy engineer to do much more than keep up with the procession, to keep on reading what was coming up. All the best papers of the engineering societies were published in the engineering papers.

They were trying to put upon the Council and the committees what was really the duty of individual members.

He did not think the annual meeting was quite the right place in which to order the members in Montreal to form themselves into a separate branch independently of the Council, because the thing was not workable and would really complicate matters and induce confusion.

Let those members who wanted to write papers write them freely, and not scold too much those who did not write when they themselves are not setting an example.

MR. ROBINSON said in order to relieve this body from the embarrassment which may follow, an accusation of usurping the power of Montreal members to do something which they wish not to do, he would make it a motion that this whole matter be left in the hands of the Council to deal with as they see fit. That the motion be not put as a vote, but simply recognized by the Council as a suggestion.

MR. JAMIESON said it appeared to him that the mover and seconder would probably withdraw their motion as a motion before the society on the promise that the president had already made that the Council would take it up and consider it.

MR. HARKOM said he only asked the Council to consider the advisability of it. He certainly felt that in their hands the matter would receive fair and due attention.

Scale of Engineering Charges

MR. J. S. ARMSTRONG moved the following resolution:—

That the Council be requested to appoint a committee to consider and, if possible, draw up a schedule or scheme of charges for engineering services.

MR. LEOFRED seconded that motion. All the professions, notaries, land surveyors, doctors, have got what they call a minimum charge. This would only refer to the minimum charge, he understood.

THE SECRETARY said that he thought it was in the knowledge of members of the Council that this matter engaged the attention of the Council something like a year ago, and that even the proposer of the tariff scheme himself failed to put up anything that he could satisfy himself with. They had spent some time over it and came to the conclusion that it would utterly fail.

The motion was put to the meeting after some discussion and defeated.

Re Specifications for Steel Water Pipes

THE SECRETARY said a member of the society, Mr. Pitcher, telephoned him just then to say he intended to be here in order to ask that the matter of appointing a committee to consider specifications for steel water pipes be referred to the Council. He now finds he cannot get here. The secretary supposed this matter might be included in the others remitted to the Council.

MR. VAUGHAN moved that it be referred to the Council.

Election of Nominating Committee, Officers and Members of the Council

The next business was the election of a Nominating Committee.

THE SECRETARY said the following were the nominations by the Council for the formation of a Nominating Committee, and the by-laws required that this Nominating Committee shall be elected by the Annual Committee. Suggestions have been received from the branches, who have taken some means to ascertain the views of their members. The suggestion in regard to the local member is that of the local members of the Council. The suggestion for District No. 2 is from the local councillors in the Maritime Provinces.

The following name was suggested as a member of the Nominating Committee for District No. 1, H. M. Jacques.

Adopted unanimously.

THE SECRETARY said District No. 2, which was the Maritime Provinces and the United States, put forth two names, F. W. W. Doan and G. Stead.

On being put to the meeting, Mr. Doan was declared elected.

District No. 3, Province of Quebec, F. X. A. Leofred and R. O. Sweezie.—Mr. Leofred was elected.

District No. 4, Alexander McPhail and James White.—Mr. White was elected.

District No. 5, J. G. Sing.—Elected.

District No. 6, W. L. McKenzie.—Elected.

District No. 7, J. H. Grey and L. G. Robinson.—Mr. Robinson was elected.

Votes of Thanks

MR. MOUNTAIN moved a vote of thanks of this meeting to the railways of the Eastern Passenger Association, to the Montreal Tramways Company, to the Canadian Foundry Company, Limited, and to the Canadian Pacific Railway for courtesies extended to the members in session at this annual meeting.

This was seconded by Mr. Monsarrat and carried unanimously.

MR. McNAB proposed that the Council be requested to convey to the Dominion Conservation Commission the thanks of the society for the valuable copies of the reports of the commission which were furnished gratis to the members of this society.

This was seconded by Mr. Duff and carried unanimously.

THE PRESIDENT then said if there was no other business to be brought before the meeting he would declare it closed.

The meeting then adjourned.

PETROLEUM.

The annual output of crude petroleum from Canadian oil wells, for 1912, still continues to decline, the production having steadily fallen off during the past five years. Twelve years ago Canada produced about 50 per cent. of the domestic consumption of petroleum and its products, while at the present time not over 5 per cent. of our consumption is derived from Canadian oil wells. The output in 1912 was 243,336 barrels or 8,516,762 gallons, valued at $345,050, as compared with 291,092 barrels or 10,188,219 gallons, valued at $357,073 in 1911. The average price per barrel at Petrolea in 1912 was $141 or considerably higher than the average price in 1911, which was $122⅔.

The price of crude oil increased steadily through the year, rising from a minimum of $1.24 in January to a maximum of $1.65 in the latter part of December.

These statistics of production have been furnished by the Department of Trade and Commerce and represent the quantities of oil on which bounty was paid, the total bounty payments being $127,751.39 in 1912 and $152,823.29 in 1911.

The production in Ontario by districts as furnished by the supervisor of petroleum bounties, was in 1912 as follows in barrels: Lambton, 150,272; Tilbury and Romney, 44,727; Bothwell, 34,486; Dutton, 4,335; and Onondago, 7,115; or a total of 240,935 barrels. This agrees very closely indeed with the production in Ontario on which bounty was paid, viz., 240,657 barrels. In 1911 the production by districts was: Lambton, 184,450; Tilbury and Romney, 48,708; Bothwell, 35,244; Dutton, 6,732; and Onondago, 13,501.

The production in New Brunswick in 1912 was 2,679 barrels, as against 2,461 barrels in 1911 and 1,485 barrels in 1910.

Exports entered as crude mineral oil in 1912 were 18,500 gallons valued at $3,964 and oil refined, 36,945 gallons, valued at $6,147. There was also an export of naphtha and gasoline of 25,791 gallons, valued at $4,261.

The decreased production has been accompanied, particularly during the past two or three years, by a very large increase in imports of petroleum and petroleum products. The total imports of petroleum oils crude and refined in 1912 was 186,787,484 gallons, valued at $11,848,533 in addition to 2,144,006 pounds of wax and candles valued at $119,520. The oil imports included crude oil, 120,082,405 gallons, valued at $3,996,842; refined illuminating oils, 14,748,218 gallons, valued at $1,022,735; gasoline 40,904,598 gallons, valued at $5,347,767; lubricating oils, 6,763,800 gallons, valued at $1,077,712 and other petroleum products 4,288,463 gallons, valued at $413,477.

The total imports in 1911 were 116,892,689 gallons of petroleum oils crude and refined, valued at $6,009,730 and 1,959,787 pounds of wax and candles, valued at $106,424. The oil imports comprised crude oil, 71,653,251 gallons, valued at $2,188,870; refined and illuminating oils, 13,690,962 gallons, valued at $722,403; gasoline, 23,338,773 gallons, valued at $1,976,032; lubricating oils, 5,308,917 gallons, valued at $806,452, and other petroleum products, 2,900,786 gallons, valued at $315,973.

The principal increases in imports have been in crude oil now used so extensively in British Columbia by the railways and in gasoline.

ELECTRICITY IN IRON AND STEEL INDUSTRY.

By J. E. Dalemont.*

The recent development in iron and steel plants has been characterized by two important features, i.e., the large direct consumption of the blast furnace gas in gas engines of large capacities and the direct drive of reversible rolling mills by electric motors.

The average consumption of coke may be estimated to one ton (1,000 kgs.) per ton (1,000 kgs.) of pig iron produced by blast furnace process and the quantity of gas produced is not less than 159,000 cubic feet.

Its average composition is:

CH_4	0.5 to 1.8%
H	1.8 to 2.8%
CO	21 to 26 %

Of this quantity about 70,000 cubic feet is used for heating the air required by the blast furnace process and the balance, about 89,000 cubic feet, is usually collected from the top of the furnace and distributed in the boiler room and elsewhere for heating purposes.

In the last ten years, owing to the progress of the gas engine industry, almost all the blast furnace gas is used directly by gas engines for generating power; it is estimated that of the 89,000 cubic feet mentioned before, about 64,000

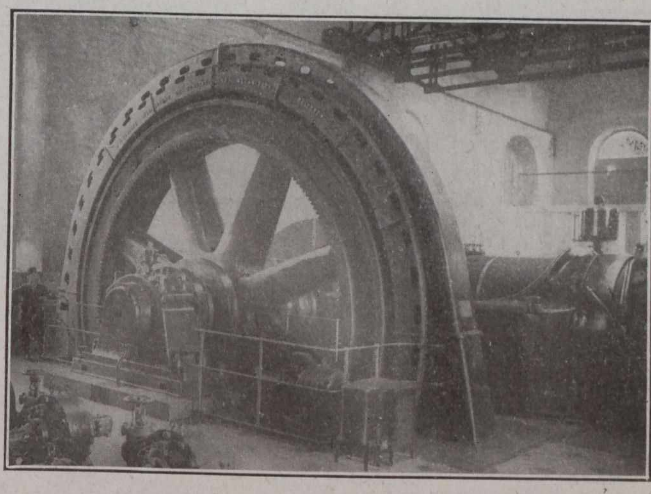

Fig. 1.—Alternator Driven by Gas Engine.

cubic feet are available for power purposes, after making allowance for the operation of the blast furnace accessories.

The advantage of this may be easily understood if we recollect that with the gas engine 28 to 30 per cent. of the calorific energy of the gas is transformed into mechanical energy, while the steam engine does not transform more than 12 per cent.

This explains also the efforts made in the last ten years to bring the gas engine construction to a very high standard. In 1900 the largest engine was not over 100 horse-power and now many engines of 3,000 to 4,000 horse-power have been built and installed, and there are units in operation of 5,000 horse-power each.

The calorific energy remaining in the gas after completion of the iron process in blast furnace practise per ton of iron produced, is approximately 1,700,000 calories for 64,000 cubic feet of gas (referred to before) which is the estimated average to be used in gas engines.

* General Manager, Engineering Works of Canada, Limited.

Some tests made with large units have shown that per kilowatt obtained the consumption of gas by a gas engine of good design is:

3,160 calories at full load
3,770 calories at ¾ load
4,020 calories at ⅔ load

Comparing this with the steam turbine, using superheated steam of 300 degrees C. at a pressure of 160 lbs. per square inch, the average number of calories required per kilowatt produced may be estimated between 7,500 to 8,500. About 475 kilowatt hours may be generated with the energy remaining in the blast furnace gas, produced per hour and per ton of pig iron. One may easily realize the advantages the iron and steel plants have obtained from the new use of the blast furnace gas, generating at a very low cost electric power which is applied for lighting purposes or motors.

Similar results may also be obtained in coal mines by means of gas producers of high efficiency and the use of coal of low selling value. The gas, either drawn from the furnace or gas producers, must be washed out completely by means of special cleaners, as the cleanliness of gas is an absolute necessity for effective operation of the gas engine.

The next most important question is: What will be the total expenses per kilowatt hour at the terminals of the electric machines driven by such a gas engine? This, of course, to a large extent depends upon special conditions, which cannot be easily covered by a general estimate, but we may say that in Europe, in several large plants, the cost of production never exceeded .24 cents. With gas producers this figure is somewhat higher, about .55 cents. Of course, with higher wages paid for help on this continent, the figures should be somewhat increased.

Owing to the somewhat different industrial and economical conditions, gas engines came, in Europe, into larger use some years before an extended application was made on this continent. The French company, "Société Alsacienne des Constructions Mechaniques," owing to its large experience in mechanical construction, has achieved in this new line a remarkable success, as demonstrated by the numerous installations of complete plants, many of them having a capacity of 10,000 and 15,000 horse-power.

Fig. 1 shows one of the alternators driven by a 94 r.p.m. gas engine, six of which were installed in the mills at Homecourt. The A. C. generators have been built in the Belfort shops of the company.

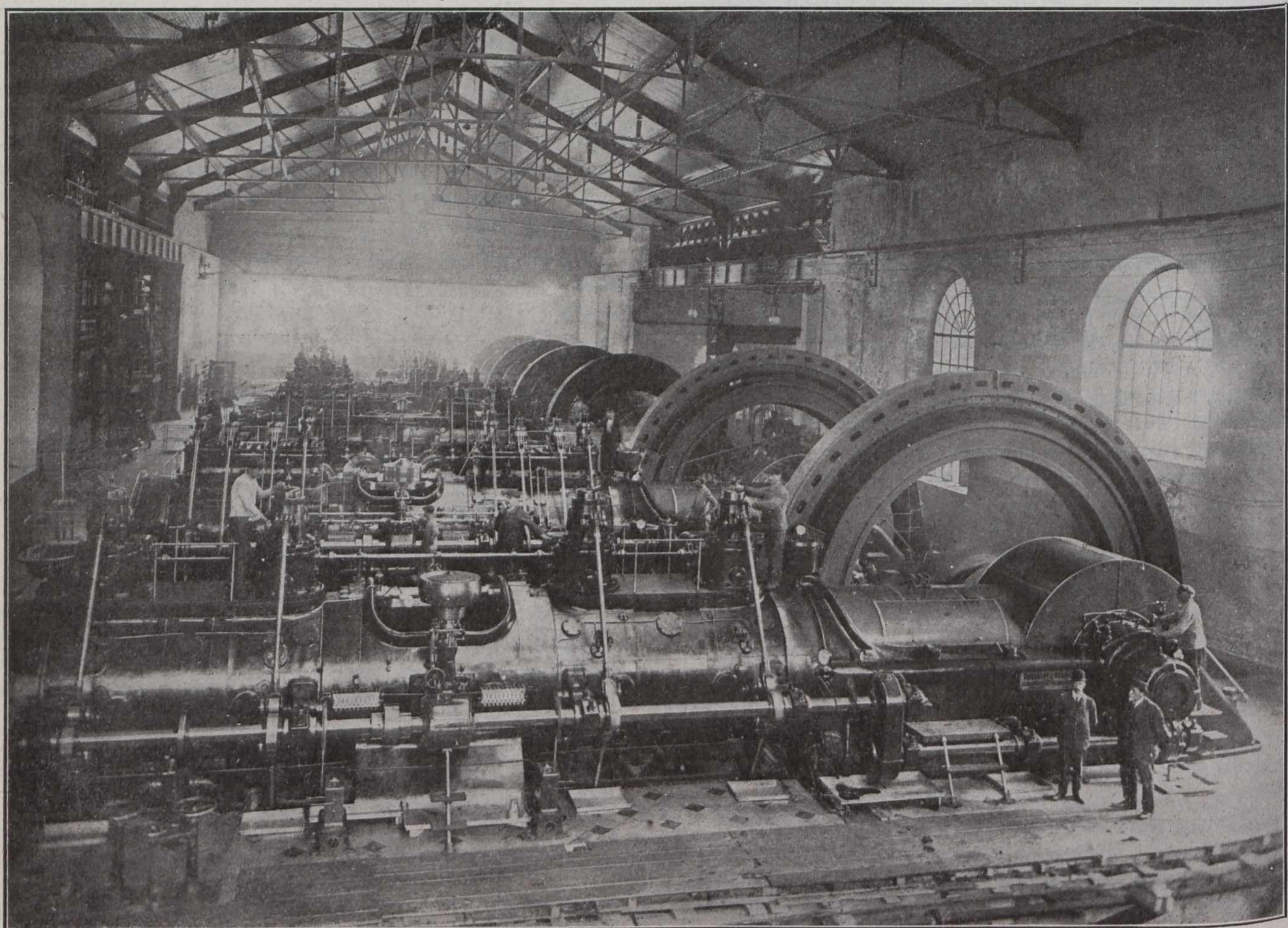

Fig. 2.—Central Station of Steel Plant.

The gas engines for this special application are built up to 2,000 horse-power, with two cylinders tandem, two and four tact and up to 4,000 horse-power with four cylinders tandem.

It is not intended to give here a complete description of the engines; however, some details of the distribution to the cylinders are shown which will be found interesting.

A sliding valve opens on one side the admission of air, and on the other side the admission of gas, so that gas and air can be mixed in the valve box and then admitted to the cylinders by the admission valve. This valve, as well as the exhaust valve, are operated by means of eccentrics mounted on an auxiliary shaft, which is driven by the main shaft. Its speed is half of the speed of the engine, and obtains its movement from the main shaft by means of conical gears.

The regulator is provided with an adjustment to vary automatically the speed within the limits required.

The regulator changes the composition, i.e., the gas admitted and the compression is reduced at the same time with the load, although the gas is perfectly inflammable, even for the smallest admission at no load. The valves are cooled by water circulation. The ignition can be produced either by a normal circuit at 60-100-220 volts with magnetic breakers or by a "Bosch" magneto with mechanical breakers, placed in duplicate on both sides of the cylinders in order to obtain a complete ignition. The anticipated ignition can be regulated during running.

For starting large engines, the compressed air has given the most satisfactory results. It is used at a pressure of 140 to 230 lbs. per square inch. As soon as the engine starts to run and the first explosion is obtained, the admission of compressed air is automatically suppressed on the corresponding side.

Fig. 2 shows a central station installed recently in a large steel plant by the "Société Alsacienne." The gas motors are fed with blast furnace gas and directly connected to alternating current generators. Frequently the alternators to be driven by gas engines have been built with the stator inside and the rotor outside, in order to increase the flywheel effect.

FEBRUARY PRECIPITATION.

An excess of precipitation occurred during February in Central and Southern British Columbia, Southern Alberta, Eastern Saskatchewan, Western Manitoba, Upper Ontario and the Georgian Bay region, and eastern districts of the Maritime Provinces, elsewhere the average value was not reached. The negative departures were quite marked, particularly in Vancouver Island, B.C., and the lower lake region of Ontario, where the fall was, as a rule, less than half the usual amount.

On the last day of the month the ground was snow covered throughout Canada, except on the British Columbian coast, and the depth was considerably greater than at the close of January. In the interior and north of British Columbia more than five feet of snow was on the ground. A slight covering in the neighborhood of Swift Current increased to a depth of twenty-five inches over Northern Manitoba, and to five and eight in Northern Alberta. The Highlands of Ontario, together with northern districts, were covered by over thirty inches, this being also the case in Eastern Quebec and Cape Breton Island. Good sleighing prevailed in nearly all districts during the greater part of the month.

The following table, included in the report of the Meteorological Office, Toronto, shows the total precipitation of fourteen stations for February, 1913:—

	Depth in inches	Departure from the average of 20 years
Calgary, Alta.	....	....
Edmonton, Alta.	0.60	—0.14
Swift Current, Sask.	0.30	—0.35
Winnipeg, Man.	0.60	—0.09
Port Stanley, Ont.	1.70	—1.28
Toronto, Ont.,	1.17	—1.15
Ottawa, Ont.	2.20	—0.30
Kingston, Ont.	1.50	—0.59
Montreal, Que.	2.80	—0.43
Quebec, Que.	2.90	—0.16
Chatham, N.B.	2.30	—0.49
Halifax, N.S.	3.30	—1.22
Victoria, B.C.	1.90	—1.67
Kamloops, B.C.	1.00	+0.19

WATERWORKS INEFFICIENCY.

Conservation, published by the Commission of Conservation, Ottawa, has written interestingly in regard to waterworks figures which the commission has gathered in Canada. It is as follows:—

Ninety-five and a half million dollars are invested in waterworks systems in Canadian towns and cities. The annual outlay for maintenance, exclusive of interest, amounts to $3,435,199. There are, in all, 5,215 miles of mains in use, and the total daily consumption of water passing through these, reaches 360,477,638 Imperial gallons.

These are the figures obtained by an investigation just completed by the Commission of Conservation, the results of which are being published as a report on the waterworks of Canada. They indicate something of the magnitude of the investments that are placed in Canadian public service utilities. By far the larger number of these plants are owned by the municipalities themselves, but there are a few of the smaller ones that are owned and operated by private individuals or corporations.

A Glimpse at the Details.—An examination of the details going to make up these totals present some interesting conditions. Thus, the estimated cost of supplying water varies from seven cents per 1,000 gallons for the municipalities of Nova Scotia, to 23 cents per 1,000 gallons for those of Saskatchewan, with costs in the other provinces ranging between these extremes.

In Saskatchewan, where the cost of delivery is higher than in any of the other provinces, the amount of water used is much less. In the city of Moose Jaw, for example, the daily consumption rate is only 15 gallons per head of population. All the water is metered and no flat rates are levied. The meter rates range from 10 cents to 25 cents per 100 cu. ft., somewhat below the average for the province. In the matter of meter rates, however, there is an exceedingly wide variation in Saskatchewan. In one small town these rates range from 25 cents to 75 cents per 100 cu. ft.

Waste of Water.—In eastern Canada the consumption rate is more uniform, but there are indications of considerable waste in many cities. Last year an Ontario city employed experts to ascertain the causes of waste. They found some serious leaks in mains, as well as wastage by individual users. The expert engineer, in his report, states that:—

"Water is pumped at the present time at the rate of about 190 Imperial gallons per capita daily. At least three-fourths of this water is wasted without benefit to any one. Some of this wasted water no doubt escapes from leaks in the pipe system, but probably most of it escapes from leaky plumbing fixtures in the houses and shops of the city."

One hundred and ninety gallons of water weigh nearly one ton, so that this city is each and every day in the year, pumping four and a half tons of water for each family of five persons. The average consumer may truthfully say that he is not using that amount of water, but he is paying for that amount and, if of the well-to-do class, prabably for more than that amount.

And it is not unique in this respect. There are very few cities on the North American continent in which enormous water waste cannot be found, and this despite the well-known fact that it is only necessary to install meters to put a stop to it. The Canadian who is really patriotic can not do better than consider carefully this question, particularly as far as it affects his own municipality. It is axiomatic to a waterworks expert that fifty gallons of water per head of population is ample and that—unless water is used for irrigation or similar purposes—all that is pumped over and above that amount is wasted.

CITY WATER WASTE.

There is, as has been often mentioned in this journal, a considerable waste of water in some of our Canadian cities. A report to the council of the city of Ottawa on this subject by a special committee appointed to examine into it, probably partially applies to the state of affairs in many other cities and towns. In Vol. 21, No. 8, August 24th, 1911, of The Canadian Engineer, we published a table regarding the cost of water supply in a number of Canadian municipalities of comparatively small size. It may possibly interest some readers to look this up in connection with the present article

The report reads:—

At the last Council meeting there was referred to this committee the question of water waste in the supply system throughout the city. In order that the committee may be in a position to immediately take up the consideration of this important question, I have prepared certain information which I beg to place before you along with my recommendations in the matter. I have, of necessity, gone into this question in detail so that the seriousness of the existing conditions may be quite apparent.

Rate of Consumption.—During the past year the amount of water pumped each day averaged 17.7 million Imperial gallons. The highest consumption, amounting to 20.6 million gallons, occurred on Saturday, July 13th, and the lowest consumption, amounting to 15.0 million gallons, occurred on Sunday, October 27th. On Wednesday, February 12th, of this year, the consumption amounted to 19.7 million gallons, and the daily average for the month of January amounted to 18.0 million gallons.

Pumping Capacity.—The present pumping capacity is actually about 30 million gallons per day, made up as follows:

Pump No. 1	3 million
2	3 "
3	3 "
4	5 "
5 and 6	8 "
6 and 7	8 "
Total	30 gallons per day

Of this amount 16 million gallons is accounted for by the two units, five and six, and seven and eight, most recently installed. The water wheels to operate these four pumps are in one wheel case so that when an accident occurs, as in October last, to any part of these water wheels fully one-half of the available pumping capacity is thrown out of business. This leaves the city with 14 million gallons available for its use, whereas last year the consumption averaged 17.7 million gallons per day, and as stated previously, reached as high as 20.6 million gallons on Saturday, July 13th last. Furthermore, at certain periods of the day, notably between 9 a.m. and noon, the rate of pumping would rise as high as 23 million gallons per day. Even with one of the large units being out of business, the capacity would be reduced to 22 million gallons per day. Any break-down occurring to any one of the old pumps would not materially affect the output as they are in smaller units and operate independent of each other.

It will plainly be seen that additional pumping capacity is urgently required unless an immediate and vigorous policy of waste prevention is pursued.

Consumption per Capita.—The rate per capita during 1912 was 185 gallons per day. The highest it ever reached during any year was 192 gallons per day during 1907. On February 12th last, however, the consumption amounted to 206 gallons per capita, while on Sunday, the 9th of February, it amounted to 194 gallons.

The pumping station records show that from midnight to 3 a.m. the amount of water pumped is about 85 per cent. of the average rate of pumping for the 24 hours. In other words, while the average daily consumption during 1912 was 17.7 million gallons, the rate of pumping during the night amounted to 15 million gallons per day. A very small portion of the water pumped at night represents legitimate use, nearly all being waste, and this waste so shown can be safely assumed to go on to a large extent throughout the 24 hours. If no such waste existed, then the night rate of pumping would be a small fraction of the average rate of pumping, certainly not more than 10 per cent. as against 80 to 90 per cent. as at present.

Let us consider the rate of pumping for February 12th last. The total quantity pumped that day was 19.7 million gallons, or a per capita rate of 206 gallons daily. From midnight to 3 a.m., the rate of pumping was 87 per cent. of the daily average. In other words, the quantity pumped per capita during the whole 24 hours was 206 gallons, the rate of pumping from midnight to 3 a.m. was 179 gallons per day. The figures for last Sunday, the 16th, are as follows:—

Total quantity pumped	18.3 million gals.
Quantity per capita per 24 hrs.	191 gals.
Rate from midnight to 3 a.m.	173 "

or the night rate was 90 per cent. of the average daily rate.

It is rather striking to observe that the consumption per capita per day increased from 101 gallons in 1889 to 168 gallons in 1893, an increase of 67 gallons per capita per day in four years time. I have so far been unable to find any satisfactory reason for this sudden increase.

At least 75 per cent. of this daily average is wasted without benefit to anyone. Both Sir Alexander Binnie and Mr. Allen Hazen state that 75 per cent. is wasted, and for this statement Mr. Hazen gives the following reason:—

A. There are no great manufacturing uses of water; manufacturing establishments are mainly located upon the river and obtain their water from it for manufacturing purposes and do not draw from the city works.

B. The experience of other cities which probably need to use, and do use, as much water as is used in Ottawa where systematic study has been made of the waste of water and intelligent efforts have been made to cut off such waste as far as possible, indicate that the amount actually used is not more than one-fourth as great as the amount pumped in Ottawa.

C. The night rate of pumping indicates this. Most of the actual use of water is in the day time. There is no reason why any large quantity of water should be used during midnight and 3 a.m.

From these statements, not more than 50 gallons per capita daily should be actually necessary.

Effect of Waste of Water upon the System.—The effect of allowing this enormous quantity of water to waste is that the whole waterworks system must be built larger than would otherwise be necessary. The distribution mains must be larger and the pumps must be of greater capacity. If the water is purified, the purification plant must be made larger in size and if the supply comes from a distance, such as is proposed by bringing the water from the Gatineau Hills, large additional storage must be provided for besides the enormous cost of laying main supply pipes so much larger in diameter.

No amount of reasoning can justify the necessity of this useless waste. No one derives the slightest benefit from it, not even the oft repeated statement that it serves to flush out the sewers, because it is discharged at a steady rate, and for flushing purposes is of little value. For the benefit of all concerned it is absolutely essential that this waste should be reduced as far as possible within reasonable limits without incurring any greater expense in detecting and rectifying the waste than would be represented by the waste itself.

Waste Detection in the Past.—Until last year, practically no means were taken to to detect waste. Last summer the Pitometer Survey was carried out to detect leaks in the distribution mains, but barely one-half of the city area was covered. Leaks amounting to 4.4 million gallons per day were discovered, but this does not mean that the daily pumpage was reduced by that amount, as some of it disappeared in other leaks where the pressure was largely increased, due to the stopping of these leaks already found by the survey.

Meters.—Ottawa is practically an unmetered city as the following table will show:—

The wilful class of waste, as far as my observations go, is extremely great throughout the city. By wilful waste I mean everything that can come under the term "of knowingly letting water run without anyone deriving any benefit from it."

During the first half of this month, as stated previously, the night flow averaged 85 to 91 per cent. of the daily flow. When one considers the day pressure is 90 lbs. at the pumping station, as against 80 lbs. at night, then the night flow would still be greater if the pressures were the same throughout the 24 hours. On Sundays the pumpage is only 5 per cent. less than on week days. Large quantities are wasted daily by the continued running of taps to keep them from freezing. This can be easily observed from the daily quantity pumped, as on very cold days the consumption jumps away up; for example, on February 15th, the minimum temperature was 4 degrees above zero and the consumption per

City	Year	Population	Consumption in million gallons Max.	Min.	Aver.	Gallons per capita	No. of Services	No. of Meters	Per Cent. metered	Per Cent. of consumpt. metered
Ottawa	1912	95,575	20.6	15.0	17.7	185	22,278	41	0.2	3.9
Springfield	1911	90,527	12.4	5.5	8.8	96	12,985	8,414	65	48
Lawrence	1909	81,000	....	....	3.0	44	7,416	6,633	90	59
Hamilton	1911	82,095	....	....	8.03	98	.....	....	..	....
St. John, N.B.	1911	46,016	....	....	11.5	250	6,457	193	3.2	14.5
Louisville	1910	201,600	....	....	18.4	92	35,159	2,847	8.1	33
Vancouver	1911	112,240	....	....	18.0	160	24,861	1,638	15	....

From the report made by the Pitometer Survey firm, published on page 1037 of the 1912 council minutes, you will observe that most of the leaks occur in the services and distribution mains, but that the house fixtures are not so bad as they are generally found in other cities. The following table will show what can be done in the way of waste prevention combined with metering:—

City.	Year.	Per cent. of meters.	Per capita daily consumtion gals.	Reduction per capita per day, gals.
Cleveland, O.,	1900	6	169	70
	1908	92	99	
Grand Rapids	1899	6	174	39
	1908	34	135	
Richmond, Va.	1890	1	168	55
	1907	53	113	
Milwaukee, Wis.	1891	40	112	32
	1903	90	80	
New Bedford, Mass.	1899	12	107	23
	1908	32	84	
Hartford, Conn.	1900	6	85	26
	1907	98	59	
Minneapolis, Minn.	1899	22	94	36
	1908	75	58	
Lowell, Mass.	1893	28	83	25
	1907	73	58	

How is the Water Wasted?—Water waste is divided into two heads:

a. Unknown.
b. Wilful.

In the first class we have all the leaks in the distribution mains and house services. These are known to exist, but are not visible until further examination has been made. Services that have been abandoned are generally a prolific source of waste, especially as they generally get frozen and in the spring of the year burst and continue running to waste unnoticed in many cases because of the seamy, rocky nature of the ground through which a large proportion of the services in this city is laid.

capita was 190 gallons, while on February 12th, the minimum temperature was 10 degrees below zero and the consumption per capita was 206 gallons. A few examples of wilful waste may prove interesting.

A building in the city has an electric booster pump in the basement. This pump is kept running for eight hours each day, pumping water into a tank on the roof. This tank is provided with an overflow which is nearly always running to waste.

In an engineering work the water is kept running night and day in connection with a hydraulic air compressor, simply, as they tell you, to keep the pipes from freezing.

Suppression of Waste.—There are two methods which may be used for the suppression of waste:

(a) The examination of the entire distribution system, including all mains, services and internal plumbing fixtures. This can be done by certain methods which have only been developed within the last two years. Much of this waste can be located and eliminated by the use of the Pitometer, the aquaphone, etc.

(b) The introduction generally of the meter system. The wilful waste of water is very largely due to the lack of a meter system. Not only would the services be kept from running when not in use, but any defective plumbing would be immediately repaired. Again, a supply of water should be placed on a strict business footing, and so do away with such absurd cases as the following, quoted from the Pitometer Survey report:—

"The gas works on King Edward Avenue were using a large quantity of water, so a separate gauging was made for two days, and they were found to have a mean consumption of 125,000 gallons per day. At present they pay a flat rate of $245 per year, but this quantity of water at the minimum meter rate of 6 cents per 1,000 gallons would produce a revenue of $2,737.50."

The St. Lawrence Pulp and Paper Mill, on Montreal Street, was found to be using a large quantity of water. They were tested several times and found to be drawing at rates varying from 100,000 to 175,000 gallons per day.

They run both day and night and as they only pay a flat rate of $27 per year there is evidently a big loss of revenue here.

J. B. Booth & Company pay a flat rate of $1,636.86. We made a prolonged test of this plant and found that one of their services, if metered, would produce more revenue than this. This service had a steady flow of 93,500 gallons per 24 hours, which would produce, at the minimum meter rate of 6 cents per 1,000 gallons, a revenue of $2,047 per year.

Conclusions.—From the foregoing it will be clearly observed that immediate action must be taken to either increase the pumping capacity (and incidentally enlarge the distribution system) or pursue a vigorous policy of waste reduction. Undoubtedly the policy to pursue is that of waste reduction, and this is strengthened by the fact that, as the future supply for this city is likely to come from the Gatineau Hills the installing of additional pumps, which could only be of service for three years at the most, would be an unprofitable investment, and cost a great deal more than is necessary to spend on waste reduction. To be in a reasonably safe position before the warm weather comes in, it is quite apparent that immediate action must be taken.

Recommendations.—I cannot too strongly advise your committee to pursue a policy of waste prevention in preference to that of increasing the pumping capacity and enlarging the distribution mains. I submit the following recommendations for your consideration:—

1. That the city purchase two pitometer instruments and employ the necessary water survey force.

This recommendation is already in force in a large number of American cities, and also in Toronto and Montreal, where excellent work is being done. The city can be divided into districts, and by means of these instruments the flow can be ascertained from time to time, and any excessive flow can be readily observed and means taken to locate any defects which may cause same and have it repaired. These instruments can also be used to determine the pump slippage.

An appropriation amounting to $7,000 has been placed in this year's estimates for this work.

If it is decided to purchase two pitometers, then one of the pitometer survey people should be brought here for about a month to break in an assistant who will be kept on the staff for this purpose.

2. That all business premises be metered. This should include meters on all elevators, syphons, beer pumps, booster pumps, etc. That is, every service outside of an ordinary dwelling house should be metered.

3. That all public services be metered, including all buildings, parks, etc. Also, that a meter should be placed on all government services.

4. That an efficient force be maintained to carry out a thorough inspection of all pumping fixtures on all premises and dwelling houses.

5. That detailed plans be made of all the existing mains throughout the entire city.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.

The annual convention of the American Railway Engineering Association will be held at Chicago, March 18th to 21st. E. W. Fritch, 900 S. Michigan Avenue, Chicago, Ill.

TEST OF WIRE ROPE FASTENINGS.*

By C. W. Hubbell.

A 5/8-in., six-strand plow-steel cable was bent around a thimble and the ends secured to the standing part by a standard 5/8-in. Crosby clip of the U-bolt type, with the nuts drawn as tightly as possible by a 12-in. wrench. The cable slipped under a load of 8,360 lb. In a second test with a new clip tightened with a 24-in. wrench, the cable slipped at a load of 10,020 lb., and after the nuts were again tightened, slipped at 12,380 lb. In a third test made with two new clips, the nuts were tightened under a load of 6,000 lb. with a 12-in. wrench, and the load was increased to 21,710 lb., which broke the cable where it was in contact with the lower U-bolt. As the rated ultimate strength of the cable was 36,000 lb., it was thought to have been weakened by the distortion under the U-bolt, which was set in contact with the standing part, while the head took bearing on the free end. It was assumed that in practice the head of the clip should always be placed on the standing part of the cable and the U-bolt on the free end.

A 95-lb. cast-iron clamp, 33½ in. long, made in two pieces, with grooves fluted to receive the cable, and connected by five 1-in. bolts having a theoretical holding power of 19,500 lb., was placed on a 2-in. seven-strand galvanized steel-wire cable. The bolts were drawn as tight as possible by one man with an 18-in. wrench, and the cable slipped under a load of 12,000 lb. The nuts were tightened by one man with a 30-in. wrench, and a slip occurred under a load of 12,500 lb. The nuts were again tightened, and the third slip occurred under a load of 16,500 lb. The clamp was removed and replaced on the cable in a new position, and the nuts tightened by two men with a 30-in. wrench. The cable slipped under a load of 17,800 lb., and in successive tests under 12,700 and 15,000 lb. When tightened with three men on the same wrench, turning each nut from one-eighth to three-eighths of a revolution, the cable slipped at a load of 19,300 lb. In the last test the groove in the clamps had a diameter of two inches, permitting the cable to rest on the bottom of the groove.

A lighter clamp of different design had a groove 1¾ in. in diameter, designed to develop a wedge action increasing the bolt pressure when the clamps were forced together and the cable distorted enough to bear on the bottom of the groove. The clamp was 12 in. long, weighed 47 lb., was provided with five ¾-in. bolts and had a theoretical ultimate strength of 22,650 lb. for each half. The bolts were fastened by one man with a 24-in. wrench and no slip was apparent under a 10,000-lb. load. The nuts were tightened and the load increased to 20,900 lb. without apparent slip. The clamp was removed and found practically uninjured.

It was concluded that, first, where more than one clamp is necessary they should be placed as close together as possible, in order that the necessary adjustment of cables to bring them all into action shall be as light as possible; second, the clamp bolts should be tightened from time to time as the load is applied; third, the safe holding power of a cable clamp may be taken at about 3,750 lb. per sq. in. or area of the bolts which secure the two halves of the clamp.

*Abstract of address presented to to Philippine Society of Civil Engineers.

COAST TO COAST.

Ottawa, Ont.—Canada's mineral production last year was valued at $133,127,489, an increase of $29,906,495, the highest on record, or twenty-nine per cent. greater than the previous year. There was an increased output in the value of every mineral and in the quantity of all but silver, which decreased two per cent. Ontario still leads with a total production of $51,023,134.

Edmonton, Alta.—Seven hundred and thirty-one new companies, with a capitalization of $91,351,883 were incorporated in Alberta last year, as compared with 573, with a capitalization of $72,455,100 during 1911. Since the incorporation of the province there have been 2,300 companies incorporated in the province, with an aggregate capital stock of $267,304,508.

Ottawa, Ont.—An agreement has been reached between the Algoma Steel Company and the government in regard to the duty rebate made to the Algoma Steel Company on 75,000 tons of rails imported into Canada last summer. The capital were allowed a refund of half duty on 50,000 tons for the G.T.R. and 25,000 tons for the C.P.R. Hon. Frank Cochrane pointed out that two big railways have 500 miles graded and ready for rails which they cannot get, and which the company say they cannot supply at such short notice.

Fredericton, N.B.—A demand in the form of a petition signed by 5,000 people in all parts of the province of New Brunswick, asking for better roads, has been presented to the government by the Good Roads Association. The premier said that, while he did not agree with the idea of building the trunk roads outlined in the Good Roads Association programme, it was the aim of the government to expend $100,000 a year on fixing the "bad spots." He also suggested that a highway engineer be appointed to make specifications for the repair and improvement of these bad spots, so that in a few years the condition of the highways throughout the province would be improved.

Edmonton, Alta.—Landscape Architect Morell has designed a civic centre for Edmonton. Property owners of this land proposed by Architect Morell in his scheme have agreed to sell it to the city at a cost of $2,567,000, to be paid in forty-year debentures bearing five per cent. interest. The commissioners, in reporting on the matter, declared that in their opinion this was the logical location for a civic centre, but that the time is not opportune for the city to invest two and a half millions in a project of this kind. They therefore recommended that the promoters of the scheme take the matter up again at a later date, and submit more reasonable prices.

PERSONAL.

SIR JOHN JACKSON, the well-known engineer and contractor, of London, is making a tour of Canada.

J. H. LYONS, who was for some time employed at the filtration plant at Toronto Island, has accepted a position with the National Paving Company, Regina. He will assume his new duties at once.

J. W. TURNER, former superintendent of waterworks of the city of Strathcona, has, since the amalgamation of Edmonton and Strathcona, been appointed superintendent of waterworks for the Amalgamated cities.

MASON H. BAKER, B.A.Sc., D.L.S., A.M.Can.Soc. C.E., graduate of the Faculty of Applied Science, Toronto University, in 1906, has resigned his position as city engineer of St. Thomas to accept a similar position in Prince Albert, Sask.

MR. R. H. MERRIMAN has resigned his position with the B. Greening Wire Company as regards active connection with the firm. Mr. Merriman, it is understood, has decided to go into the agency business. He still retains his financial interest with the company.

PHILIP J. DUFF, A.M.Can.Soc.C.E., had joined the staff of George F. Hardy, consulting engineer, 309 Broadway, New York. Mr. Duff has recently completed the work on the construction of a new thirty-ton sulphate pulp mill for the Dryden Timber and Power Company, Limited, of Dryden, Ont.

MR. J. S. DOBIE, B.A.Sc., graduate in civil engineering of Toronto University in 1895, was elected president of the Ontario Land Surveyors' Association at their annual convention held recently. Mr. J. W. Fitzgerald, of Peterborough, was elected vice-president and Mr. L. V. Rorke re-elected secretary-treasurer.

MR. WILLIAM H. CONNELL, Assoc.M.Am.Soc.C.E., Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa., on March 4th delivered an illustrated lecture on "Organization of Municipal Highway Departments," before the graduate students in Highway Engineering at Columbia University.

MR. A. A. KINGHORN, B.A.Sc., of the University of Toronto, who has been for seven years in the Works Department of Toronto, and is at present superintendent of the construction of roadways, will sever his connection with this department on March 22, to take a position as manager of the Asphaltic Concrete Company of Toronto, Limited.

H. VICTOR BRAYLEY, who for some time past has been connected with the Transcontinental Railway at Ottawa, has accepted the position of general manager for Gunn, Richards & Company, New York and Boston, whose business is that of efficiency engineers. Mr. Brayley has opened a temporary office in Ottawa for two or three months before moving the Canadian head office to Montreal. Mr. Brayley has been secretary of the Ottawa branch of the Canadian Society of Civil Engineers for three years.

SASKATCHEWAN LAND SURVEYORS.

The annual meeting of the Saskatchewan Land Surveyors was held recently at Regina. The feature of the meeting was a paper on "The Selection of Bridge Sites," by A. P. Linton, B.A., B.Sc., assistant chief engineer of the Department of Public Works. Another excellent paper, but one of a more technical nature, was read by E. H. Phillips, D.L.S. and S.L.S., district surveyor and engineer. Cyrus Carroll, one of the oldest surveyors in the province, was made a life member of the association.

CANADIAN MINING INSTITUTE.

The 15th annual meeting of the Canadian Mining Institute was held at Ottawa recently, about 250 delegates from every part of Canada being in attendance.

The meeting was opened by H.R.H. the Duke of Connaught, who referred to the vast importance of the mining industry in the Dominion, which was, he felt sure, merely on the threshold of future possibilities.

Dr. E. A. Barton was elected president, Mr. Thos. Coutley 1st vice-president and Mr. G. G. S. Lindsay 2nd vice-president.

THE IRON AND STEEL INSTITUTE.

The Iron and Steel Institute, London, will hold its annual meeting at the Institution of Mechanical Engineers, Westminster, on May 1 and 2. At this meeting the Bessemer gold medal will be awarded to Adolphe Greiner, general director of the Societé Cockerill, Seraing, vice-president of the institute. The annual dinner will be held at the Hotel Cecil on May 1.

THE AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.

The fourth annual meeting of this society was held in the United Engineering Societies Building, New York City. The following officers were elected: President, Mr. H. J. Cole; 1st vice-president, Mr. E. Wigmann; 2nd vice-president, Mr. Geo. T. Clark.

The evening session was held at 8 o'clock and was opened with an address by the incoming president, Mr. Howard J. Cole, of Montclair, N.J. Mr. Edward F. Croker, ex-chief of the New York Fire Department and president of the Croker National Fire Prevention Engineering Company of New York City, delivered an illustrated lecture on "Fire, Its Effects and Its Prevention."

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

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

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

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

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James: Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

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

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

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

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

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

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

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

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

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

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

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

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

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

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

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

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

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

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

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

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

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

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

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

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