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The Canadian Engineer

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LAYING TORONTO'S SECOND INTAKE PIPE

PLACING 2400 FEET OF 6-FOOT PIPE ON THE BED OF LAKE ONTARIO, AND CONCRETING IT INTO PLACE—CONTRACTOR'S PLANT REQUIRED—SPEED OF CONSTRUCTION

IN June, 1911, the City of Toronto called for tenders for the laying of a 6-foot riveted steel pipe from the filtration plant, situated on Toronto Island, to a point in Lake Ontario, about 2,400 feet from the Island shore. Early in August of that year, the contract was awarded to Messrs. Roger Miller & Sons, Limited, Toronto. It was in the nature of a lump sum contract, varying from the original specifications to the extent of the substitution of steel for 6 by 8-inch wooden piling throughout.

General Progress of the Work.—During the autumn months of 1911, work was begun, the operations centering chiefly upon the excavation necessary at Toronto Island, beginning at the north end adjacent to the new pumping station, and extending toward the south shore of the Island. The excavation was first made to a depth of 15 feet below lake level, and was about 85 feet in width at the water line. Fig. 1, looking south toward the lake, shows the greater part of this Island excavation. The work entailed the removal of some 20,000 yards of excavation, principally sand.

This portion of the pipe line was designed to include a tank near the shore to serve as a manhole for pipe inspection. It measures 11 feet by 8 feet 6 inches, with a depth of 24 feet. The placing of this tank in its proper position was greatly facilitated by the use of coffer-dams, which were in progress simultaneously with the Island excavation, so that by the time the latter was finished the tank was in place, and pipe-laying was in no way delayed.

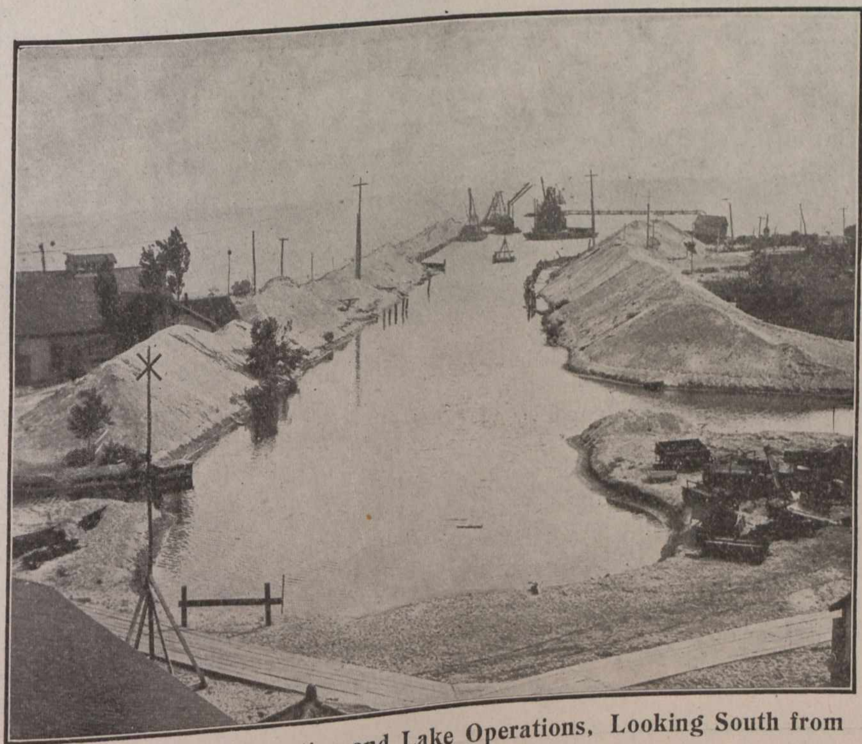


Fig. 1.—Island Excavation and Lake Operations, Looking South from Filtration Plant.

One length of pipe was put in by December, 1911, and connected up with the tank. The water was particularly low at the time, the top of the pipe being only 4 feet below water level. Pipe-laying operations were, therefore, necessarily discontinued as extreme weather set in.

With the opening of spring, the contractor's plant had been put in shape, and work began with the season. Owing to a revision of the plans by the city, necessitating the lowering of the pipe line through the Island to the same level as that extending from the tank outward into the lake, after three lengths of pipe were laid work was discontinued. The pipes and tank were taken out, and the excavation was extended to a further depth of 6 feet, bringing it to an average of 21 feet below the water line. The removed portions of the line were then re-set and connections made with the filtration plant, as shown in Fig. 2.

Remarkable progress was made with the work during the summer months of 1912, despite a good deal of adverse lake weather. The entire line was laid, steel piles driven, crib placed, and the whole length concreted out into the lake as far as indicated in Fig. 3. The pipe line was ready for use by the end of January, 1913, and the job was completed with the exception of a small amount of back fill, which was placed in a short time in the early spring.

Description of Contractor's Plant.—During the winter months of 1911-12, the contractors built the required plant for carrying out the work in the lake. To cope with the numerous exigencies attending work of this nature, particular attention was devoted to the design and construction of mechanical details, and as a result, the greater part of the plant was built and assembled especially for the work. The advisability of the extreme care taken in this procedure was evidenced later in the successful continuity of operations, and the entire absence of delays due to lack of equipment, materials, etc.

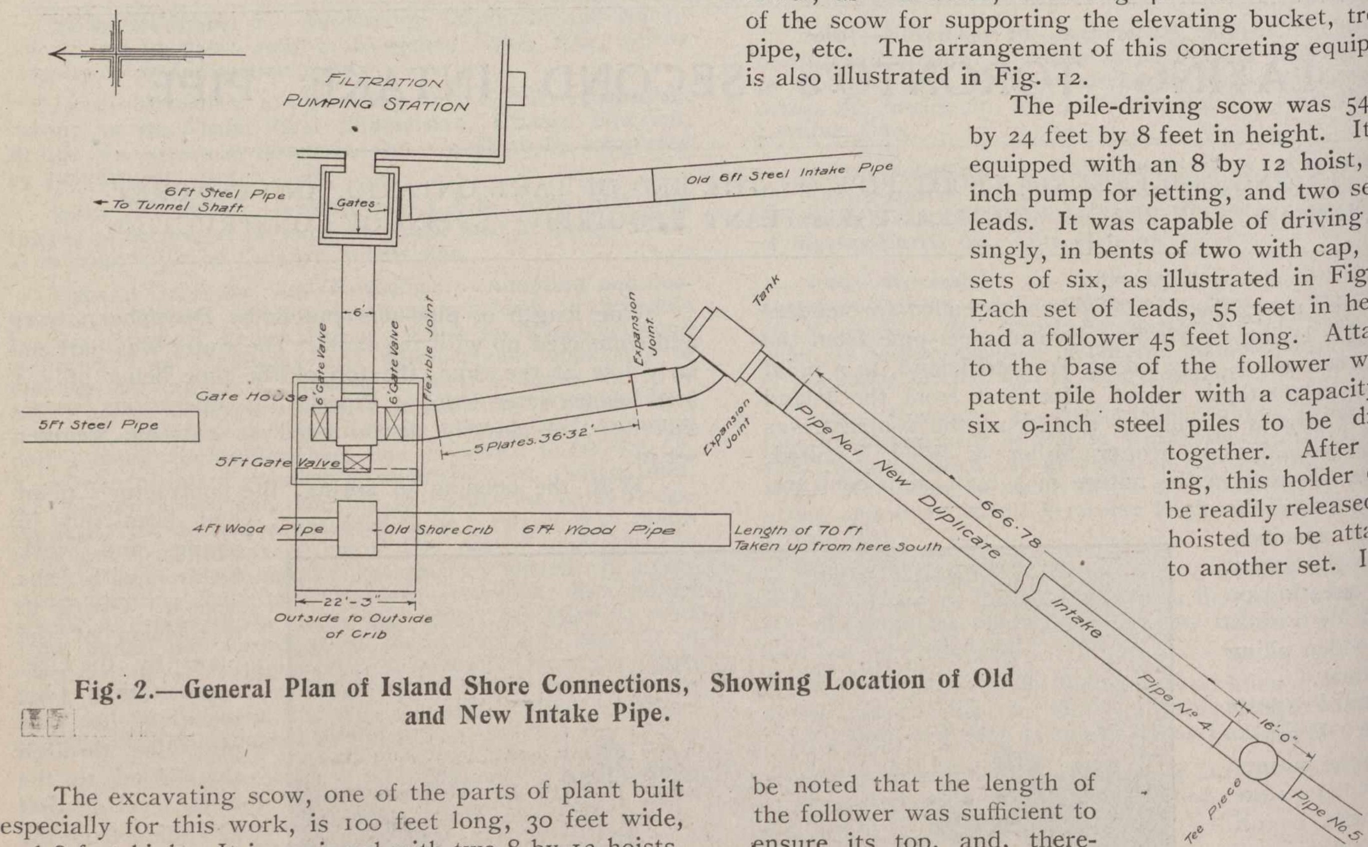


Fig. 2.—General Plan of Island Shore Connections, Showing Location of Old and New Intake Pipe.

This scow, shown in Fig. 4, was also equipped with four sets of specially designed and patented thribble blocks and four powerful winches, used for manipulating the pipe sections.

The concreting scow, whose dimensions were 100 feet by 28 feet by 8 feet, is shown at work in Fig. 5. It was furnished with a derrick, an 8 by 12 hoist, a 1-yard clam, a 1-yard mixer, bins for sand and broken stone, and a tower, as illustrated, extending 40 feet above the floor of the scow for supporting the elevating bucket, tremie-pipe, etc. The arrangement of this concreting equipment is also illustrated in Fig. 12.

The pile-driving scow was 54 feet by 24 feet by 8 feet in height. It was equipped with an 8 by 12 hoist, a 6-inch pump for jetting, and two sets of leads. It was capable of driving piles singly, in bents of two with cap, or in sets of six, as illustrated in Fig. 10. Each set of leads, 55 feet in height, had a follower 45 feet long. Attached to the base of the follower was a patent pile holder with a capacity for six 9-inch steel piles to be driven together. After driving, this holder could be readily released and hoisted to be attached to another set. It will be noted that the length of the follower was sufficient to ensure its top, and, therefore the driving hammer being always above water.

The excavating scow, one of the parts of plant built especially for this work, is 100 feet long, 30 feet wide, and 8 feet high. It is equipped with two 8 by 12 hoists, operating two 1¼-yard clamshell buckets. One distinguishing feature is the installation of two 6 by 8 independent swinging engines. The booms used were 65 feet in length, and either derrick had a working capacity of 20 tons.

Another scow, used principally for deep water work, especially in connection with the placing of the crib at the end of the pipe line, and for the towing and placing of pipe sections, was also 100 feet by 30 feet by 8 feet. It was equipped with a steel derrick of 25 tons capacity, a 65-foot boom, a 9 by 12 hoist, and an 8 by 8 independent swinging engine. It had a clam of 1½ yards capacity.

The air scow was 30 feet by 18 feet by 5 feet. It was equipped with a hand derrick, jetting pump, and a 6-inch centrifugal pump directly connected to two separate engines. This pump served to remove the sand from in and around joints of the pipe sections when they were being connected up, the diver employing the suction pipe for this purpose whenever necessary in making his connections.

One important feature of these five scows was that each was equipped with an air compressor by means of which the divers were furnished with air.

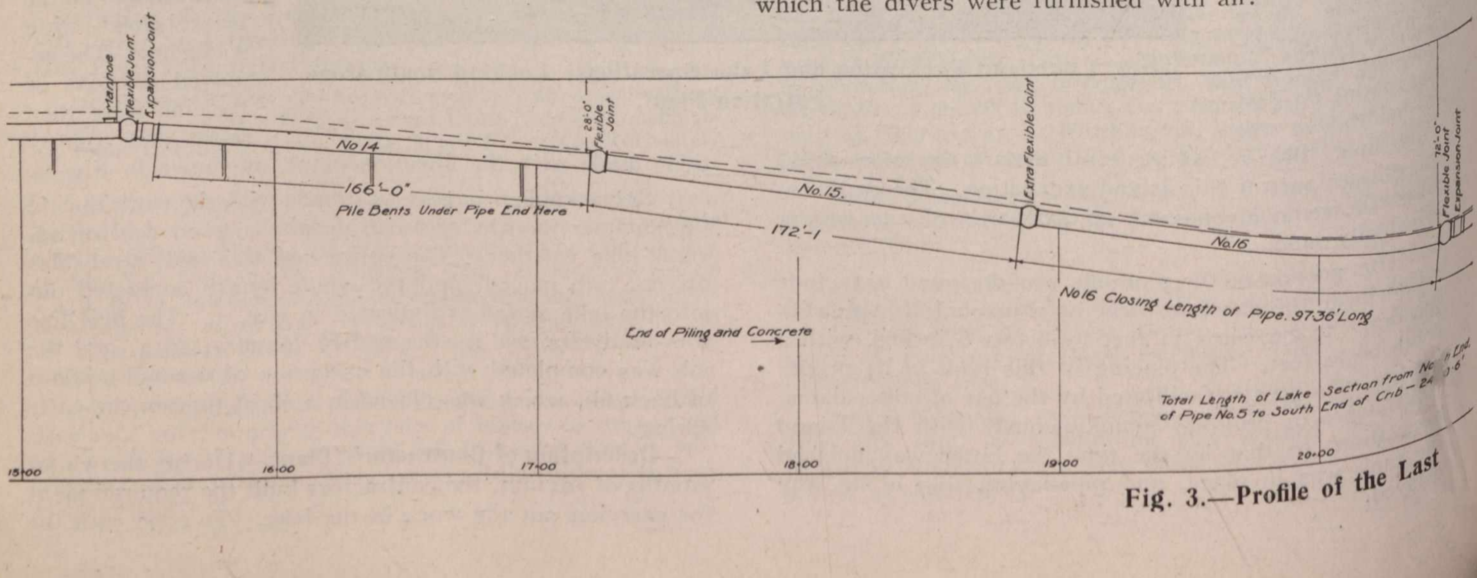


Fig. 3.—Profile of the Last

There were, in addition, several deck scows 70 feet by 24 feet by 6 feet for carrying materials such as piles, broken stone, etc. The sand required for concreting was taken directly from the bed of the lake.

Pipe Line.—The pipe line points in a southwesterly direction from the Island, as indicated in Fig. 2, which shows clearly the connections of the old and new pipe with the pumping station. The course follows the bed of the lake into about 110 feet of water. The last several sections showing its position as the decline assumes a steep gradient, is indicated in profile in Fig. 3.

The pipes were, as stated, of riveted steel, 6 feet in diameter. They were manufactured by the Canada Foundry Company, Toronto, and delivered to the city at John Street wharf. They were eighteen in number and were 166 feet in length, with the exception of several that were equipped with manholes, and were 168 feet long. Fig. 5 shows one of the sections, together with a tee, several of which were used, one at the crib, and another as shown in Fig. 2.

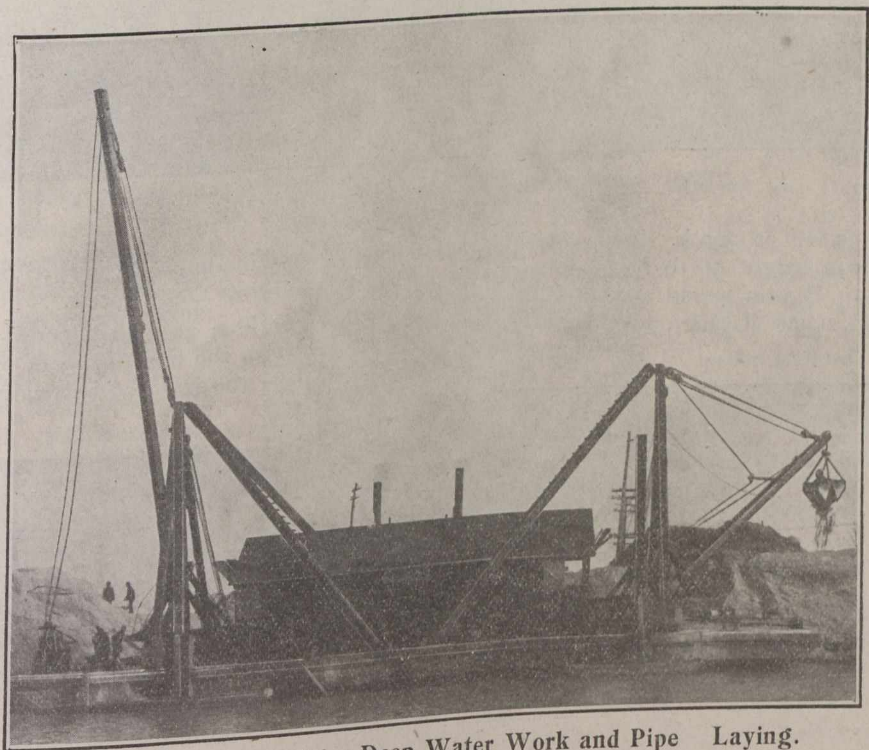
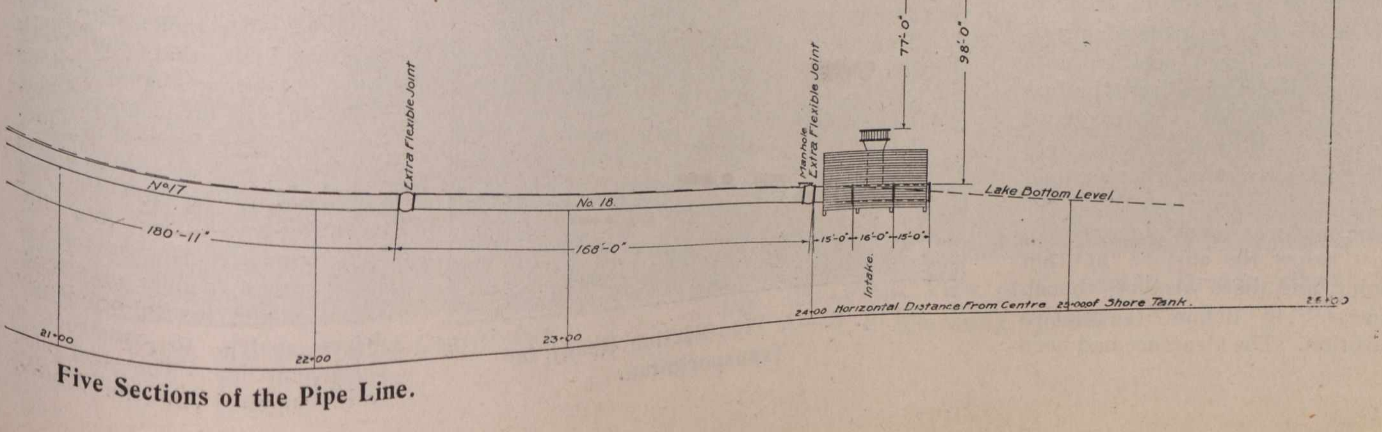


Fig. 4.—Scow Used for Deep Water Work and Pipe Laying.

Before placing the pipes in water, they were equipped with bulkheads at each end, and rolled into the bay. They were then towed into about 12 feet of water, where, after applying two 1¼-inch cables around each end, the bulkheads were removed sufficiently to allow the pipe to be sunk by the entering water. Then, the scow, equipped with the thribble blocks and winches, was floated over it and the pipe lifted into contact with the bottom of the scow. The whole was then towed out into its proper position in the lake, and the pipe lowered into line. Specially designed knuckle joints, facilitated the removal of cables after the pipe had been lined up and a few bolts inserted. The cable arrangement was such as to permit accurate and minute changes in the position of the pipe, so that the divers found no difficulty in fitting the sections together. There were forty-four 1¼-inch bolts in each connection. At each joint, also, there was a wooden gasket of well-seasoned pine, 1 inch in thickness, with joints carefully broken, and put together with copper nails.

A 72-inch flexible joint, made by the Canada Foundry Company, Toronto, was provided in the pipe line at every stage where there was an appreciable change of grade, until the point was reached where the lake bed descended rapidly, as shown in Fig. 3. From this point to the end of the line, a flexible joint was placed at the end of every pipe section. These joints each allowed a movement from the centre line of the previous pipe of 21° 30′. Expansion joints at regular intervals each allowed a play of 18 inches. They were equipped with a 2-inch rubber ring inserted between angles, and held in position by eight or nine bolts around the circumference of the joints. Fig. 7 shows a pipe connection equipped with a flexible joint, and shows an expansion joint also.

Several points of interest arose in connection with the manufacture and delivery of these pipes that might well be mentioned. The shipping of this 72-inch pipe had an important bearing on the manufacture, as it was specified in flanged lengths of 166 and 168 feet, and the shipping of these sections allowed all circumferential joints to be shop riveted. Further, calculations were made to insure the pipe being of ample strength for safe



Five Sections of the Pipe Line.

carrying on two points. Careful measurements were made of the track, siding, curves, etc., and the site of delivery was similarly inspected to insure convenient unloading and storage.

For each shipment four 40-foot heavy capacity flat cars were used, and each length, which weighed approximately 47 tons, was loaded on crandles and swinging bunks. Fig. 8 illustrates the position of a pipe section when ready for transportation.

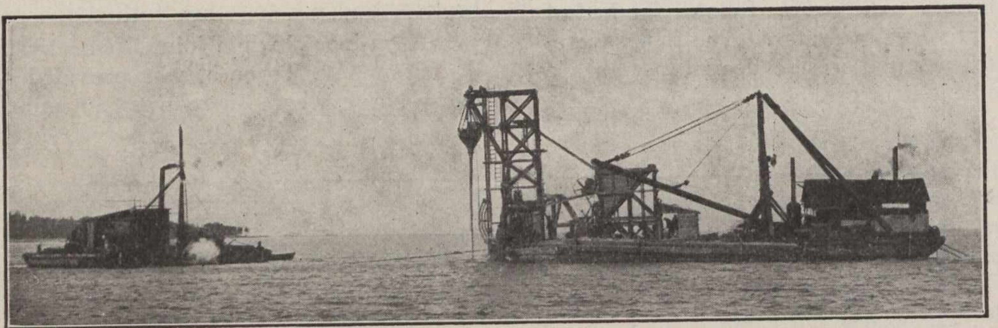


Fig. 5.—General View of Concreting Plant.

The Crib and Intake. — The crib which surrounds the intake is a structure 40 feet square and 25 feet in depth. It was built at the John Street wharf to a height of 10 feet, and completed after launching. It was towed out of the bay through the Western Gap, where it was loaded with about 25 tons of stone, held in suspension by three cables and a steel derrick, and then the whole outfit was towed by three tugs into the lake. Fig. 9 shows the crib on its way to the end of the pipe line.

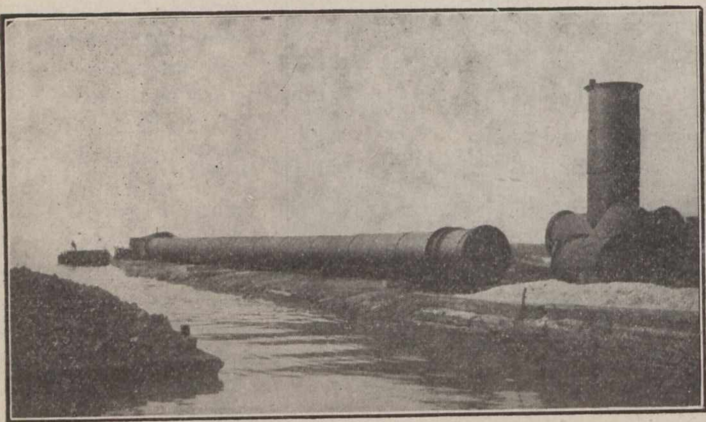


Fig. 6.—A Section of Pipe, With Expansion Joint.

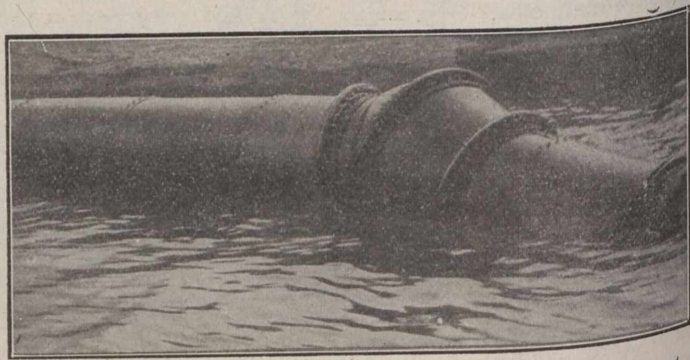


Fig. 7.—A 72-inch Flexible Joint Connected Up, and (at extreme right) An Expansion Joint.

When above its proper location, special precautions were taken to produce uniformity in the operation of lowering and to provide accurate knowledge for those at the surface, of its progress as it was being sunk. This formed one of the portions of the work where greatest care had to be exercised in order to place the crib as nearly as possible to its ideal position with respect to the pipe line, the last section of which was unplaced until the crib was finally seated. The difficulty will be understood when it is remembered that the pipe line was approximately 110 feet below the surface at that point, and there were no "bench marks" to define its relative position. The structure had been divided into sections, as shown in Fig. 10. These were then filled with stone, which was successfully carried out by means of lowering the material in a cage directed by a tow cable to whatever section was being filled. The extremity of the cable was then transferred to another section by the diver. The centre section, surrounding the tee with which the pipe line terminates, was filled with concrete to eliminate all danger of displacement of the intake. This operation, carried on at such a depth, necessitated a tremie pipe of small diameter, owing to the excessive strain upon the upper portion of its length, when discharging the concrete.

The pipe line, as stated, ended in a tee, one flange connecting with the line, its mate provided with a bulkhead, and the third placed vertically and projecting out of the crib to the intake proper, which is flared to it, and is 8 feet in diameter. It is cylindrical in form, standing vertically with closed top, while its sides are formed by a number of steel bars, as illustrated in Fig. 10, which prevent the intrusion of suspended matter of any considerable magnitude. Further, the inner part of the intake is provided with a steel plate, placed vertically to prevent the longitudinal entrance of sticks of wood, etc.

Fig. 8.—A Pipe Section Ready for Transportation.

Piling.—Steel piles were used, it being felt that the work could not be satisfactorily done with the use of wooden piles, the depth of water, and of sand, the length of the line, etc.—conditions indicated that it would be almost impossible without tongue and grooving or some special manner of attaching one pile to its previously driven mates, to construct a permanent line. The steel piles were supplied by the United

States Steel Products Co., and were perhaps the first departure from the customary 6-inch and 12-inch steel piles previously used. They were of 9-inch section, 18 feet in length, and weighed 21.3 pounds per square foot. They were driven in panels of six (as shown in Fig. 11) for a distance of 1,800 feet on either side of the pile line (3,600 linear feet in all) or to such a point where it was deemed that the line was sufficiently low in the water to obviate all necessity of piling and concreting. A steel rod was placed across the top of the piles every 7 feet, it being ⅞-inch in diameter.

Concreting.—The concrete used was a 1:2:4 mix, and was placed with the use of a tremie pipe, the depth of concrete work varying from 20 to 55 feet. About 4,000 yards were used.

In connection with the shore tank, previously mentioned, the concreting of it into position was greatly facilitated by placing the forms before it was lowered into the excavation, and when properly located, it was then easily concreted.

Personnel.—The work was done for the City of Toronto, for whom Mr. R. C. Harris is Commissioner of Works, and Mr. George C. Powell, Deputy City Engineer. Mr. C. W. Allen was resident engineer on the initial part of the work, and was succeeded by Mr. A. U. Sanderson for the remainder. The contractors were, as stated, Roger Miller and Sons, Limited, Toronto, and we are indebted to Mr. A. E. Gibson, member of the firm, for most of the information and illustrations contained in this article.

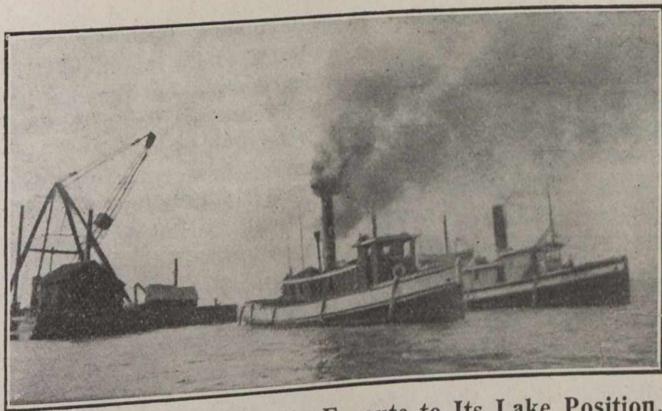


Fig. 9.—The Intake Crib, Enroute to Its Lake Position.

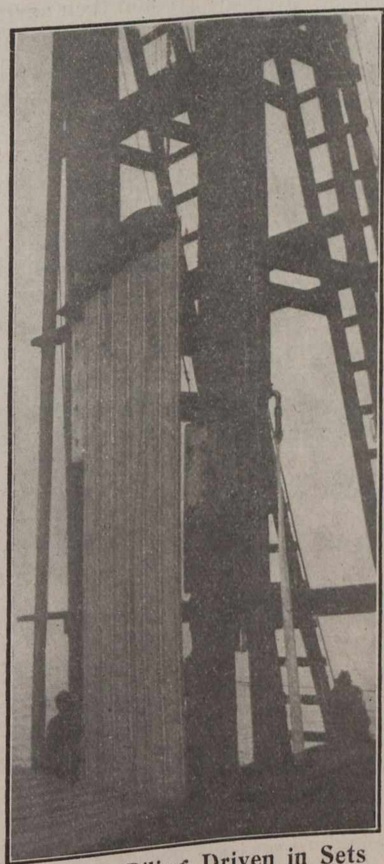


Fig. 11.—Piling Driven in Sets of Six at a Time.

LARGE CONTRACTS FOR WATER POWER PLANTS

In connection with the new enterprises of Dr. F. S. Pearson in Barcelona, Spain, known under the name of The Barcelona Traction Company, the Swiss turbine builders, Escher Wyss & Co., have secured large contracts for the supply of water wheels and pipe lines. Besides an auxiliary plant of 4,000 h.p., four large installations are being equipped by Escher Wyss & Company. Three of these utilize water from the River Ebro. The first installation comprises five units of 16,000 h.p. each under a head of 140 feet, and is nearing completion. For the second and third, the turbines are well under way. These installations comprise in one case four units of 15,000 h.p., under a head of 250 feet, and in the other, four units of 11,500 h.p., under a head of 165 feet.

The same company are supplying the water wheels and pipe lines for a high-pressure plant in the Pyrenees, built by a concern controlled by the Barcelona Traction Co. There are five turbines of 7,000 h.p. capacity each, under a head of 2,800 feet. They have obtained great experience in building plants for high heads, having built the famous Adamello power plant, operating under 3,000 feet head; the plant of the Rio de Janeiro Tramway, Light and Power Co., as well as the "Necaxa" plant of the Mexican Light & Power Co.; both these latter being enterprises of Dr. Pearson, like The Barcelona Traction Co., and developing over 100,000 h.p. each.

Fig. 10.—Illustrating Construction of Intake.

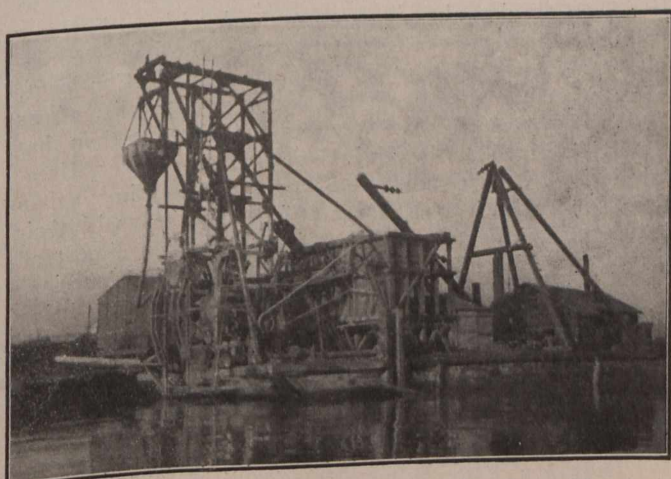


Fig. 12.—Front View of Concreting Dredge, Showing Elevating Apparatus, Etc.

SOME EUROPEAN PAVEMENTS—REPORT.

Mr. E. H. THOMES, Mem. Am. Soc. C.E., assistant engineer, Bureau of Highways, Borough of Queens, New York City, has returned from a tour of inspection of roads and pavements in Europe, and has presented a report containing some good information on paving materials and paving methods in numerous localities. The following is a summary:—

Pavement Studies in Liverpool.—At Liverpool, City Engineer John A. Brodie is conducting measurements of pavement wear under actual traffic. Cast iron sockets are imbedded in independent concrete supports in the sidewalk, and sometimes an additional one in the centre of the street. In these sockets can be placed standards which carry a taut wire device or a stiff wooden straight edge with sliding T square and vernier scale for the accurate measurements of the road surface. Each apparatus is adjustable so that accurate measurements can always be taken under similar conditions.

The oldest example of pitch grouted macadam in Liverpool was laid on Princes Street in 1901 and has been in continuous use ever since without any repairs. It is still in very good condition, with a mosaic surface having a good contour excepting a few slight depressions; in places it has a slight surface flush of tar still showing life. The traffic here amounts to about 120,000 tons per yard width per year. An adjoining water-bound macadam in the same street has cost from 10 cents to 25 cents per square yard per annum for repairs. The following figures show the average depth of wear in inches per annum on Princes Street:—

For water-bound macadam ....0.54 in. per year
For tar treated water-bound macadam..0.35 in. per year
For pitch macadam ....0.15 in. per year

Mr. Brodie showed a very interesting object lesson of the relative wear of the pitchmac on Princes Street and the plain macadam adjoining. A section of each had been removed and the tar washed out and the mineral aggregate separated into sizes. The plain macadam stone was all rounded with a large percentage of fine stuff, showing the wear from the rubbing and grinding effects which extend to a considerable depth in ordinary macadam, especially in wet weather. The stone from the tar macadam showed only a slight wear and rounding on the surface stones, the rest had practically as sharp edges as when laid twelve years ago.

More satisfactory results with tar macadam seem to have been obtained in Liverpool and other places in Great Britain than in most other countries. The improved results here, as well as at a few places on the Continent, seem to be due to some extent to the good quality of tar used, which in some places appears to be better than that usually obtained in the United States. Moreover, Great Britain has a more moist and more uniform climate than New York, with less extremes of frost and heat with their deteriorating effects. Tar has been used for almost all bituminous macadam work abroad, but the American natural and artificial asphalt paving cements are being introduced into Europe and are meeting with favor. It is generally considered that natural asphalt is better than tar for paving under most conditions, but in many cases it is an open question whether the results justify the usual additional expense of the asphalt.

A good practice which is increasing in favor here and abroad is to use tar in the lower part and asphalt for the wearing surface. Tar is less affected than asphalt by dampness, ordinarily in foundations, it is cheaper and more easily manipulated and for a longer period before hardening, but the asphalt is less affected by the extremes of temperature on the surface and it seems to withstand traffic better and lasts longer. Tar has been used longer and in a greater variety of methods of paving constructions in England than in any other country, but failures have occurred in all places.

Pitchmac pavement was developed by Mr. Brodie and the bituminous binder is sold by S. R. Clare & Co., Liverpool, under the trade name of "Pitchmac." The pavement contains about 13 per cent. of binder. A similar pavement was under construction upon an old cobble-stone pavement as a foundation. A 3-in. loose layer of new 2½-in. stone on top of the old foundation was well rolled and then covered from hand dippers with 1¼ gals. of tar mixture per square yard. This was then covered with a 2½-in. loose layer of 1½-in. stone well rolled and covered with about 1½ gals. of tar mixture. This was rolled hot with a 10-ton roller and covered with a layer of clean, dry, warm stone chips and rolled to a finish. Gasoline torches were used to dry the stone as laid in the roadway just prior to the tarring. The tar mixture consists of equal parts of refined coal tar and fine sand containing about 3 per cent. of powdered chalk. The hot materials were brought onto the street in two separate wagons by a traction engine from the central plant. The tar tank was covered with asbestos and black canvas, and held about 1,000 gals. The tar and sand were mixed together by a special mixing machine from which the mixture was wheeled along the street and dipped out and spread on the prepared broken stone. Mr. Brodie thinks he gets cheaper and better results with the mixture than with tar alone. The sand reduces the expense and stiffens the binder and the chalk or limestone dust seems to toughen it. Good results have also been obtained with this mixture as a joint filler and as a maintenance coating on new and old stone and wood block pavements. This idea seems worthy of a trial here.

Owing to the great increase of traffic, the tendency abroad as well as here is to strengthen and increase a well drained stone or concrete foundation to a depth of from 6 to 12 ins. and maintain a wearing surface of stone or wood block, or bituminous material, suitable to the traffic and local conditions.

Stone Block Pavement.—Table I. shows the percentages of pavement in ten German cities which were visited. The largest percentage here and elsewhere abroad is stone block pavement. The blocks vary in size from the small 3-in. blocks in Liverpool to the large blocks used in southern Europe. I was much interested in the old Roman type of road with large irregular stone blocks, laid close together, and the later type still in use in Italy of large rectangle stone slabs from 1 to 2 ft. wide, from 1 to 3 ft. long and about 6 ins. or more thick, mostly with a sand bed and joint, some with mortar.

In France alone there are about 120 types of stone block pavements differing either in dimensions, permissible variations or taper. An effort is being made abroad, as has been done in this country, to standardize the sizes of stone paving blocks. The tendency abroad as here is to reduce the depth of block to about 5 or 6 ins. The length varies from 5 to 14 ins. and the width from 3 to 8 ins. Sand, gravel, cinders, broken stone, concrete, etc., are used for foundations. Sand, cement mortar, cinders fine gravel, stone chips, and tarred chips are used for bed and the same materials are also used in the joints, also tar and other bituminous materials, but sand and tar are used most. The majority of stone pavements seen abroad had fairly wide joints considerably worn.

In Germany there is quite an amount of 3 or 4-in. cubical stone block pavement called Kleinpflaster, the German word for small paving. Some of these pavements have been laid for many years and are smoother and more satisfactory than one might expect. When carefully constructed they make a fairly good economically maintained pavement for light and medium heavy traffic. A hard tough stone is necessary. The blocks are usually laid in sections with concentric semi-circular courses. This arrangement is more suitable to the irregular shaped blocks, as one side is usually shorter than the other. Blocks are also laid in random courses with edges at 45° to the line of traffic; where the joints are on an angle to the traffic, there should be less noise and less wear and the blocks may lay smoother. Small stone blocks have also been laid for many years in Liverpool, Birmingham and other places and their use is now being promoted by the Durax Dustless Roads Co., of London, under the name of "Durax Pavement." Their stone is cut into cubes cheaply and rapidly by drop hammer machines. The blocks are laid as described above and rolled with a road roller and they also use tarred chips as a bed and in the joints, which may be of an advantage. Stone chips seem to remain in the joints flush with the surface and may be better than gravel tar joints common here. Worcester, Mass., uses the stone chips in grouted joints and their stone block pavements are among the best in the country. Stone chips are not used in narrow joints or only to hold blocks in place while the joints are being filled. A Durax pavement has been recently laid in the Brooklyn Navy Yard. About a 3½-in. cubical Medina sand stone pavement similar to the Durax was laid last year in the experimental pavements on Second Avenue, near Third Street, New York City. The joints were laid at 90° to the curb. With the smaller stones it is easier to obtain a smoother dressed face, smaller joints and better foothold for horses, but there are more joints and more blocks per square yard, the expense is increased and the strength and bearing power is reduced. Narrower blocks are used on steeper grades, with stone liable to wear slippery. Larger blocks are sometimes grooved to improve the foothold. Large blocks are sometimes redressed and used over again. The larger blocks are more liable to rock unless well bedded. Softer blocks are less slippery on steep grades.

Track-ways of hard stone slabs in stone or wood block pavements are used in some cases in England, Italy and other places. In England, a similar stone slab gutter or channel is used along the curb for traffic and to carry the drainage. Curb stones are usually about 10 to 12 ins. wide and about the same depth, laid on concrete or otherwise. Curbs 5 to 7 ins. wide and 15 to 20 ins. deep are also used. Granite curb is preferred.

Liverpool and other cities have a number of very good stone and other pavements, as well as a number of poor pavements. I saw some special dressed stone brick pavements in Liverpool with such smooth surface and close joints that I thought was asphalt block pavement until I examined it closely. The small or medium sized stone block pavements with smooth, well dressed faces, laid on concrete, with close uniform joints filled with cement or bituminous grout, are of course very satisfactory, but they are very expensive and few places can afford to lay this type of pavement. Some stone pavements in Great Britain cost over $6 per square yard, at the cheaper foreign prices for labor and materials.

The Liverpool stone block pavements have been held up as a model by some tourists, and there are a number of first-class stone pavements there, but in my opinion the general average excellence does not compare with the stone block pavements of Hamburg. In Hamburg are many miles of smooth, close jointed Swedish granite pavements with blocks made about 7 to 9 ins. long, 5½ ins. wide and about 6 ins. deep, in very straight courses, at right angles to the curb except at intersections. The stone seems to wear quite uniformly smooth and the tar remains in the joints flush with the surface. This shows first-class materials and workmanship.

Wood Block Pavements.—Creosoted wood block pavements are favored in London and Paris for heavy traffic streets, where noiselessness is desired. The average life of creosoted wood block pavements in Paris has been about nine years and in London it has been about twelve years. Paris has about 3,000,000 sq. yds. of wood block pavements, or about one-quarter of its street paving.

The wood block plant in Paris, which is owned and operated by the city and lays or furnishes all the wood blocks used in Paris, is located on the Seine at Javel Quai, and is well equipped for handling the work. It has a machine which saws 16 blocks at one time and automatically discards the waste ends and sawdust, and conveys the blocks to the treating tanks. The practice there has been to only dip the blocks into hot creosote for a short time to obtain 2 or 3 lbs. absorption per cubic foot. The trend now is towards a 10-lb. treatment under pressure at high temperature, but it is not certain that the improved results justify the additional expense. The wood is carefully selected, the top and bottom of logs and tapped and untapped timber are treated separately.

The Paris plant has a capacity of about 200,000 blocks a day and furnishes over 400,000 sq. yds. of wood blocks per year. It has machines for cleaning old blocks, trimming off burrs, and sawing them smaller for relaying. These machines are portable and can be electrically operated on the street by connection with the underground electric wires.

Sheffield, England, also has a municipal wood block plant. The most satisfactory results in England have been obtained with creosoted soft wood blocks of "Pinus Sylvestris," known by the various names of Swedish Yellow Deal, Baltic Red Deal, Baltic Fir, Scotch Pine, Scotch Fir, etc., a close grained uniform wearing timber is selected. In Paris, the Landes Pine of France has been more satisfactory. These soft woods are somewhat like our short leaf yellow pine, but finer grained. The soft wood is more satisfactory because the top fibres crush down and mat together at the joints; this keeps the dirt and water out and makes the best kind of an expansion joint around each block. Soft wood wears more uniformly and the surface is covered with stone chips or grit which becomes more easily embedded in the soft wood and this makes the surface more durable and less slippery. Soft wood pavement is laid on steeper grades abroad than rock asphalt, because the latter is harder and more slippery.

The long leaf yellow pine paving block, which is usually used in this country, is intermediate between the soft and hard wood abroad. The size of the European block is about 3 ins. wide, 8 or 9 ins. long and 4 to 5 ins. deep. The usual depth of about 5 ins. permits a longer wear or allows the partly worn blocks to be cleaned, trimmed, sorted into sizes and turned over for relaying on a sand or mortar bed, or to be sawed to a uniform depth and relaid upon smooth concrete. The 5-in. Baltic wood block does not split up as much as our 3½-in. yellow pine blocks.

Various foundations and beds are used, but the prevailing practice, especially in England, is to bring the concrete to a perfectly smooth, true finish by tamping and floating over with a layer of mortar on the fresh concrete. The concrete is allowed to set up and the wood blocks are laid directly on the smooth concrete. Sometimes untreated hardwood blocks are dipped into bituminous cement just before laying, or are laid on the tar mopped concrete. Treated blocks are sometimes laid this way.

The English practice of smooth concrete foundation probably is the best method for their deeper soft wood blocks, but it is a question whether with our 3½-in. harder yellow pine blocks there would not be more noise and pounding of the blocks and foundation and a greater expense. I would suggest that provision be made in one of our repaving contracts for laying adjoining sections of long leaf and short leaf yellow pine blocks by the English method and by our own and that complete records of the work be kept. Our method of laying wood blocks on a mortar bed and rolling with a tandem roller has some advantages and our wood block pavements are equal to those abroad.

In Vienna the wood and stone blocks are laid in courses at an angle of 45° each way from the centre longitudinal axis of the street. This has the advantage that the wheels and horse calks strike the joints obliquely and there should be less wear and noise. It also affords better opportunity for expansion of wood block pavement, but it is an open question whether the results warrant the increased cost of laying. In most European cities the wood and stone blocks are laid at 90° to the curb as is the custom here, but many of our American cities have laid wood block at an angle with the curb. One or more courses are usually laid alongside of and parallel to the curb and the railroad tracks. Abroad, wood blocks have been laid in panels with blocks alternating in different directions, etc., but sufficient advantage over the ordinary method has not yet been demonstrated.

Formerly thin wooden strips were frequently used between the courses but they are now only used in the bottom of the joints filled with mortar on light traffic streets to protect and seal the joints until the traffic mats down the top of the blocks. Grout is usually used in the joints but sand and bituminous cement is also employed. The bituminous joint is a better practice but it is a question whether the result is worth the additional expense in some cases. Clay, sand, sawdust, felt, tar, tarred oakum and other bituminous mixtures, removable wedge-shaped blocks, springs, plates, etc., have been used for expansion joints along the curbs to prevent buckling and pushing out of the curbs, but no entirely satisfactory remedy has yet been found. I was most impressed by the two kinds of compressible plates being used in Paris. This expansion joint is a bellows-like box of tar paper or thin metal, about 1 in. thick and ½ in. less in depth than the block. The box keeps dirt, etc., out of the joints until the blocks expand under traffic and weather conditions and the top of the blocks crush down and seal the joints. This compressible plate is made by G. Vallee, 5 Rue Saint Ambroisie, Paris. This looked to me to be worthy of a trial here, especially on light traffic streets. Transverse expansion joints are not so commonly used abroad. The expansion joints along the curbs are inspected and taken care of. One reason why the wood pavements in Paris do not buckle more is because the pavements are flushed with water several times a day and the blocks are kept in a more uniformly moist condition. The blocks do not dry out before they are laid or they are soaked before laying.

I would recommend that a trial be made here of the foreign practice of occasionally employing a bituminous maintenance coating on old wood blocks to waterproof the surface and prevent the blocks drying out and the joints filling up and buckling in wet weather. In Paris a large hot asphalt smoother was run over the surface of bituminous treated joints to smooth and seal the surface. Sand, grit, or stone chips are spread on the surface, which makes it more durable and less slippery.

Pavement Testing Machine.*—The National Physical Laboratory, where the English Road Board tests are made, has a new apparatus for accelerated tests of pavements. This apparatus consists of a circular roadway about 104 ft. long and about 2½ ft. wide, upon which any selected type of test pavement may be laid. On this roadway roll eight wheels which cover all parts of the roadway. The wheels are about 3 ft. in diameter and their load and speed can be varied as desired. The road can be sprinkled and the temperature varied to imitate weather conditions. This machine has not been in operation long enough to reach definite results. Engineers in Great Britain as well as on the Continent are far behind us in the matter of physical and chemical test of paving materials. It is only in the last two or three years that the foreign engineers have gone into this matter to any great extent. Most of their paving testing apparatus is of the American type, but they may develop some new ideas of value.

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*See *The Canadian Engineer*, Oct. 30, 1913, p. 651.

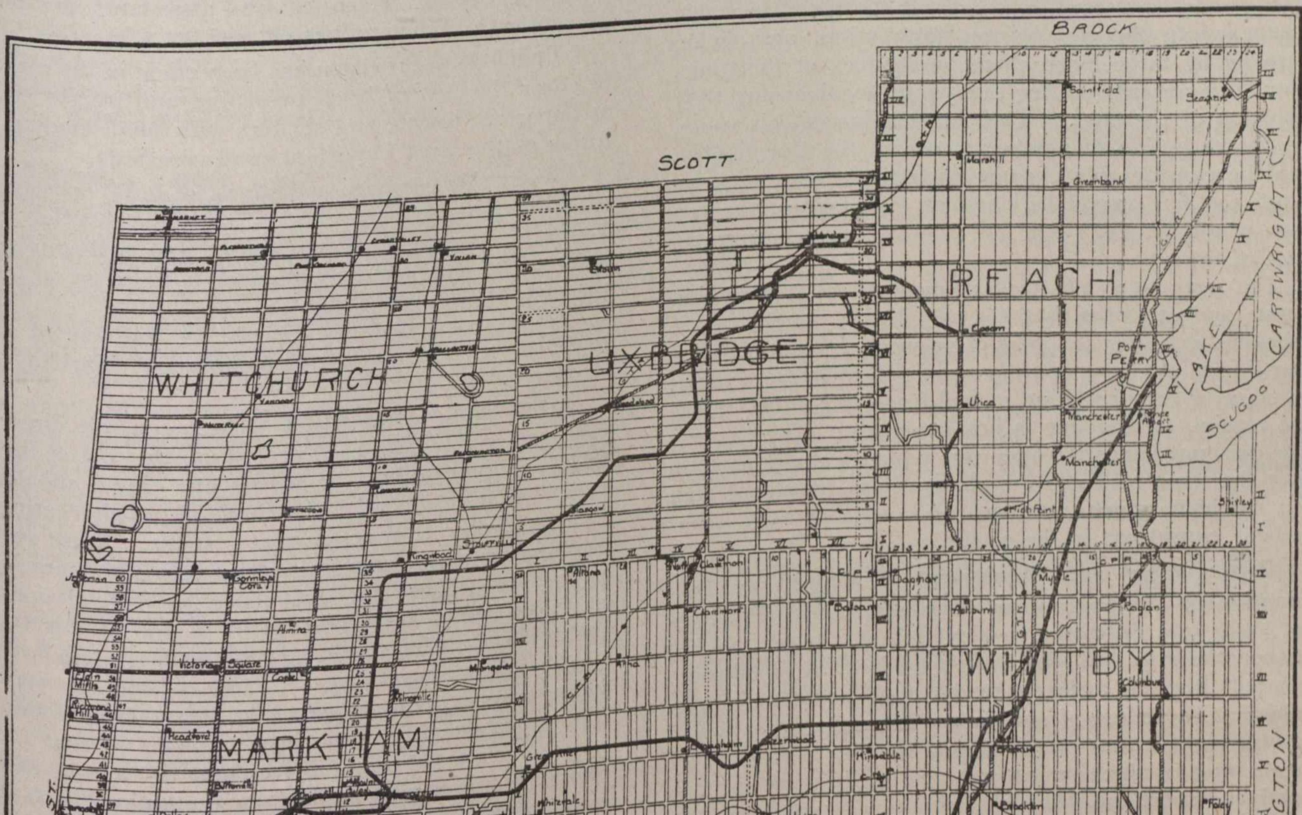
Table I.—Pavements in German Cities.

No.	City.	Population.	Total sq. meters, roadway pavements.	Percentage of each pavement — Wood.	Asphalt.	Large stone.	Small stone.	Macadam.	Other kinds.
1	Berlin	2,070,695	6,806,309	1.94	43.96	53.96	0.01	0.11	0.02
2	Hamburg	932,078	4,644,402	0.6	8.4	85.7	1.2	1.8	2.3
3	Dresden	546,882	4,450,700	0.5	6.4	41.7	0.7	49.9	0.8
4	Cologne	516,167	4,018,577	1.0	5.0	64.0	1.0	21.0	8.0
5	Frankfort-M.	414,598	3,778,152	1.9	11.8	46.9	7.8	30.5	1.1
6	Charlottenburg	305,181	1,670,724	5.0	64.0	25.0	0.5	5.5	...
7	Berlin-Wilmersdorf	109,729	795,962	0.8	53.5	4.7	23.1	0.4	17.5
8	Berlin-Lichtenburg	133,166	670,732	...	8.0	84.6	0.2	...	7.2
9	Pottsdam	62,224	590,300	0.03	11.6	35.0	3.0	27.27	23.1
10	Coblence	56,487	436,850	0.8	6.0	57.1	...	36.1	...
	Total of 98 German cities of over 50,000 popul'n.	17,336,320	107,409,023	0.62	5.57	48.02	3.26	36.41	6.12

A PROPOSED MUNICIPAL HYDRO-ELECTRIC RAILWAY FOR TORONTO AND NORTH-EASTERN DISTRICT.

LAST May the municipal councils of a number of townships in the vicinity of Toronto forwarded resolutions to the Hydro-Electric Power Commission of Ontario requesting a report and estimates on a proposed municipally owned electric railway connecting the various municipalities in the district to the city. In response to these resolutions the Commission has recently submitted a report containing all necessary information with respect to the district, and estimates of traffic, cost, operating revenue, and expenses, of the proposed line. The following information is derived from this report:—

Selection of Trial Lines for Estimates.—A survey party was organized to run preliminary lines through the district to obtain data for preparing estimates on the cost of roadbed construction. A reconnaissance was first made to select routes for these lines, and it was decided that a study of three different sections should be made between the northeastern boundary of the city of Toronto as far as Unionville. From this village, both easterly and northerly, the route was more or less fixed by the centres of population, and the general contours of the country.



Surveys Made for Estimating Purposes.

The lines surveyed for estimating and study purposes are shown on the accompanying map. In the event of construction being decided upon, the actual location line may or may not follow these exact routes.

The most easterly route of the three between Toronto and Unionville was run so as to pass through the centre of Scarboro township, but it was found to be very unfavorable for construction. The middle route would give almost as good service to the residents of this township and would be much cheaper to construct. A large section of the district traversed by the third route will probably be annexed to the city before many years, and, being controlled by three large estate companies at this time, it should be an easy matter to arrange for financing their proportion of the cost. The construction of this route, with the exception of a viaduct, across the Don Valley, would be considerably cheaper than the others, and, although the line would be one-half mile longer, the terminus would be some one and one-half miles nearer the centre of the city.

The estimates on traffic, capital cost, operating revenue and expenses that are included in the report are applicable to either the middle or westerly routes. The latter line might have slightly more suburban traffic, but, this class of revenue being at low fares, the effect on the total receipts of the line is not important. The easterly route does not appear to offer any inducements, other than being the most central through Scarboro township, and, as it would be much more expensive to construct, it has not been considered in the report.

Construction and Equipment—Roadbed.—An examination of a topographical map of the district shows that there is a difference in elevation of almost 700 feet between the city and the height of land at Goodwood. This will give an average grade of .5% that cannot be avoided. The effect of such a grade on the operation of heavy freight trains would result in slow service, but, since cars and short trains only are to be used on comparatively short runs with substantial layovers at terminals, no appreciable effect should be noticed on the schedules. The unavoidable short grades encountered have been kept below 2 per cent. and curves below 5 degrees.

The character of the soil throughout the entire district, with the exception of Uxbridge township, consists of a comparatively light loam, while that in the township mentioned, is very sandy. Gravel is present in sufficient quantities adjacent to the trial lines to ensure an ample and cheap supply for track ballast. These conditions should allow for grading being done at a very economical figure.

The estimates on track construction have been prepared on a 14-foot roadbed, 80-lb. rails, 6 in. by 8 in.—8-ft. cedar ties spaced 3,000 to the mile, gravel ballast, 8-bar woven wire fence with proper gates, cattle guards, etc. These requirements should provide a good type of construction for an interurban line.

Bridging and Railway Crossings.—All culverts and bridges have been designed to carry 100-ton locomotives, in order to provide proper structures to handle any traffic that may be obtained from interconnection with the steam lines. Plate girder bridges on concrete abutments would be used in the majority of cases, but some steel viaducts will be required.

Following the practice of the present roads in the district, all overhead railway crossings were estimated upon as crossing two tracks. Half interlocking plants have been figured upon for protection of all railway grade crossings, the operation of which would be taken care of by station men or other employees whose regular duties would require their attention in that vicinity. These plants would consist of a small central tower with outside stairs. A mechanical interlocking machine would be provided, controlling home and distant signals on the steam roads, and derails and home signals on the electric line. The signals on the electric line would be located close to the crossing, so that car conductors could operate the plant themselves, when station attendants are not on duty, with a minimum loss of time.

Buildings.—Provision has been made in the estimates to cover the cost of brick passenger and freight stations at important towns, and shelters with small loading platforms at the most important road crossings.

A suitable car barn and shops, of brick construction, would be located near Markham at the junction of the Uxbridge and Port Perry lines, and galvanized iron shelters, on steel frames and concrete footings, at termini for housing cars over night.

Fireproof sub-stations would be constructed as extensions to the station buildings at Markham and Brooklyn.

Overhead Construction.—The 2,400-volt direct current system has been used in figuring the cost of the electrical equipment, but the layout and traffic should give very similar results with the single-phase alternating current or 1,200-volt direct current systems. These systems, while being more expensive in first cost and operating expenses for a short line than the older low-voltage direct current system, are necessary for a line of this type, in order that holiday traffic may be properly handled without the capital cost being raised to an amount that would cause unusually heavy expenses for normal operation. These systems have also been chosen, so that the line may be able to take care of freight traffic and be extended short distances without installing additional sub-station equipment and trolley feeders.

If it is decided to construct only a short portion of the complete line, as discussed later in this report, it would be possible to use the low voltage direct current system until such time as the extensions would warrant the system that has been figured upon.

The single catenary bracket arm type of construction has been used in estimating the cost of overhead equipment. Thirty five-foot wooden poles, spaced 150 feet apart, would be used with a 7/16 in. Siemens-Martin mild steel messenger and a 4-0 grooved copper trolley. If desired, steel poles could be used, which would increase the capital cost slightly.

Rolling Stock.—Car equipments would be equipped with quadruple 100 or 125 h.p. motors, hot-water heaters, automatic air brakes, pantagraph trolleys, double end multiple unit control, and would be provided with smoking and small baggage compartments, in addition to the regular passenger section. Cars for suburban use would be, of course, lighter and less expensive.

Main line cars would be capable of operating up to 60 m.p.h. and maintaining schedule speeds of 25 to 35 m.p.h. with stops varying from 4 per mile, to one every two miles. Comfortable trailer cars would be carried on reduced schedules, on holidays and rush hours.

Express cars for milk and light express traffic would be provided with large motors so that freight cars could be shifted or hauled short distances. Doors and other facilities would be supplied so as to provide for rapid and easy loading of milk, etc.

The locomotives estimated upon would weigh about 60 tons, and would be capable of hauling from 6 to 20 cars of freight, or three or four passenger trailer cars for excursion business. Quadruple 100 or 150 h.p. motors and multiple control would probably be used.

As snow fences have not been provided for under Roadbed Construction, provision has been made under this heading to cover rotary ploughs.

Standard steam road freight cars would be required for freight and express business. These cars could be used for large inward and outward bound shipments and by utilizing sidings between stations, the loading or unloading points could be located so as to reduce the haul by team.

Estimated Capital Costs.—The cost of right-of-way was obtained from information gathered in the field. This is a matter that rests entirely with the municipalities, and it may be possible to obtain a private right-of-way for the complete line at a much lower figure than that which has been used. The Commission has received advice from some two or three owners of land, situated between the city and Unionville, intimating that they are prepared to give a free right-of-way through their property.

The figures used in the estimates to cover the various items entering into the capital cost of the road were obtained from manufacturers, and also from the railways operating in the district.

Considerable time was given to this work and much useful information was obtained from personal visits of the manufacturers, which data will be available for further detail study in the event of construction being decided upon.

Plans and profiles were prepared of the various lines surveyed and the quantities of grading, draining, etc., figured for the different sections. Attention was also given to the probable cost of ballast and borrow pits, which information is given in the detailed estimates attached to this report.

Overhead charges of seven per cent. (7%) have been added to the total capital cost to cover engineering, interest during construction and bond discount. As the figures used in each portion of the estimate are conservative, the total cost should be ample to cover the type of line described.

Estimated Operating Revenue.—The total estimated revenue of the proposed line was divided between passenger, freight, mail, etc. Each of them has been checked by statistics of other electric lines operating through somewhat similar districts. The working conditions of these lines were carefully studied over a number of years, and readjustments had to be made as they did not all class their expenses under the same heading.

Basing figures upon a comparison of the proposed line with the electric and steam roads in the district, it was estimated that within two or three years after the commencement a revenue approximating $450,000 should be obtained.

Estimated Operating Expenses.—In preparing estimates on the cost of operation of the proposed line, liberal allowance was made to include all possible expenditures and the rates used for maintenance and operation were probably higher than necessary. The number of car crews required to give the service was determined by the inspection of train sheets, and the number of station and repair men, by a study of the requirements of other steam and electric roads. Statistics covering the cost of maintenance and repairs of track and rolling stock were available from the returns of electric lines operating under similar conditions, and the cost of this branch of operating expenses was determined by applying these statistics to the annual car and locomotive mileage from the train sheet. Expenses such as station and car supplies, general office expenses, etc., were also taken into consideration.

Estimates Prepared.—To enable the project to be examined as to the effect of the alteration of any section of the line, a series of estimates was included showing in detail the capital cost, operating revenue and expenses for a number of combinations. Five schemes were proposed, ranging in length from 71 miles to 16 miles, and in capital cost from $2,470,766 to $693,003.

Conclusions.—To build a road as set forth in the report would require some 64 miles of line, the Toronto terminal considered located in the northeast part of the city and the freight handled by a subsidiary company. The territory through which the line passes, with the exception of some 15 or 20 miles, is very fertile, and thickly populated, and examining the project broadly it has the appearance of affording a splendid opportunity for obtaining a good business from the commencement of operation. The distance from any point on the line from Toronto would be less than 45 miles, and as all these points receive a very unsatisfactory service from the present steam lines, the best of the existing traffic should be easily obtained.

PREPARATORY TREATMENT OF SEWAGE—OBSERVATIONS AND EXPERIMENTS.

Charles Gilman Hyde, professor of sanitary engineering, University of California, presented very recently a paper to the League of Pacific North-West Municipalities, recounting his observations made in the fall of 1912, during an extended trip to the east, upon sewage disposal plants visited wherein particularly interesting features of preparatory and final treatment of sewage were represented. Professor Hyde also bases his remarks on many other experimental and practical installations demonstrating possibilities in the preparatory and final treatment of sewage. But in his introduction he mentions particularly the fine-screening devices of the rotary type observed at Brockton, Mass.; Reading, Pa., and Baltimore, Md., and the Imhoff tank experiments and installations visited at Worcester, Mass.; Philadelphia, Pa., and Chicago, Ill. At Worcester and Chicago, these devices were experimental in character, and were being operated in conjunction with comprehensive testing stations. At Worcester, Baltimore, and Chicago, sedimentation with subsequent sludge digestion in independent chambers was noted; though at Worcester and Chicago, these devices were again experimental. At Worcester, chemical precipitation with accompanying sludge pressing on a large and efficient scale was examined. At Worcester and Chicago, experimental sprinkling filters, and at Brockville, Reading, and Baltimore, large installations were inspected. At Brockton and at Worcester, Professor Hyde remarks that the intermittent sand filter plants are most interesting.

The following is a transcription of the paper printed as written with various divisions and headings:—

Composition of Sewage.—In considering problems of sewage treatment and disposal, attention cannot be too firmly fixed on the fact that sewage essentially consists of two more or less independent parts, each vitally important in its own particular way. Sewage consists primarily of a very considerable portion of the water supply of a community together with such ground and surface waters as may, by accident or design, enter the sewers. In these waste waters have become dissolved a large amount of organic and some mineral matters from household, industrial, street and other wastes. In addition to the liquid wastes the sewage carries a load of suspended matters, both organic and mineral.

It is the organic matter, dissolved and suspended, which is dangerous from a sanitary point of view, is subject to putrefaction and decomposition and is capable of producing a nuisance. The suspended mineral matter requires removal in order to protect streams from unsightly deposits, and final treatment devices (like sprinkling filters and contact beds) from undue clogging. The dissolved mineral matter, while exercising an important influence upon certain phases of the problem of disposal, does not, as a rule, require removal by any special process.

The Sewage Treatment Problem.—Because sewage consists essentially of two parts—suspended solids and a liquid containing dissolved or partially dissolved organic and mineral matters—the sewage treatment problem is two-fold in its nature. It is true, of course, that crude sewage may be disposed of by a single process, as for instance, by dilution in relatively large bodies of water and by treatment in contact beds and intermittent sand filter beds, by broad irrigation, etc. The presence of suspended matters, however, greatly reduces the volume which can be effectively treated by these devices and experience indicates that, in many cases, it is extremely wise to employ some preparatory treatment in order to relieve the burden upon them. The removal of suspended matters by fine screening or subsidence will increase the volumetric capacity of such devices as sprinkling filters, contact beds and intermittent sand filters from 30 to 100 per cent., depending upon conditions. Furthermore, the removal of these matters tends to increase the efficiency of these devices even when they are operated at the higher rates which are thus made possible. At the same time their maintenance and operation are rendered simpler and less difficult. It is also undoubtedly true that water courses may, through the processes known under the general term "self-purification," receive sewage in increased volumes varying more or less directly with the percentage of organic matter of a thoroughly unstable character which is removed by special treatment.

It must be borne clearly in mind that preparatory treatment alone does not solve the sewage disposal problem unless the effluent may be disposed of in bodies of water of much size and under such conditions that sanitary laws are complied with. In California the laws governing the discharge of sewage into all waters are to be found in Chapter 374 of the Public Health Act of the State (Revised Status of 1913) and under these regulations it is necessary that all communities, industrial establishments, institutions, etc., desiring to dispose of crude or treated sewage in either salt or fresh water on the coast, tidal estuaries or in the inland streams must receive special permission so to do from the State Board of Health. Such permits will announce the particular conditions under which any party in question will be allowed to dispose of sewage or industrial wastes.

Necessity for Preparatory Treatment.—From the brief and untechnical discussion above it will be seen that the preparatory treatment of sewage is frequently an economic, as well as a sanitary, necessity. It is almost always required except where disposal of crude sewage by dilution can be accomplished without nuisance or contrary to state laws.

Even the Pacific Ocean is not in every case capable of receiving crude sewage in large volumes without producing a nuisance or even, in extreme cases, without becoming a menace to public health. A most interesting instance in point is the situation at Los Angeles where, due to complaints of beach pollution in the vicinity of the sewer outfall at Hyperion, between Playa del Rey and El Segundo, the city is advised and proposes to adopt some preparatory treatment of the sewage. The suggested minimum treatment is screening through revolving very fine mesh screens of the Weand or similar type.

A large number of disposal projects in this state has thus far involved only preparatory treatments. Just how these projects will meet with the requirements of the law and the approval of the State Board of Health remains to be seen. In almost every case, however, the preparatory treatment of the sewage will represent a correct and necessary first step although final treatment methods may require to be applied in many cases before the real solution of the disposal problems of these places is arrived at.

California Conditions as Affecting Sewage Treatment.—Speaking generally, the climatic conditions in California aré strikingly favorable to all processes of sewage treatment which involve biological activities, that is, the activities of bacteria, worms and other organisms which operate to decompose, digest, hydrolyze, gasify or oxidize the organic and mineral matters in sewage. The activities of the organisms in question are greatly affected by temperature, high temperatures tending to induce rapid development and great activity and low temperatures tending to inhibit development and to lower the vitality and the activity of the organisms. Except at the higher altitudes in California freezing weather occurs but rarely and for short intervals while over large areas of the state heavy frosts are only occasionally known. In fact the conditions are such that sewage treatment works must be designed and operated with the expectation of extraordinary biological activities. In septic and Imhoff tanks it is necessary to prevent excessive scum formation and in the latter tanks, especially, large scum chambers must be provided readily accessible for frequent scum agitation and if necessary scum removal. It is to be noted in this connection that scum formation is more or less directly related to biological activity and the production of gas through the decomposition of organic matter.

Sedimentation and Sludge Digestion.

The Single-Story Septic Tank.—All single-story septic tanks, however much they may vary in shape and size and in design with respect to baffles, etc., may be classed as of the Cameron type although not necessarily infringing upon the well-known Cameron patents which are generally held by sanitary engineers in America to be non-valid. This particular matter has been discussed from time to time in detail in Pacific Municipalities. When the ordinary or so-called Cameron septic tanks were first exploited they were thought to be a panacea in the solution of sewage treatment problems and were introduced throughout the state in promiscuous fashion. In many cases they were built without careful consideration of local conditions in determining, first, whether this type of treatment would meet those conditions and, secondly the proper proportioning and design of details.

There are certain important fundamental principles involved in the design and operation of this type of tank.

Where these have been observed and where the conditions have been favorable both as respects design and environment the results have oftentimes been quite satisfactory. It must be admitted that the single-story septic tank has represented a distinct advance, under certain conditions, over former methods of sewage pre-treatment where sludge removal by sedimentation was necessary. There are situations where, in view of its simplicity in design, construction and operation, the single-story septic tank is a logical and advisable sewage pre-treatment method. The question of odor production, to be discussed shortly, is possibly the most important consideration in determining the satisfaction of use of this device. It is also to be observed that septic sewage is more difficult to treat in final treatment devices, such as sprinkling filters, intermittent sand filters, etc., than is fresh sewage containing an equivalent load of organic matter.

The Two-Story Sedimentation and Sludge Digestion Tank.—For many years various experiments have been conducted with the hope of discovering some method of treating sewage in such fashion that the solids could be removed and digested through biological action while the liquid portion of the sewage, relieved of its suspended solids, might pass on to final disposal in a fresh (not septic) condition. Plain subsidence and chemical precipitation have solved the problem from the standpoint only of the removal of suspended matters but these processes have presented the sludge disposal problem in an acute form. What has evidently been needed is a combination whereby subsidence might be accomplished as effectively as possible and at the same time the sludge might be digested independently of the liquid portion of the sewage through processes of digestion, liquefaction and gasification which are known to operate in the so-called single-story septic tank. Various two-story tanks have been proposed for the purpose, together with certain combinations of plain sedimentation and independent sludge digestion chambers. Some of the two-story tanks suggested have been very complicated and have been aimed at the removal of colloidal substances (namely, those solids which seem to be on the border line between suspension and solution) as well as the suspended solids in the sewage. Unquestionably the best known and the simplest device and the one which has met with the most general approval of engineers because of its ready adaptability to sewage treatment problems is the two-story tank generally known as the Imhoff tank, named for its inventor, Dr. Karl Imhoff, of Essen, Germany, and used by him for the pre-treatment of the Sewage of numerous communities in the Emscher Valley. The tank has thus become known also as the Essen and Emscher tank. Its purpose is avowedly the removal of the coarser suspended solids from the sewage and the subsequent more or less complete digestion of these independently of the flowing sewage.

The Imhoff tank consists essentially of two parts or stories: (a) an upper flowing-through or sedimentation chamber through which the sewage passes with a slow forward motion such that the heavier matters, held in suspension by the velocities in the sewers, are now deposited in the chamber which has a sloping slotted bottom so steep that the sludge must slip down and pass through properly designed slots into the lower chamber; (b) a lower or sludge digestion chamber designed to receive the sludge and to retain the accumulated deposits of several months of operation while these are being worked over, decomposed and digested through the action of bacteria and other organisms. Well designed Imhoff tanks should remove from 90 to 95 per cent. of the "capable-of-settling" suspended matters and from 50 to 70 per cent. of the total weight of suspended matter in the sewage. One of the essential facts of this device is that the sewage passes from it in a fresh condition, free from the disagreeable odors so commonly associated with the ordinary septic tank above described.

Independent Sedimentation and Sludge Digestion.—As above suggested, the great difficulty with plain or coagulated subsidence has been the subsequent disposal of the enormous amount of highly putrescible sludge resulting from these processes. Recently it has been proposed to design sedimentation tanks in such a fashion that the sludge may be drawn off at frequent intervals into separate chambers where it could be digested independently of the main bulk of the sewage under very much the same sort of conditions as obtain in the digestion chamber of the Imhoff tank or in the septic tank. Experiments involving this general scheme have been conducted by the Massachusetts State Board of Health at Lawrence, Mass., by the Sanitary District of Chicago and by the cities of Philadelphia and Worcester, and works on a large and comprehensive scale for the pre-treatment of sewage in this manner have been constructed and are now in operation in Baltimore. The results of operation at Baltimore are not yet available to the writer and at the time of his visit to the plant, nine months ago, the works were scarcely in operation. The experiments at Chicago, Philadelphia and Worcester indicate that the sludge can be partially digested by this method with a consequent reduction in the bulk of solids treated. This reduction is due to the change in the character of the solids through decomposition and loss of water content. Decomposition is accomplished mainly by the bacteria and is accompanied by the liquefaction and gasification of some of the organic matter. The experimental evidence has not yet been very satisfactory from the standpoint of complete digestion of the sludge and the question of odor production is important, as will be shown later.

The Odor Problem.

General Conditions in California.—It is to be remembered that, whereas the early California was a land held in great estates, the California of to-day is a state of relatively small subdivisions while the California of to-morrow will be a state comprising very many small and medium sized communities, some extremely large and populous cities and a vast number of intensively cultivated areas which will be suburban in character. This will mean a large population per square mile and an extraordinarily compact rural development. The people of California do demand and have a right to require a complete absence of offensive odors in the vicinity of their homes. Oftentimes, without doubt, prejudice enters into the problem and odors are alleged to occur which really do not exist, at least in the degree which complainants state that they observe. On this account sewage disposal problems of certain municipalities in California are to-day by no means easy to solve and it would appear that the conditions will become increasingly difficult as time advances.

In considering any sewage treatment project the direction of prevailing winds should receive most careful attention and temperature and other climatological features should be deemed important and should be studied in their relation to each problem in hand.

Some Fundamental Considerations.—It has already been pointed out that the flow of sewage is mainly comprised of the water supply of a community. In places where sanitary sewers only are provided and where these sewers are laid above the ground water table the volume of sewage is entirely made up of the water supply. Fresh sewage has a distinctly mouldy or musty odor which is not generally considered to be disagreeable. It is not pungent and is too slight to be carried to any considerable distances by winds or otherwise, even from large volumes of sewage. Stale or septic sewage, on the other hand, has a strong pungent odor probably due in large part to hydrogen sulphide which is formed through the action of the bacteria from the mineral sulphates and from the sulphur in the organic compounds in the sewage. To the presence of sulphur compounds in the sewage must be mainly attributed the odors which are produced therein under the general action known as decomposition, especially decomposition taking place in the absence or limited presence of air. Foecal wastes contain small quantities of sulphur but the really great source of sulphur in sewages is ordinarily found in the dissolved mineral sulphates in the water supply of which the sewage, as stated above, is mainly comprised.

Almost all of the ground waters of California are hard and contain a considerable weight of dissolved sulphates. Certain surface waters in this state, especially those derived from coast watersheds receiving small rainfall, are also extremely hard and contain very large amounts of sulphates. The weight of dissolved sulphur in the public water supplies of the state is frequently as great as 500 lbs. in a million gallons; occasionally the figure may rise to 1,000 lbs. per million gallons and in very extraordinary cases the sulphur content may be as great as 3,500 or 4,000 lbs. per million gallons.

When sewages are exposed to the action of anaerobic bacteria decomposition sets in and various species or groups of bacteria develop and act upon it to produce hydrogen sulphide—the gas which is mainly responsible for the disagreeable odors arising from decomposing sewage, especially in septic tanks—both from the organic matter and from the sulphates present. There is some evidence that aggravated cases of production of hydrogen sulphide are caused by the desulphurization of the dissolved mineral sulphates by one or more species of bacteria. Since these sulphates are mainly in solution and are not contained in the organic matter it is apparent that if odors are to be avoided in sewage treatment works the sewage should be kept as fresh as possible and should not be exposed to the action of bacteria of decomposition prior to its final disposal by some suitable process. When the decomposition of the sludge is effected in a chamber apart from the liquid sewage the latter may be maintained in a fresh condition and may not be exposed to the activities of the bacteria in question. On the other hand, since the sludge from ordinary city sewage contains but limited amounts of sulphur either hydrogen sulphide is not formed or, if formed, is quickly absorbed or combined with iron and other salts so that it does not become apparent to the senses.

Odors With Single-Story Septic Tanks.—In the single-story septic tank, where sewage, sludge and scum are all in contact, it is apparent that the dissolved sulphates in the sewage are subject to the action of so-called "sulphur" and other bacteria and consequently may be decomposed with the ultimate production of very large quantities of hydrogen sulphide which is thrown off into the air above such tanks or is liberated from the sewage after passing from the tank. This gas-laden effluent, when aerated, spread upon land, etc., may and frequently does produce local nuisances. In one case recently investigated by the writer it would appear that the odors from septic sewage while being spread out upon land in irrigation could be detected and cause comment, if not an actual nuisance, at a distance of from 2,500 to 3,000 feet or, say, fully one-half mile.

The disposal of septic tank effluents by sub-surface irrigation or by final treatment in contact beds dosed from the bottom by automatic devices would appear to be favorable methods under certain ruling conditions. Sub-surface irrigation is adaptable, generally speaking, to very small plants only but contact beds may be used in large installations. The use of sprinkling filters with septic tank effluents is undesirable in settled communities because of the fact that the spraying of the gas-laden sewage through the air may liberate the hydrogen sulphide in such volumes as would be almost certain to produce local nuisances. Indeed, in very closely built-up communities the use of the septic tank with surface treatment of sewage, as in irrigation, is becoming almost prohibitive.

Odors With Two-Story Imhoff Tanks.—Tanks of the Imhoff type do not ordinarily produce disagreeable odors because the liquid portion of the sewage passes through them in a fresh condition while the sludge is independently decomposed in a separate chamber out of contact with the liquid in question. From the preceding statements it will be seen that the great proportion of the sulphur will ordinarily have passed through the tank with the liquid sewage without change. Doubtless some hydrogen sulphide is formed from the sulphur present in the sludge, but this is combined with iron and other salts and does not cause offence. If the flowing-through chambers of Imhoff tanks are not kept clean, if scum is allowed to form upon their surfaces and sludge to clog the slots, septic action will very shortly be established and the effluents therefrom will contain more or less hydrogen sulphide and will become correspondingly offensive. A very considerable experience with Imhoff tanks in Germany and a more limited experience with these tanks in America indicate that where they have been properly designed, and especially where they have been properly maintained, they have been satisfactory from the standpoint of the production of odors.

Odors From Sedimentation Works With Independent Sludge Digestion Chambers.—The experiments which have been conducted at Chicago, Philadelphia and Worcester indicate that independent sludge digestion is apt to be unsatisfactory from two standpoints; first, because it is difficult to secure effective digestion of the sludge under conditions which almost necessarily must obtain in plants of the type in question and, secondly, because offensive odors are created during the process of digestion. The full explanation of the manner of production of these odors is not immediately forthcoming, but it would appear that only a fraction of the disagreeable odor is caused by hydrogen sulphide and by other organic compounds containing sulphur. Much is due to other organic substances. The action of gasification in this process is apt to give rise to large amounts of dry scum which do not digest satisfactorily and which cause physical difficulties with plants of the type in question.

Some California Experiences in Preparatory Treatment.

Experiences With Septic Tanks.—A very large number of septic tanks has been built in California both by communities and by individuals. Some of these tanks are operating with fair satisfaction as far as odors are concerned, but others are not satisfactory and are causing local nuisances on account of the strong odors which are produced therein. No chemical or physical studies showing the operating efficiency of the tanks in California, with one exception, have been made and therefore no information is available with respect to the percentage of removal of suspended matter by these devices. Data are lacking as to normal, maximum and minimum efficiencies. In certain cases, due to too active gasification, which in turn is partly attributable to extremely favorable climatic and other conditions, there has been a very excessive scum formation, so much so that this has required frequent removal and has been not only a source of trouble and difficulty in operation but undoubtedly also a cause of low efficiencies or at least of lower efficiencies than would otherwise obtain. In general it is to be noted that too active gasification is responsible for the appearance of large quantities of digested or partially digested suspended matter in the effluent. In Ohio, in 1906 and 1907, the State Board of Health made 16 separate examinations of eight plants with the result that on eleven occasions the removal of suspended matter, by weight, was nothing or actually negative and on only five occasions was there a positive removal of suspended matter. In no case was the percentage of removal as great as 50. These tanks were probably as well designed on the average as would be the case anywhere.

Experience With Imhoff Tanks.—To-day there are in operation in California only six Imhoff tanks, but a number of others are now under construction and still others are projected. It is apparent that operating experience, under California conditions, must be very limited, especially as most of the tanks in question have been operating but a very short time. Unfortunately most of the tanks thus far built have been provided with tight covers and have not been suitably arranged for carrying out the most essential features of operation. On this account septic action has in some cases taken place to a limited extent in the flowing-through chambers. In at least two cases very excessive amounts of scum have been allowed to accumulate in the scum chambers connected with the digesting chambers. In one instance at least nine feet of scum accumulated in these chambers and very little sludge had settled to the bottom of the tank. This had not digested in several months' time. In at least one tank in California sludge digestion has been accomplished satisfactorily and the sludge which has been dried out upon the bed provided for the purpose has been representative of the best that Imhoff tanks have been able to accomplish.

Experiences With Sewage Screens.—Practically no data have been gathered as yet in California with respect to the efficiency of sewage screens under practical working conditions. Recently interesting data with respect to the amount of suspended matter which may be removed from sewage by such devices have been experimentally gathered at Sacramento and at Stockton. Fine rotary screens of the Weand type are advised to treat the sewage of Los Angeles at the Hyperion sewer outfall and one unit of this general type is being installed at the Anaheim Sugar Factory for the pre-treatment of its wastes. While in general it may be remarked that the field for fine screening of sewage is comparatively limited in California, it may also be said that there are undoubtedly numbers of conditions and circumstances under which the process might be used with success. Greater attention should be paid in this state to the rough screening of sewage, especially in conjunction with pumping devices.

SPEEDY REINFORCED CONCRETE CONSTRUCTION AT FORT WILLIAM, ONT.

A SAMPLE of reinforced concrete construction that is probably a record for Canada, or, at all events, an unusual example of speedy erection, taking into consideration the handicap which severe frosts present and likewise the lack of facilities for quick transportation, is a building here referred to and illustrated in several of its stages of construction by the accompanying photographs. It is built of reinforced concrete with an exterior of brick. Its dimensions are 100 feet by 125 feet, and consists of five stories and a basement. Its foundation is 8 feet below sewer level, a total depth of 20 feet below the ground surface. The building is set upon 1,300 piles, varying from 40 feet to 55 feet in length, according to the variation in the depth of rock over the area.

Fig. 1.

The contract for the erection of the Grain Exchange was awarded to A. C. Stewart & Company, general contractors, Fort William, and was signed on the 14th of February, work commencing the following day. There was a depth of 4 feet of frost to remove in the excavation. This was undermined and shattered with a 2-ton pile hammer falling 50 feet. Excavation began on February 17th, and the first piles were driven on March 5th. Fig. 1 shows the progress that had been made up to March 15th, the excavation work and the pile driving proceeding simultaneously. Concreting the basement began on April 2nd. Piling was finished on the 11th of the month,

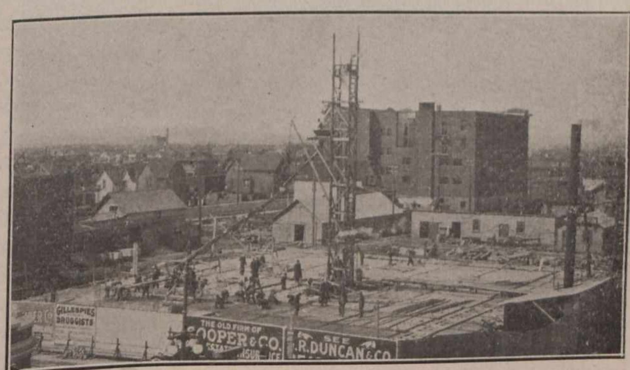


Fig. 2.

and excavation work completed on April 28th. A 4-inch Emmerson pump was installed to prevent undue flooding of the foundation work from the spring melting of snow and ice.

Fig. 2 illustrates the progress which had been made up to May 5th, at which date the concrete was entirely laid in the basement and ground floor, and the building was, so to speak, at ground level. The first floor was poured by May 15th, the second floor by May 23rd, and so on to the 6th, or roof, the pouring of which was completed on June 21st. Fig. 3 shows the progress up to May 20th, and Fig. 4 shows its appearance on June 21st, when the concreting of the roof was completed. At this date, also, the brickwork was up two stories, and the majority of the pyro-bar partitions were in position.

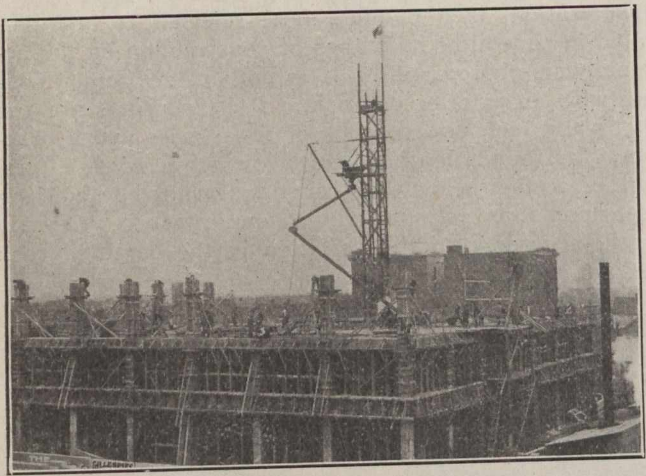


Fig. 3.

The Dominion Grain Commission leased the entire third floor of the building, and for their inspection room, designed to carry 300 lbs. per sq. ft., a test of one slab was taken when the concrete was forty days old. This particular slab was 16.0 feet by 17.4 feet in dimensions, and experienced a deflection of 0.10 under a test load of 500 lbs. per sq. ft., a total of 70 tons.

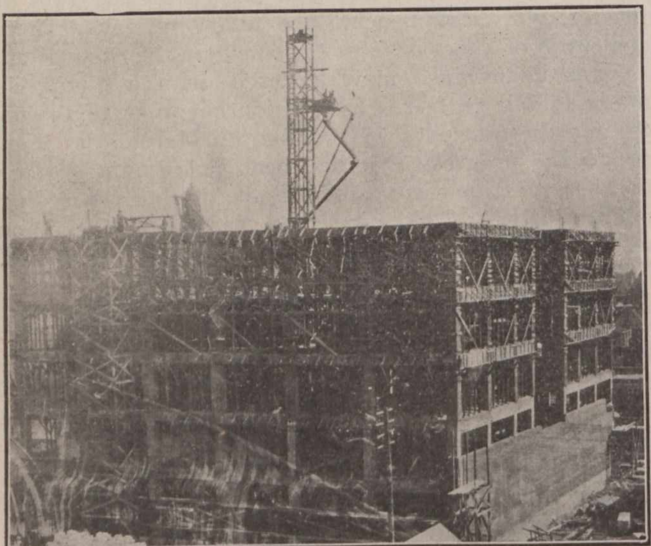


Fig. 4.

The entire building was bricked, and the roof finished, on August 16th; while the wood trimming, painting, and terazzo floors were finished by the end of September. The only items that prevented the contractors from handing over the building to the owners on October 1st were owing to unavoidable delays in the delivery of the elevator machinery, and of the marble for the main entrance. Notwithstanding this, the Grain Commission occupied the entire floor the first week in October, a number of offices were occupied the following week, and the building was accepted by the owners a few weeks ago, the total cost being $320,000.

While any statement of this construction surpassing previous records might be termed erroneous by various companies in the United States, it must be remembered that building construction in the south has not to contend with heavy winter frosts and snow; with an excessive run-off in the spring due to melting snow and ice, and the long and difficult means of transportation which contractors have frequently to overcome in Canada.

While it is not possible to make speed comparisons of buildings that are materially different in construction, the following data of some recent contracts in the United States may be of interest:—

A building in Jersey City, N.J., is 100 feet by 100 feet, with five stories and basement. It comprises soil bearing foundations and flat slab floor construction. The contract was signed February 20th, 1912, and the building substantially completed September 1st, 1912.

Long Island, N.Y., has a building 60 feet by 355 feet, three stories. The contract was signed September 11th, 1912, and the building was completed on January 1st, 1913. Concrete piles were furnished by the owners, and the contractor, for this portion of the work, began operations about August 15th.

There is a warehouse at Jacksonville, Fla., that is 110 feet wide, 60 feet deep, with five stories and basement, one-half of the foundation resting on wood piles. The contract was signed November 23rd, 1912, and completed July 15th, 1913.

A 175-foot by 258-foot three-story factory building at Baltimore, Md., rests on concrete piles. Its foundation work began February 1st, 1913, and the building was accepted as completed on May 7th.

An eight-story building, 60 feet by 200 feet, with soil bearing foundations at Brooklyn, N.Y., was completed just seven months after commencement, in 1911.

RESOURCES OF THE PEACE RIVER DISTRICT.

Possibilities of the Peace River district and the far northwestern territory through which winds the Mackenzie River were the subject of an interesting address given recently by Mr. Charles Camsell, of the Dominion geological survey, under the auspices of the Vancouver Chamber of Mines, at Vancouver. Mr. Camsell characterized that district as unparalleled in the fur trade at present, and a future country where mineral will be largely produced, from all present indications. The mineral indications found there by Mr. Camsell gave indications of probably large deposits of copper, zinc, silver and lead, as well as gold.

In addition to its other vast resources there would be oil. Oil and tar exudes from the earth in areas which were spread over from 150,000 to 300,000 acres. These, he said, were the best possibilities in the world. Oil, and where to find it, and find it in big quantities, is Britain's most intensely interesting problem just now, owing to the fact that the use of oil fuel is growing to such a degree that it is but a question of time when all the big ships will of necessity have to use it as the cheapest and best-known fuel for economical operation.

Mr. Camsell also spoke of the geological study he had made of the Similkameen district of British Columbia, where he spent considerable time. The general formations were for depth and permanence of the mineral lodes, he said. The district was fast being opened up by large mining interests and was receiving a careful prospecting, as the result of which in time the Similkameen district would become one of the most important from what knowledge his studies had gained for him while in that district.

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CONTENTS OF THIS ISSUE.

WATER IN OIL WELLS.

This subject has been receiving a good deal of discussion in the technical press. It is an important one, as the importance of incursion of water into oil wells cannot be emphasized too thoroughly or too soon. It would appear, from recent reports from one or two important oilfields in other countries, that this problem has not yet been solved in a manner efficient enough to obviate the abandonment of what might ultimately have been producing wells. It seems extraordinary at this date that, although every drilling man of experience recognizes the danger of the inflow of water, no device or method has yet been introduced which can be relied upon to exclude water from oil wells—to such an extent, at least, as would not involve their abandonment. Great attention has been given to this matter by some of the most experienced both in European and American oil-boring practice, and yet no satisfactory solution of the difficulty has been discovered. The existence of such problems as this affords ample justification even of the necessity of the formation of a technical institution where experienced drillers and others could meet together and endeavor to discover some more efficient method of dealing with the question than is at present available. Now that the Canadian oil industry has received a decided impetus by the discovery of important oil indications in Alberta, and by the proposed adoption of oil as a fuel in numerous branches of industry in the west, an investigation of the water problem would not be out of place.

THE ENGINEER AS AN EXPERT WITNESS.

An interesting reference was made in the article by Walter J. Francis, C.E., entitled "Engineering as a Profession," (*The Canadian Engineer*, Nov. 6th, 1913, page 685), where it is stated that the engineer's remuneration for professional services in the law courts is something like $1.25 per day. This question regarding the inadequacy of fees to professional witnesses has been under consideration a great deal in England during the past season. It was aroused by a complaint made by an association of shipbuilders that the allowance for expert witnesses was too meagre in the case of Board of Trade inquiries, and the result has been the formation of a special committee of representatives of the Institution of Naval Architects, the North-East Coast Institution of Engineers and Shipbuilders, and the Institution of Engineers and Shipbuilders in Scotland, to consult as to whether representation should not be made to the Board of Trade regarding this inadequacy of fees. It appears that an act, passed in 1894, provides for the payment of expenses in respect of the attendance of witnesses at Board of Trade inquiries on the same scale as in the ordinary courts. The Board, however, allows only $15.75 and first-class railway fare. Under the County Court rules and the High Court Orders, which apply to Board of Trade inquiries as well as to the ordinary courts, an extra fee of from $5.25 to $26.25 may be obtained for "qualifying to give evidence." The consultative committee of the North-East Coast Institution of Engineers and Shipbuilders think that while the Board of Trade has no jurisdiction to raise the fees proper, it might in practice allow expert witnesses and leading officials of shipbuilding firms attending inquiries and giving evidence an additional qualifying fee, in terms of the Rules of Court, of from $5.25 to $26.25, making a total of $21 to $42.

But in Canada, although members of other professions are, generally speaking, given some recognition for their qualifications for giving evidence, the engineer is reimbursed for his services by a dollar and a quarter per day, there being no consideration given his ability and training more than if he possessed only that acquired by the handling of pick and shovel.

FIRE-RESISTING CONCRETE.

Of recent years complete confidence has been established in the fire-resisting qualities of properly constructed concrete. These, combined with its durability and strength, render it particularly suitable for the construction of buildings in which more or less hazardous occupations are to be carried on, or which are to be erected in areas wherein it would be difficult to cope with a conflagration.

For fire-resisting concrete quartz sand should be used, and broken trap rock is, perhaps, more suitable than any other substance. Limestone is probably next in order of suitability, although it will eventually run into a crude form of glass or be calcined; but that will not take place until the cement itself has been disintegrated. Contrary to the commonly received opinion, cinder concrete is not unsuitable from a fire-resisting point of view. The chief objection to its use is that it is far from strong. Heat does not affect it to a great extent; indeed, it has been found that small pieces of coal embedded in concrete have remained entirely unaffected by heat. That was due to the low heat conductivity of concrete; indeed, it might almost be said that it is an insulator of heat—so much so, at any rate, that the hand can be borne on the top of a slab of concrete five inches in thickness under which a fierce fire has been raging for five hours or more.

This non-conductivity is well shown by the following account of a steam conduit built of concrete. The conduit was about 500 ft. long, and was built between a mill and a boiler-house, and was made just wide enough to take two steam pipes 6 in. in diameter and two smaller pipes. After the pipes had been laid in position a concrete cover was constructed over them, so as to render the conduit proof against any moisture in the soil or surface water. The conduit was carried some 2 ft. 6 in. below the surface—not sufficiently deep to be beyond the influence of the specially heavy frosts which were periodically experienced in the neighborhood in which the conduit was laid. The concrete troughing was left open at both ends, to make it easy to ascertain whether there was or was not any leakage. It was assumed that if any vapor was found to escape from either end of the conduit there must be some leakage which would permit the water to vaporize. The conduit was allowed to dry thoroughly, which took about two weeks; but no vapor has at any time been visible, and the loss of heat, which has been measured, through the concrete is so small as to be negligible.

The province of Quebec has constructed about 225 miles of macadamized roads and about 60 miles of gravelled roads this year. In all about 900 miles of roads have been constructed or have undergone extensive improvement, according to Hon. Mr. Taschereau, Minister of Public Works. The King Edward Highway is practically completed and about 40 miles of roads between Quebec and Montreal are at present under construction.

LETTERS TO THE EDITOR.

Further Discussion of "Bending Moments in Flat Slabs."*

Sir,—The paper by Mr. V. J. Elmont on "Bending Moments in Flat Slabs," published in your issue of September 25th, 1913, and the discussions which have followed it, disclose but one real criticism of the flat slab, namely, its lack of reinforcement, in a number of systems at least, at right angles to the edges of the slap in what might roughly be called the middle third of the space lying between the column centres.

That negative bending moments exist across strips having these edge lines as axes must be admitted by all who give any consideration to the matter. Their magnitude is unfortunately a source of much difference of opinion. Mr. Elmont estimates the maximum negative moment at the centre of an edge line and at right angles to it as $gl^2 \div 28.8$. The researches by Mr. Frank J. Trelease conducted on rubber models for the Corrugated Bar Company indicate a moment which, when expressed in Mr. Elmont's notation and in terms of the span centre to centre of columns, becomes $gl^2 \div 87.5$. It would be interesting to have Dr. Eddy's estimate of the magnitude of these moments, but notwithstanding Mr. Elmont's assertion that he (Dr. Eddy) had found far greater values for them than his critic had indicated in the original paper, Dr. Eddy nowhere in his treatise on flat slabs, so far as the present writer has been able to ascertain, attempts to assign a value to the particular moments under discussion. His brief consideration of them is concluded by the following general statement:—

"The curvature of these sections (normal to the edge lines) is controlled by the stiffness of the mushroom heads, which is so great as to make the curvature very small. No considerable tensile cross stresses are consequently to be apprehended; but in case the stiffness of the head were to be decreased, stresses might arise such as to develop longitudinal cracks over the middle rod of the side belts." Indeed, it could scarcely be expected that the advocate of a system without reinforcement for the resistance of a particular stress, would establish mathematically the existence of such a stress unless it were so small as to not exceed the safe resistance of the material at the section under consideration. The comparative silence of Dr. Eddy on this matter can scarcely be interpreted otherwise than as an admission of a stress condition somewhat difficult to meet with the rod arrangement of the mushroom and certain other systems.

The writer does not, however, support the view that the tensile stresses across the edges of flat slab panels are of necessity seriously objectionable. Undoubtedly the size of the column heads and the width of the diagonal belts of rods have an important bearing on the magnitude of these stresses. It is a fundamental principle of structural engineering that a load will divide itself among a number of resistance-paths in proportion to the rigidity of those paths. If, therefore, strong resistances are supplied by stiff column heads and plentiful diagonal reinforcement, the floor load will travel to the columns largely along these lines. But in a reinforced concrete slab, necessarily continuous in construction, one cannot force the loads to exclusively follow paths marked out by reinforcement steel. The presence of the concrete as a unify-

*This article appeared in *The Canadian Engineer* for Sept. 25th, 1913, and was discussed by Dr. H. T. Eddy and Mr. V. J. Elmont in Nov. 6th issue.

ing mass involves the transfer of a certain part of the loading to the side belts of rods along lines at right angles to them, and tension along these lines cannot be overcome, no matter how much diagonal reinforcement may be used. But if the tension is small, as it probably is in well-designed slabs, it should be no more objectionable than the tension which often exists over the tops of beams and girders in floors of ordinary reinforced concrete construction due to under-reinforcement for negative moment or the placing of the steel so low as to be quite ineffective for the purpose for which it was intended. In any event, it is not a question of the ability of flat slabs to support the applied loads with entire safety, but simply one of the probable effect of the existence of certain small edge cracks on the embedded steel or on the finished flooring. Corrosion tests conducted in Germany by Professor E. Probst have shown that cracks on the under side of concrete beams produced by stressing the embedded steel up to nearly the breaking point have no deleterious effect on the metal, so that it would appear safe to dismiss the former effect as of no great consequence. Cracks in the finished flooring would be objectionable only if visible, and as far as the present writer knows, these have not been observed in buildings with flat slab floors.

C. R. YOUNG,

University of Toronto, November 20th, 1913.

* * * *

Discussion of "Bending Moments in Flat Slabs."

Sir,—In an engineering discussion, fairness is presupposed on the part of those taking part therein, unless they have been misinformed. Mr. Elmont's discussion, noted in your issue of November 6th, hardly comes up to this standard.

He credits Mr. Mensch with being the first, to his knowledge, to have applied flat slab to actual building. The writer has noted Mr. Mensch's statement that he had used flat slab construction in the Armourdale Plant of the Procter and Gamble Company, and was sufficiently interested to write to the company for information, and the reply from their superintendent, Mr. Robert Anderson, states that 'the only concrete used in these buildings was the reinforced concrete foundations and footings. The buildings themselves were mill construction." Concerning the flat slab, Mr. Anderson states in another letter: "We beg to advise that this floor slab is in one portion of our Kansas City plant, and covers a room 100 feet square. This floor slab is directly on the earth and is designed to support tanks which have conical bottoms, distributing the weight of the entire tank on six columns around the periphery and one point in the centre. These tanks will hold 396,000 pounds of water each, this being divided on the seven points mentioned." Thus Mr. Elmont's knowledge of what Mr. Mensch accomplished seems to be somewhat misleading; that is, supposing the superintendent of the Procter and Gamble Company is familiar with the character of the construction of the buildings.

Mr. Elmont's remarks about Matrai are equally interesting. A mere resemblance in plan of the arrangement of reinforcing hardly proves the construction to be flat slab. Matrai's idea, as he has expressed it freely, was to put up a building which would not depend on the strength of the concrete. He would provide wires for tension members and girders to resist the pull of the wires, the concrete being merely spread upon the wire to distribute the load over these suspension members. A cheap concrete was to be used, cinder concrete, or even a natural cement mortar. The office of the concrete being merely secondary—a means of distributing the load over a steel system, and yet Mr. Elmont would have the readers infer that Matrai arranged the reinforcement for flat slab, a form of construction in which the motive was entirely different.

Equally interesting is Mr. Elmont's representation of the unreinforced or helpless character of the concrete in his so-called unreinforced areas. Placing the steel in the concrete does not prevent tensile deformations in the tensile zone. It merely limits or controls the magnitude of these deformations. If Mr. Elmont will consider the curves of flexure on which Grashof theory is based he will see that the tensions in the areas which he refers to are normal to the lines joining the columns, and hence can be resisted and controlled by steel in the same direction in the top of the slab in the area about the column, rather than in the areas midway between columns, and that steel in this area has greater load carrying power, hence designers of the Turner slab prefer to limit and control these stresses by steel placed in accordance with their standard design.

The writer will frankly agree with Mr. Elmont that the Deere and Webber test was not a sufficiently severe test to warrant very serious consideration. It was not the test load that was required by the city of Minneapolis, which demands ordinarily that the test shall be double the working load. On the other hand, when we bear in mind the fact that it requires a drop of only 23 degrees Fahr. to exceed the normal tensile strength of concrete, providing the ends of the slab are fixed, positive conclusions cannot be drawn from the discovery of a check in the slab. The safe plan is to see that the steel is there to take the tensions, and to count on the concrete for compression. A microscopic check which cannot be found except by the use of a magnifying glass should cause no one having an engineering education to consider the defect as sufficiently serious to merit extended discussion. The writer makes this statement, not with a view to advertising someone else, but merely as a question of fair dealing which should be recognized on its face as such.

Interesting misinformation is contained in his article as to what floors of ordinary buildings are designed to carry. The Turner slabs are designed for a working stress on the steel of 13,000. Sixteen thousand pounds working stress is used by the average structural steel engineer, and doubling the working load on a structural steel building, thus increasing this stress to 32,000 pounds, makes the stress in the steel only a shade under the yield point value of the metal, and eliminates the factor of safety. In the concrete structure, with 13,000 pounds working stress, we have an opportunity to put on 216 times the working load, live plus dead, without straining the steel more than would be the case in doubling the load on the structural steel building, and we have not anywhere nearly reached the ultimate strength of the construction. A mushroom slab which would ordinarily be rated at a 350-pound working load has been loaded to 3,300 pounds per square foot in the centre of the slab and deflected and bent out of shape 9 inches and still carried the load without further deformation. These are facts which rather upset Mr. Elmont's contention.

The average critic of flat slab construction, it would seem to the writer, has never heard of the fundamental theory of work enunciated by Clapeyron, almost seventy years ago, which principle has been developed so that the theory of work is used to-day in the computation of stresses in statically indeterminate structures in determining the deflections in all bridge structures, and forms the ground work in a large part of the science of structural engineering.

The consideration of the principle that the external work of the load must equal the internal work of deformation and that the active energy of the load passing through the height of deflection is stored up as potential energy within the slab, and a consideration of the manner in which this potential energy is stored up, should be sufficient to cause Mr. Elmont to admit frankly his error in the premises. If the radial deformation about the head at a given section at a distance R from the centre of the column and within the line of inflection be called ΔR, then the circumferential deformation must be $2\pi \Delta R$, and we can readily show that the amount of energy stored up in the circumferential direction is fully three times that which is stored up in the radial direction, and to assume with that in view that the same formula can be applied to the flat plate that is suitable for the beam strips becomes as absurd on its face as Mr. Elmont's endeavor to attribute to the man who put in a concrete foundation resting on the earth throughout, the origination of flat plate construction in commercial form in the floors of the warehouse buildings, a form so popular that it is almost universally imitated by all who are successful in concrete construction. Certainly it would seem that a reasonable degree to fairness ought to exist among engineers, and that they should not, without personal knowledge, undertake to assign the credit for a radical departure in modern construction to those who did nothing whatever toward materializing such construction. Hearsay evidence seems to be accepted without question by men with no legal training and frequently the mere assumption that certain conclusions without proof are a mechanical fact and are based on natural laws is also unfortunately a failing of the laymen, and it would seem to be the office of a reputable engineering paper to do all in its power to eliminate such error.

It should be noted that Mr. Elmont's final quotation from Professor Talbot, in the last paragraph of his reply, is with reference to the very cracks in the Deere and Webber test which were discussed in quotation from Professor Talbot made by Dr. Eddy, in which it was explicitly stated that "so far as any one knows, they are not detrimental to the structure." Mr. Elmont evidently disagrees with Professor Talbot on this point, but he will have to adduce far more convincing reasons in support of his position than he has yet given before the profession will be willing to agree with him rather than Professor Talbot.

C. A. P. TURNER.

Minneapolis, Minn., Nov. 11, 1913.

* * * *

[Mr. Elmont was furnished with a copy of the above communication, and in reply, he has transmitted the following.—Ed.]

Sir,—In November 6th issue of this journal the writer answered a discussion on his paper "Bending Moments in Flat Slabs," sent in by Dr. Eddy. Now Mr. C. A. P. Turner takes the word from his mathematical assistant, continuing his discussion.

In answering, the writer considers it necessary to remind Mr. Turner that the point of the writer's paper was, to show theoretically what he considers has been shown practically by Prof. Talbot's careful testloading of the Deere and Webber building, i.e., that there are heavy negative bending moments perpendicular to the sides of a flat slab panel; these should be provided for by placing reinforcing steel where the moments act and in quantities depending on the value of the moments. Most flat slab designers, including Messrs. Eddy-Turner, do not adopt this arrangement.

Messrs. Eddy-Turner's practical reason for not wishing to adopt the writer's recommendation seems to be that numerous testloadings of flat slabs have shown that their design is safe, these slabs having been designed in their usual way with an allowable steel stress of 13,000 lbs. per sq. in. This argument, however, carries no conviction to the writer's mind; firstly, because a safe structure according to the Eddy-Turner definition is one which can "carry twice the live load without failure and can do this for months at a time without signs of distress"; as explained in the writer's answer to Dr. Eddy this definition is unsuitable to efficient structural engineering. Secondly, the writer thinks that no conclusions about the point of his paper can be drawn from Messrs. Eddy-Turner's testloadings because they have not been conducted carefully enough—as it also was said in a recent discussion in the American Society of Civil Engineers—"they are largely confined to the loading of single bays and deformations or strains not measured."

The second and third last paragraphs of Mr. Turner's discussion are, the writer assumes, intended as a theoretical explanation of his standpoint; the main words contained in them seem to be statically indeterminate structures, Clapeyron's theory and potential energy. Though the writer has had the opportunity to calculate and build a number of statically indeterminate reinforced concrete structures, and is familiar with Clapeyron's theory and the definition of potential energy, he is at a loss to get any sense out of these two paragraphs, and therefore is unable to pass any opinion about the wisdom contained of them.

The writer had no reason to doubt the source from which he received the information that Mr. Mensch was the first engineer who used reinforced concrete flat slabs in an actual building, hence his statement that credit was due to him. If this is not the case, credit is due to somebody else for it, *palmam, qui meruit, ferat*. No matter who it is, it is not of any consequence in connection with the point of the discussion, the distribution of bending moments in flat slabs.

V. J. ELMONT,

Montreal, November 17th, 1913.

A general survey of the mineral production of Canada for 1912 has been issued by the Department of Mines in the Dominion Government. The total value of last year's output, the greatest yet on record, was $135,048,296. This is an increase on 1911 of $31,827,302. Since 1886 mineral production has risen from $2.23 to about $19 per capita. Ontario leads the list with a production of $51,985,000, British Columbia comes second with $30,000,000, and Nova Scotia third with $18,922,000. A substantial increase in the price of most metals was a feature of the year, as was the extended development of ore reserves, pointing to much greater annual outputs in the future. Coal has been the most important product in point of value with a total production of $36,019,044; silver coming next in importance and nickel, copper and gold following. With the exception of petroleum every important mineral mined in Canada showed an increased production in 1912.

SOME NOTES ON HIGH RAILWAY ABUTMENTS.

By Alan Fraser, B.A.Sc.,
Assistant Engineer, Frank Barber, Toronto.

THE bridge seat of railway bridges is often high above water level or above the elevation of some similar obstacle to be crossed, such as another railway track or a highway. Therefore, occasions may frequently arise wherein the back fill or embankment supporting the track may be allowed to fall in front of the abutment shown by the *RD* in Fig. 1. This does not necessarily mean that the fill may come into contact with the surface of the bridge seat, such a condition being, to say the least, bad practice, and is in most cases not permissible. Attention is called to this fact in order to more fully appreciate the following, it being sufficient to state that the back fill should not, under any conditions, encroach upon the bridge seat.

With this in view the following points should be kept in mind when designing:—

(1) With a ballast wall on top.

(2) Angle between back of ballast wall and vertical axis, designated by θ.

(3) Angle of repose of the back fill.

(4) Distance from top of ballast wall to the bridge seat, designated by *S*.

A little thought will convince the reader that, other things being equal, the solution of the problem of keeping the back fill away from the bridge seat becomes easier as the angle of repose of the back fill increases. The ballast wall is, generally speaking, that part of the abutment immediately above the bottom of the bridge seat.

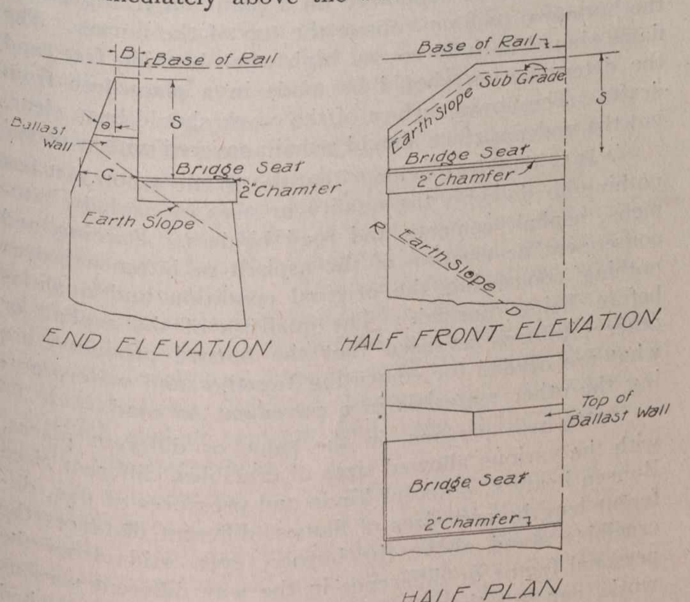

Fig. 1.

The frost batter is merely the slope on the back of the ballast wall.

Where, in Fig. 1,

B = width at top of ballast wall,
S = distance from top of ballast wall to the bridge seat,
θ = angle between back of ballast wall and the vertical axis,
C = width of the ballast wall in the same horizontal plane as the bridge seat.

Then, $C = B + S \tan\theta$ thus giving an empirical method for obtaining the thickness of the ballast wall in the plane of the bridge seat.

As the distance, *S*, becomes greater the problem of keeping the back fill away from the bridge seat increases in difficulty where wing walls are dispensed with. Where *S* becomes as high as eight feet, walls known as "lug walls" are used. These project left and right from the ballast wall. They are simply a continuation of the ballast wall and are shown in Fig. 2. It may be well to mention here that *S* increases in direct proportion to the increase of the span of which the bridge seat is an end support. The lug walls are developed to withstand as much of the

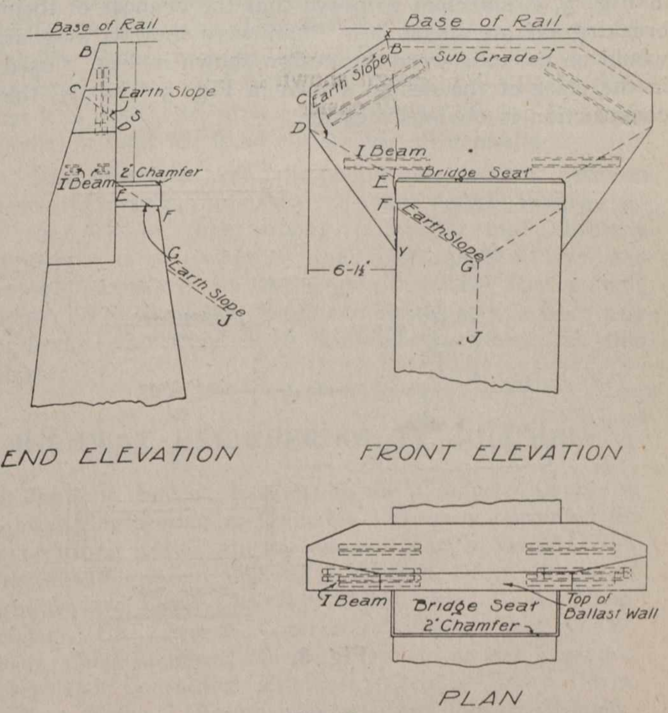

Fig. 2.

tendency to break off along the line xy as possible. It is not uncommon to use old rails or small I-beams as a reinforcement for these lug walls. The trained engineer need not be informed that the webs of I-beams should be in the vertical plane, so that the webs take up as much of the shear through xy as possible. The reinforcement of the projecting lugs is placed as economically as good practice will permit. The webs of I-beams, when used, may be assumed to take up all the shear that the concrete cannot resist, and this excess of shear is assumed to be distributed evenly over the webs. The reinforcement should be placed as near the back fill as possible, so that any tendency the back fill may have to snap off the projecting parts is, to a certain extent, overcome.

There is, of course, a limit to the safe projection of the lug walls. If beyond 5 or 6 feet, it may be expected that great difficulty will be experienced in their construction. The cost of the lug walls and the tendency (in spite of reinforcement) for them to break off becomes excessive. The attention of the reader is called to an article in October 23rd, 1913, issue of the "Engineering News," which treats with this type of abutment.

Where the depth *S* becomes over 12 feet (approximately one-tenth of the span) a patented design (No. 150003) obtained in August, 1913, by the writer, overcomes the problem of designing an economical, safe and easily constructed abutment without wing walls. This is shown in Fig. 3. The lines designated KL, LM, MN, NO, OP, PQ correspond with the surface of the back fill during its fall from K to Q. The back fill will be observed to leave the bridge seat entirely free from encroachment.

Comparing this design with that shown in Fig. 2, where BC, CD, DE, EF, FG shows the surface of the back fill during its slope from B to G it will be observed that a considerable amount of concrete is saved. For a 120′ 0″ span the use of the abutment shown in Fig. 3 means a saving of approximately eight to ten yards both for single and double track lines. The fact that the projecting lugs in Fig. 2 are reduced from 6′ 1½″ to 2′ 6″ in Fig. 3, is sufficient to prove that the chances of their breaking off are much less than were they as long as would be the case were the design shown in Fig. 2 used in the place of the design shown in Fig. 3. Lastly, the construction is obviously easier.

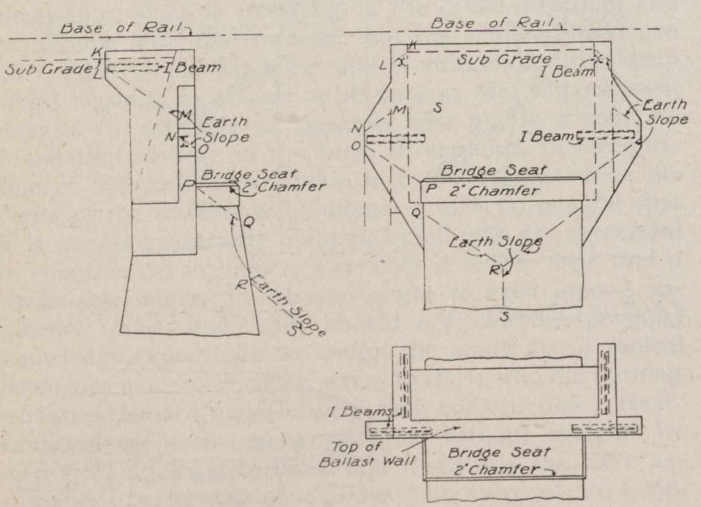

Fig. 3.

In order to keep the earth away from the bridge seat, it would, of course, be theoretically possible to reduce the length of the lug walls by constructing small curtain walls at both ends of the bridge seat. If this were done, however, the curtain walls would form a trap, as it were, between themselves and the steel deck girders. In this receptacle, however, the ice and snow collected during the winter would melt in the spring and tend to rust out the bed plates. Furthermore, there is a possibility of these curtain walls being destroyed during the erection of the steel work. In one case that the writer has observed, huge vertical columns of solid concrete were used to support the greatly extending and unsupported lug walls. The saving in concrete due to the absence of wing walls became almost a negative quantity.

Transcona Board of Trade is advocating a "good roads day," in which citizens of Transcona and those of Winnipeg (whose interests are more or less directly concerned in the building of an improved road to connect the two places) will be expected to turn out to make a good highway from Winnipeg to Transcona.

Railroads covering nearly a billion locomotive miles are in the competition for the first award of the E. H. Harriman Memorial Medals, which will be made at the First International Exposition of Safety and Sanitation, to be held in New York City, December 11th to 20th, under the auspices of the American Museum of Safety.

FIXED CARBON TEST.

"THE Fixed Carbon Test, designed for coal, has practically nothing to do with the finished quality of a refined asphalt, asphalt cement or road binder. It is a brand-identifying test."

The above extract from an article which he recently wrote, clearly indicates the opinions on the fixed carbon test that are held by J. W. Howard, C.E., E.M., of New York, whose work as a consulting engineering-chemist has been chiefly notable in the bituminous field. Col. Howard discusses the value of the fixed carbon test in more detail in the following letter:—

"The question has often been asked by city and state engineers, as well as many producers of excellent asphalt and bituminous cements and road binders, what, if anything, has the 'fixed carbon test' to do with the quality of these products for pavement and road construction? The answer is that it has nothing to do with the qualities of these materials. Fixed carbon is not a definite substance nor quality in any given coal or other material. It constitutes the results of an arbitrary test of the approximate portion of coal, which will remain and continue to burn and give heat after relatively light, volatile hydrocarbons have been partially burned away by flame. This test was devised solely for coal, by the committee on coal analysis of the American Chemical Society, and published in the Journal of the American Chemical Society, 1899, No. 21, p. 1116.

"The test is made briefly as follows: One gram of coal is put in a 'platinum crucible weighing 20 or 30 grams and having a tightly fitting cover. Heat over the full flame of a Bunsen burner for seven minutes. The crucible should be supported on a platinum triangle with the bottom 6 to 8 cm. above the top of the burner. The flame should be fully 20 cm. high when burning free, and the determination should be made in a place free from drafts. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon.'

"It is therefore evident that the fixed carbon test has nothing to do with the quality or uses of asphalt, bitumens, asphalt cements and road binders. Burning and consequent destruction of the asphalt or bitumen proves nothing concerning the original condition and qualities before being burned. The qualities of the asphalt or other bitumens as used (not the burned products) are what are needed for cementing together and waterproofing the other materials in a pavement or road.

"No two persons, in the same or different places, with the various allowed sizes of crucibles, different sized Bunsen heaters, different kinds and pressures of gas, different lengths and sizes of flames, different distances the crucibles stand above the burner, even aside from the personal factor or difference in the way different persons work, can get the same quantity of fixed carbon (ashed free) or otherwise from the same sample of coal or other substance. When this variable process is applied to an asphalt or bituminous substance, even more widely varying and discordant results are obtained. It cannot be used as a basis of comparison of asphalt and bituminous materials, nor as a proof of their good or bad qualities.

"The attempted introduction of the fixed carbon test for coal into the asphalt industry has nothing to do with the determination of quality; nor can any minimum or maximum amount be set for this alleged test, between which all good asphalts and bitumens will come. Some good ones will be outside such limits, and some poor, worthless asphalts and bitumens will be inside any limits attempted to be established by fixed carbon requirements. This test is sometimes used by chemists simply as a small but imperfect indication, taken with other special chemical tests, to identify, if desired, an unknown or unnamed brand of asphalt, but has nothing to do with quality. This test should not be placed among the tests for quality of asphalt, nor any road building materials.

"The fixed carbon (coal test) should be ignored if still found in asphalt or bituminous specifications, and not enforced, not only on engineering, but also on legal grounds, that 'the test does not apply to or establish any quality of the material necessary for the construction made or to be made,' i.e., in this case it does not apply to refined asphalt, asphalt or bituminous cement or road binder for constructing and waterproofing roads or pavements."

Col. Howard admits that a great deal of chemical and physical research work is necessary and useful to those who obtain crude materials and manufacture refined asphalts, road binders, etc., but he claims that research tests should not appear in specifications for pavements and road construction. He includes the fixed carbon test among the purely laboratory tests which do not apply directly to the quality of finished asphalt products and which, he says, are now best omitted from specifications.

"The determination of the amount of hydrogen, carbon and other ultimate elements of asphalt is interesting as a scientific study," says Col. Howard, "and bear somewhat upon the commercial and engineering problems connected with the sources of supply and manufacture, but have no place in contracts and specifications. Standard methods of making the tests to establish the requisite qualities (of asphalt, etc.) are found in various publications of the American Society for Municipal Improvements, the American Society for Testing Materials, the reports of the Association for Standardizing Paving Specifications, and in various other publications.

"A set of 'Standard Tests for Asphalt Cements for Sheet Asphalt Pavement' with numerical requirements or standards, prepared by the writer, will be found in the Proceedings of the American Society for Municipal Improvements for 1911. A few of them are no longer needed for specifications but were inserted to check or confirm some of the other tests. The requisite qualities which good asphalt cements and road binders should possess are found in many products made from crude materials coming from California and other parts of the United States, from Mexico, Cuba, Trinidad, Venezuela and elsewhere, all of which asphalt cements and road binders are in successful use everywhere."

In the introduction to an article that appeared in Engineering Record recently, Col. Howard said: "The city, county, state and independent users are not concerned in the geographical source or crude materials from which asphalt products are manufactured. Specifications should have no requirements regarding the source of supply or the crude materials, nor the manner by which they are made into asphalt products. That is solely a matter for the manufacturers. Contracts should specify the qualities and tests needed for good asphalt cements or binders for use in pavement surface layers, just as they specify the qualities and tests needed for good Portland cements for use in foundations.

"Objectionable specifications which 'let in' or 'exclude' one or another asphalt, with few real quality tests, have lately been used for some highways. This is done by inserting irrelevant or useless tests for gravity, fixed carbon, paraffine, sulphur, etc., with special requirements or limits which fit the peculiarities of certain limited asphalt products, to the exclusion of others equally as good or better. Standard, essential, and useful tests are partly included and partly omitted, according to whether or not the asphalt product, thus secretly described (except to an expert), meets good requirements or not. Such wrong, unwise, and unjust specifications are being steadily eliminated by good men."

Readers who noted Mr. Pullar's suggestions of methods for making the fixed carbon test of increased value, which appeared in the Nov. 13th issue of *The Canadian Engineer*, and those also of Mr. Law, appearing in last week's issue, will notice the marked difference of opinion between Col. Howard and Mr. Law on one side and Mr. Pullar with an opposite view as to the value of the fixed carbon test; although all three evidently think that it is useless to write a specification naming the same maximum limit for fixed carbon for all asphalts.

The difference of opinion on this subject between these writers is indicative of the doubt that exists at the present time among municipal and highway engineers as to whether the fixed carbon test has properly a place in their specifications for asphalt supply. *The Canadian Engineer* invites letters from any engineers who may have well-defined views on this subject.

HIGHWAY ENGINEERING AT COLUMBIA.

The non-resident lecturers in the Graduate Course in Highway Engineering at Columbia University appointed for the 1913-1914 session are as follows: John A Bensel, New York State Engineer; William H. Connell, Chief, Bureau of Highways and Street Cleaning, Philadelphia; C. A. Crane, Secretary, the General Contractors' Association; W. W. Crosby, Chief Engineer, Maryland Geological and Economic Survey, and Consulting Engineer; Charles Henry Davis, President, National Highways Association; John H. Delaney, Commissioner, New York State Department of Efficiency and Economy; A. W. Dow, Chemical and Consulting Paving Engineer; H. W. Durham, Chief Engineer of Highways, Borough of Manhattan, New York City; C. N. Forrest, Chief Chemist, New York Testing Laboratory; Walter H. Fulweiler, Chief Chemist, United Gas Improvement Company; Frank B. Gilbreth, Consulting Engineer; George P. Hemstreet, Superintendent, the Hastings Pavement Company; Samuel Hill, President, American Road Builders' Association; D. L. Hough, President, the United Engineering and Contracting Company; J. W. Howard, Consulting Engineer; Arthur N. Johnson, State Highway Engineer of Illinois; William H. Kershaw, Manager, Paving and Roads Division, the Texas Company; Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment; New York City; Harold Parker, First Vice-President, Hassam Paving Company; Paul D. Sargent, Chief Engineer, Maine State Highway Commission; Philip P. Sharples, Chief Chemist, Barrett Manufacturing Company; Francis P. Smith, Chemical and Consulting Paving Engineer; Albert Sommer, Consulting Chemist; George W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn, New York City.

Electric blasting is being employed in certain mines in South Africa. The whole of the one level at a leading mine was fired recently by the new system. There were 300 shots in the blast, which was effected from a station, only one man being required below for the firing. Cables are now placed to enable blasting to be effected from the surface. The system so far has proven satisfactory.

TORONTO FILTER SPECIFICATIONS

BOARD OF CONTROL AUTHORIZES CALL FOR TENDERS FOR MECHANICAL PLANT OF SEVENTY-TWO MILLION IMPERIAL GALLONS DAILY CAPACITY — RESUMÉ OF ESSENTIAL PARTS OF CITY ENGINEER'S SPECIFICATIONS

TORONTO'S Board of Control yesterday gave formal permission to Commissioner of Works R. C. Harris to advertise for tenders for a complete mechanical filtration plant at Toronto Island, the plant to include pumping station, chemical storage room, coal storage building, filter house, mixing tanks, coagulating basins, clear water basins, filter units with complete equipment, crane, pumps, valves, boilers, chimney, turbo-generator set and all appurtenances.

The estimated cost is approximately one million dollars. The specifications require that work shall be commenced within ten days after the execution of the contract, and shall be carried on without delay, so that one-half of the filter plant and all its accessories shall be in satisfactory service not later than December 31st, 1914. A bonus of one hundred dollars a day is offered for completion of the first half of the plant earlier than that date, and a penalty of two hundred dollars a day is imposed for non-completion of the first half of the plant by that date. Should the plant not be completed within sixty days after December 31st, 1914, the penalty then increases to three hundred dollars a day.

It is also required that the whole filter plant shall be completed and operating satisfactorily not later than September 30th, 1915, and a penalty of fifty dollars a day is imposed for delay beyond that date, allowances in every case, of course, being made for delays caused by strikes, or by any act of the City Council, or on account of additional work ordered, or for any other delay for which, in the opinion of the Commissioner of Works, the contractor cannot be held responsible.

"It is the purport of these specifications and also of the instructions to tenderers to obtain bids for a plant which will be first-class in every respect and equal to the best on this continent, and complete in every detail, and ready to operate." This sentence in the specifications expresses the spirit in which the Works Department is regarding this plant. The Commissioner of Works and Engineers Powell, Milne and Barr, who have all done notable research work in gathering data for the preparation of the specifications for this plant, are determined that Toronto shall have a filtration plant that will not be outranked by any on this continent, and in the specifications they have guarded the plant, seemingly, in every possible way.

Specifications Ensure Good Plant.

It is the intent of the specification to permit bids to be submitted by the proprietors and licensees of any mechanical filter, provided they comply with the guarantees and duties required by the specifications. Yet, the provisions made regarding guarantees, bond and surety regulations are such as to ensure the city's receiving bids only from firms who are financially responsible and who have absolute faith in their ability to live up to the guarantees required.

A marked cheque or cash deposit is required for the sum of two and one-half per cent. of the value of the tender. A satisfactory bond must be furnished to the full extent of the contract price for the proper performance of the work, and in addition to this a bond will be required for five years from date of acceptance of the completed plant by the city, for the cost of the foundations, substructures, superstructures and chimney, in order to guarantee their not failing. This is on account of the sand on which they must be built. Similarly, all machinery, equipment and appurtenances must be guaranteed free from all visible or inherent defects for one year from date of acceptance. Eighty per cent. of the value of the work done and materials incorporated in the work will be paid monthly by the city. One year from the date on which all tests as to efficiency and capacity have been made, and the plant and all its accessories accepted as satisfactory to the Commissioner of Works, the remaining twenty per cent. will be paid. Payments may be withheld at any time if the work is not proceeding in accordance with the contract.

Besides being protected by the heavy guarantees required and the general rigid and high character of the entire specification in all details, the plant's success is further guarded by the requirements imposed regarding responsibility and reliability of the contractors. The specification says:—

"Bidders must furnish satisfactory evidence of their experience and ability to construct this class of work, and that they have construction and financial resources to enable them to prosecute the same successfully and promptly, and to complete the work within the time named in the contract. Evidence must be submitted showing positively that the tenderer has designed or constructed similar work."

Strainer System Must Be Perfect.

All modern appliances are specified under the heading of "filter equipment," and special attention is given to the strainer system. The specification says that while it is not the intention to limit the tenderers to any particular type of strainer system, it must be distinctly understood that anything in the nature of an experiment will be prohibited. Should tenders cover any design that has not been in successful operation for at least three years, the city will require a bond for the sum of seventy-five thousand dollars for the proper maintenance of such a type of strainer system for a period of five years after the completion of the plant.

Tenders must be mailed by registered post and will be received up to noon, January 20th, 1914. The Works Department will examine and compare the various tenders and expect to award the contract about three weeks after receipt of tenders. Each tenderer will be required to submit a full set of plans drawn to scale, showing the general arrangement of the plant in relation to the existing slow-sand plant and connection thereto, also showing the position of the pump room, coagulating basin, filters, etc. There drawings must show in detail the entire plant. In other words, they must be descriptive of the system by which the tenderer expects to live up to the guarantees required in the specification. Two months after the award of the contract, the successful tenderer must furnish in duplicate accurate drawings showing all parts of the plant in such detail that the whole may be erected from those plans.

While the city specifies that the plant must be "mechanical," that is slow-sand designs are barred, the competition is open to all types of mechanical plants, whether pressure or gravity, patented or unpatented, provided, of course, that all guarantees required are furnished and all other conditions of the specifications complied with.

The specification is very complete, comprising eighty pages of printed matter, with an appendix giving a very useful index to contents. The language used is clear and concise, and the general arrangement of the specification lends itself to the easy finding of any particular portion.

As previously stated in *The Canadian Engineer*, the plant is to be capable of satisfactorily filtering continuously sixty million Imperial gallons every twenty-four hours, with a maximum capacity of not less than thirty million Imperial gallons during any ten hours. The effluent at all times is to be of the standard of purity required by the specifications. This, of course, practically means that the plant must have a daily capacity of seventy-two million Imperial gallons.

Pure Water Assured.

The contractor will be required to guarantee that the mechanical filtration plant which he proposes to furnish, will remove 90 per cent. of all organisms where there are 50 to 500 bacteria per cubic centimeter in the unfiltered water; will remove 95 per cent. of all organisms where there are 500 to 2,000 bacteria per cubic centimeter in the unfiltered water; and 98 per cent. of all organisms where there are 2,000 or more bacteria per cubic centimeter in the unfiltered water.

The contractor must also guarantee removal of 98 per cent. of the B. Coli as determined by the standard methods for the examination of water of the American Public Health Association. All turbidity must be removed, leaving a bright, colorless water, free from taste. Such results must be guaranteed by the use of not more than one grain of alum per Imperial gallon of water, under average conditions. Where such is required, a sedimentation period of not less than three hours must be provided for after the addition of alum.

Each tender must be accompanied by a report of some similar plant, municipal or otherwise, of at least one-half million gallons daily capacity, such report having been made by a reputable disinterested bacteriologist, and showing the daily bacteriological analyses of the water before and after filtration for a continuous period of at least thirty days, including the percentage of B. Coli organisms removed, as well as the percentage of the total number of bacteria; also showing the removal of suspended matter, and the nature of the effluent.

A schedule of quantities must be furnished, showing in detail the prices of the various classes of work and articles to be supplied, which make up the total tender price. These unit prices are for comparison only, and if the contractor finds he has underestimated quantities he can make no claim for extra remuneration, but must supply the additional quantities necessary to the work. The idea of obtaining unit prices is good, as it allows of much fairer comparison of tenders. A firm whose bulk tender is higher than another firm's may really be figuring on lower unit prices, but the higher firm's plans would then call for more material in the work. It would then remain for the Department of Works to determine whether the greater amount of material would add anything to the stability or efficiency of the plant; also whether the lower firm had made up their low bid by skimping quantities.

The Work Involves Difficulties.

The building of the plant involves engineering and contracting difficulties, and for that reason the specification requires all tenderers to visit the site of the plant, and to familiarize themselves with existing or future obstacles to speedy and safe construction. None of the material excavated from the foundations or otherwise, nor any of the material adjoining the filter plant, or on the Island, or under the waters in the vicinity of the Island, can be used in the construction of the work, without the express consent of the Works Commissioner. It is thought that this is to avoid a repetition of troubles encountered during the construction of the existing slow sand plant.

Tenderers must describe thoroughly the method that they propose to adopt in all the foundations required. The concrete work is well guarded by the specifications, which give instructions regarding materials to be used, the placing, setting and waterproofing of the concrete work. The mixtures to be used are to be satisfactory to the Works Commissioner. The contractor must provide reliable means for handling the water, which may prove troublesome in excavations at the Island, and he must not allow the water to rise above the lowest point to which he excavates. Duplicate machinery, if required, must be provided by the contractor, so that positive drainage is assured.

While it is the intention of the city to have wash-water pumps, air-blowers and other apparatus requiring small power units, operated by electrical motors, contractors are requested to put in an alternative bid for other drives for the three low-lift pumps required. Alternative No. 1 permits these low-lift pumps to be driven by vertical, compound or triple expansion condensing engines. Alternative No. 2 permits these low-lift pumps to be driven by gas engines or in any way desired by the tenderer. In deciding whether to substitute either of these alternatives for the electric drive, the Works Department will take into consideration the cost of transporting coal, etc., to the Island.

The contractor must state in his tender when one-half of the filter plant will be completed, and ready to operate, and when the filter plant as a whole will be completed and ready to operate. Should these dates of guaranteed completion be earlier than December 31st, 1914, and September 30th, 1915, respectively, that fact would undoubtedly be a point in favor of that tenderer. The reason that the Works Department is placing a bonus, as mentioned above, on the early completion of the first half of the plant is that they really need the thirty million gallons of filtered water that one-half of the new plant would give them daily. The existing slow sand plant is not filtering the full requirements of the city.

Must Live up to Guarantees.

The Medical Officer of Health is to test the plant for clarity of effluent and bacteriological efficiency within three months after the plant, or portion thereof, is placed in operation, and in the event of failure to fulfill the guarantees the entire plant may be rejected and all payments to the contractor recovered.

The whole of the work must be carried on and completed without interference with, or interruption of, the operation of the present slow sand plant. The contractor cannot assign, or sublet, any portion of the work without the consent of the Works Commissioner.

The specification includes, of course, all the usual clauses regarding tests, workmen's rights, progress certificates, inspectors' powers, etc., but the following points covered by the specification may be interesting to engineers and contractors interested in water supply problems:—

It is the intention to utilize the present clear water reservoir, which has an area of 2.2 acres with a depth of 12 ft., but it is probable that some bidders may require a clear water basin. If so, cost of same must be included in tender. The work also includes:—

The necessary number of mechanical filter units of four million Imperial gallons each, or approved equivalent. These units to be complete with all appurtenances. Filters will be grouped on both sides of the piping gallery, which will be utilized as an operating platform. Filter tanks to be of steel or reinforced concrete. Filters to discharge into clear water reservoir at Elevation 45, Toronto datum.

The low lift pumping machinery shall comprise three centrifugal pumping units, each of not less than 36,000,000 Imperial gallons capacity per 24 hours. Units to be capable of pumping from an elevation of 30 (Toronto datum) to whatever height is necessary for delivering the water to the filters.

The necessary wash water pumps connected to the tank. Each pump shall be of ample capacity to supply all the wash water required for the entire plant.

The necessary air-blowers, each of which shall be of ample capacity to supply all the air required at the desired pressure for washing.

Interesting Specification Details.

All piping and connections from shore end of existing intakes to pumps, including hydraulically operated valves, together with well and surge overflow, all furnished and erected in place.

The amount specified by tenderer for coal storage shall provide for a building capable of storing not less than 1,500 tons of coal, and shall include coal-handling apparatus from scow to storage building, and from thence to boiler-room.

The low lift pumping station shall be of ample size and proper construction to accommodate all the apparatus requisite for pumping the water, together with the wash water pumps, air-blowers, travelling crane and other machinery, and also to accommodate certain enumerated machinery that will be moved from the old to the new pumping station, as the old station is crowded.

The window frames and sash of all buildings shall be of approved pressed steel, fitted with first quality wired glass.

All plans and specifications submitted by the tenderers shall become the property of the city, and must be specially prepared for this work, and be in sufficient detail so that the quantities of the work and materials can be computed with accuracy.

The contractor shall furnish and install all the necessary filter equipment, including strainer system, filter piping, the necessary hydraulically operated valves, all the operating tables, loss of head gauges, air and wash-water gauges, recording gauges for wash-water tank, measuring apparatus for automatically recording the amount of wash water used, filter sand, filter gravel, rate controllers, wash-water pump and gutters, air-blower with requisite motive power, sampling devices, water meters.

Tenderers may also tender on a combined air and water wash, consisting in the application of both compressed air and filtered water through the strainer system.

Tenderers may bid on a separate air and water wash, comprising the application of compressed air through a separate air-distributing system of perforated brass tubes and of the filtered water through the strainer system.

The general design of the strainer system shall be such, that in combination with other parts of the filters and filter piping a uniform distribution of wash water and of air, if used, shall be ensured over the entire bottom of the filters; it shall be designed so as to completely drain the bottom of the filters; the system shall be substantial, and provision made that the parts may be readily renewed. Further, the individual openings in the system shall be large enough so as not to be easily clogged, and yet small enough and so formed as to secure uniform distribution of the wash water.

Operating Equipment Complete.

The contractor shall furnish and install on each operating table a loss-of-head gauge of approved type, complete with all the necessary floats, float tube, counter-weight, wire, pulleys and other appurtenances. The gauge shall be arranged to accurately record the loss of head through the corresponding filter by means of an approved pen upon a chart mounted on a disk or drum revolving once in twenty-four hours, graduated in an approved manner, so as to report distinctly losses ranging from zero to the maximum, while the travel of the pen is about 6 inches. The float tubes shall be 8-inch galvanized wrought iron pipe of ample length, capped at the lower end, and securely fastened in a truly vertical position. Floats shall be seamless and spherical, about 6-inch diameter, and made of copper. The connections from the filters and effluent pipe shall be of not less than ¾-inch brass pipe, with brass nipple, through the wall of the filter.

Provision must be made to prevent the entrance of wash water or sand into the float tubes. The mechanism of the gauge shall be of brass enclosed in a strong, neatly finished, heavily nickel-plated brass case, same to be accessible for adjustment and repair. Connection shall be made to the tubes to permit of adjustment and drainage, and valves shall be placed on the connections between the tubes and the filter wall or effluent line respectively.

Special care shall be taken in transporting and placing filter sand to prevent contamination of any sort, and sand which may have become dirty, either before or after placing in the filters, shall be washed or removed or replaced by clean sand in a satisfactory manner. All contaminated sand shall be rejected. After sand is in place in the filters it shall be washed at least ten times with the washing devices connected with the filter, and the fine sand appearing at the surface shall be removed by scraping or otherwise. Sufficient sand shall be placed in each filter bed to secure a layer of the proper depth required for giving the most efficient results after the sand has been washed and scraped. The contractor must state the depth of filtering medium in inches required in the filters, and he must also state the effective filtering surface, and the rate of filtration in Imperial gallons per sq. ft. per hour.

The contractor shall furnish and erect in suitable location, approved by the Commissioner, one chimney not less than 120 feet in height above the grate bar level, with an inside diameter not less than 84 in. This chimney may be built of buff brick or other approved material, and provided with stranded copper lighting conductor, with all necessary ground and other connections, and of design approved by the Works Commissioner.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

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BOOK REVIEWS.

GRAPHICS AND STRUCTURAL DESIGN.—By H. D. Hess, M.E., Professor of Machine Design, Sibley College, Cornell University. New York: Publishers, John Wiley & Sons, Inc., London; Canadian selling agents, Renouf Publishing Company, Montreal; pp. viii. + 426; 361 text figures; cloth; 6 x 9 inches. Price, $3.00 net.

Reviewed by C. R. Young, M. Can. Soc. C E.,
Assistant Professor of Structural Engineering, University of Toronto.

In spite of the frequent condemnation of general treatises on structural engineering, there exists a considerable demand for such works. Many engineers, whose activities lie mainly outside the structural field, as well as those just entering it, feel the need of a simple, elementary, immediately-usable book on the design of a variety of ordinary, everyday structures. Numerous attempts to meet this demand have been made, and it must be admitted that they have not always been attended with success. Inadequate and erroneous treatment of the subjects discussed, with the complete neglect of others equally important, has so frequently characterized such efforts that the chances of the reader deriving any real assistance from a book of this kind purchased at random are small, indeed.

The present volume is an unusually successful venture in this difficult field. The author's special object is the discussion of useful problems "on the border line between Civil and Mechanical Engineering," and, while the book is intended for student use, it cannot fail to be of very real value to any one whose work is not too highly specialized.

Of necessity, many subjects must be treated in the borderland which Professor Hess indicates as the field of his book. The subject is introduced by the presentation in the first chapter of general data on materials, common formulas and properties of sections. Chapters 2 to 5 are devoted to graphical and analytical methods of analysis of structures, including the method of influences diagrams. Chapter 6 concerns riveted connections. Columns are given an effective short treatment in Chapter 7. A variety of steel structures are then given consideration, covering conveyer girders, trussed and suspended pipes, transmission line towers, mill buildings, a railway girder span, crane frames and bridges of travelling cranes. Unfortunately, no attempt is made at stress analysis in the case of transmission line towers, although a few pages on this subject would have supplied a very real present need in engineering literature. The author's reason for designing a railway plate girder was that it made a more comprehensive and better problem than a runway girder, and one who could design the former was well prepared for the simpler structure. A particularly useful portion of the book is the 28 pages devoted to the detailed design of the structural parts of jib and travelling cranes. In reinforced concrete, slabs, beams and columns are covered in a concise manner. Foundations, including those for machines, form the subject of Chapter 15. A very valuable chapter is that on chimneys, comprising the design of these structures in brick, steel and reinforced concrete. Chapter 17 contains a discussion of retaining walls, with a detailed design of a typical wall, while Chapter 18 is given to the consideration of the allied subject of bins. Floors, walls and roofs occupy Chapters 20 and 21. One of the most valuable features of the book is the inclusion of authoritative specifications covering materials, design and workmanship in both steel and reinforced concrete structures, and such clauses as are necessary to cover the timber and masonry work entering into ordinary structures. The volume is concluded with 195 useful problems.

One does not find it difficult to commend the book. Indeed, every mechanical engineer who has to do with structural problems at all, and every civil engineer who must at times concern himself with the structural features of the mechanical engineer's work should possess a copy.

Overhead Electric Power Transmission.—By Alfred Still. Published by McGraw-Hill Book Company, New York. 306 pages; illustrated; cloth; 6 x 9 inches. Price, $3.00 net.

Reviewed by Prof. H. W. Price,
Department of Electrical Engineering, University of Toronto.

Books have been published which deal copiously with problems of engineers in charge of construction of lines for high and low voltage and of moderate and large capacity. Other books treat the complicated problems of high-voltage, long-distance transmission. This book by Mr. Alfred Still is aimed directly at a composite field, of special value and convenience to engineers having under consideration the design of a transmission system for estimated service.

Three outstanding features of this book are these: (1) It is evidently written by a man who has been "through the mill," and has known the inconvenience of searching here and there for specific information on methods of arriving at the best choice of details of a transmission system for given service under specified operating and financial limitations. The book resembles the notes of such a man, who took time to systematically arrange and elaborate the problems he considered, and examples of his methods of solution.

(2) The information contained is thoroughly cross-indexed for convenience of the reader. An unusual supplementary index of formulas, data, charts, sample calculations,

etc., is provided for convenience of those actually engaged on transmission line calculations.

(3) This book does not assume to be the only competent source of information on the subject treated. As any proper engineering book should, it contains numerous footnotes and references advising the reader of authorities and further information on points in question.

Transmission lines are considered from many points of view: Economic choice of system, of spans, conductors, flexible and solid towers, insulators, protective devices, etc., etc. Considerable space is given to a method of applying Kelvin's Law to collected data to determine the features of system to yield maximum economy. A brief is given of the latest information on high-voltage, high-frequency disturbances and their effect on line and connected apparatus. High-voltage, direct-current transmission receives some attention. A sample set of specifications for a transmission line is included, which the author hopes will be of service, in that it may suggest points to be covered which might otherwise be overlooked.

Switchgear and the Control of Electric Light and Power Circuits.—By A. G. Collis, A.M.I.E.E. Constable & Company, Limited, London, W.C. 82 pages; 46 illustrations; cloth; 4 x 7 inches. Price, 30 cents net.

Reviewed by A. S. L. Barnes,
Hydro-Electric Power Commission, Toronto.

This is a book of 82 pages, forming one of a series, called "Electrical Installation Manuals," which is being put forward by the publishers.

The best feature of the book is its insistence on simplicity in the design and arrangement of switchgear.

Many diagrams of connections for all kinds of service are given. Some of these are good, but several of them are very difficult to read, and in one or two cases it is hardly possible to do so at all, this being partly due to the author's having attempted to include rather too much detail, partly because, to indicate various types of apparatus, he has employed symbols that are not very generally used. Again, in some cases the diagrams are surrounded by marginal lines which are badly confused with the lines of the diagrams. In one figure a dynamo appears to be short-circuited, and in another a shunted ammeter is mysteriously connected across the main bus bars—unless, perchance, these two extra lines are intended to supply current to a lamp at the back of the instrument, which appears to be of the illuminated dial pattern!

The book is not one which, in its present form, is likely to make much of a mark for itself, although its usefulness might be much improved by a careful revision of the diagrams in order to make them more intelligible.

General Metallurgy.—By H. O. Hofman, E.M., Metallurgical Engineer, Ph.D. Professor of Metallurgy, Massachusetts Institute of Technology. Published by McGraw-Hill Book Company, New York City. 909 pages; 836 illustrations; 252 tables; numerous inserts of plates; cloth; size, 6 x 9 inches. Price, $6.00 net.

Reviewed by T. R. Loudon, B.A.Sc.

As stated in the Preface, it is the object of this book "to cover the field of General Metallurgy." There are, of course, certain principles common to the various fields of metallurgical endeavor, and it is to the expounding of these principles that this book is given over. The book is very well written and the illustrations are good. As to the value of such a work portions are appropriate as a reference for the advanced metallurgist and other sections will be of value to the beginner. In most books covering a wide field of scientific work, there must necessarily be many sections of reading matter that are not truly explanatory, but are mere statements of fact. For this reason the value of such books is often doubtful, as the beginner requires above all things, clear explanations; and, on the other hand, the advanced reader already knows the facts. It must be said, though, that the amount of explanatory matter given in this book is in a very good proportion to the amount of mere statement of fact. One very noticeable feature about the book that is good is the enormous number of references given. The author has certainly spent a great deal of time on the work of gathering together a list of references that in themselves constitute a very valuable addition to metallurgical literature.

There are thirteen chapters to the book, the titles to which are as follows: Introduction; Properties of Metals; Alloys; Metallic Compounds; Ores; Fuel; Refractory Materials; Pyrometallurgical Processes and Apparatus; Hydrometallurgical Processes and Apparatus; Electrometallurgical Processes and Apparatus; Mechanical Metallurgical Operations, a chapter which is subdivided into sections dealing with Ores, Metal Alloys, Liquids, Gases, Preheating and Drying of Air, Purification of Gases; Metallurgical Products; and Economic Considerations.

The chapter on Mechanical Metallurgical Operations is very well put together, and, on account of its large amount of illustrated explanatory matter, is a valuable general reference. On the other hand, such a chapter as that on Electrometallurgical Processes and Apparatus, while it does contain certain laws that apply in Electrometallurgy, is so fragmentary that it is difficult to see just where its value lies. The chapter on Refractory Materials is very good.

As stated before, the book is a valuable addition to Metallurgical literature if for no other reason than the references given in connection with the written matter.

PUBLICATIONS RECEIVED.

The Approximate Melting Points of Some Commercial Copper Alloys.—10-page leaflet, issued under authority of the United States Bureau of Mines, by H. W. Gillett and A. B. Norton.

Mine-Accident Prevention at Lake Superior Iron Mines.—A 38-page bulletin, compiled by Dwight E. Woodbridge and issued by the United States Bureau of Mines, dealing with mine-safety problems.

Coal Mining Disputes on Vancouver Island.—40-page report of the Royal Commissioner on coal mining disputes on Vancouver Island. Issued with the authority of the Minister of Labor, by Samuel Price.

Problems in Physics.—23-page leaflet, based upon the Text-Book of Physics, by A. Wilmer Duff (editor), etc. Issued by Morton Masins, Ph.D., of the Department of Physics, Worcester Polytechnic Institute, Worcester, Mass.

Uses of Commercial Woods of the United States.—56-page bulletin, No. 12, published by the United States Department of Agriculture. Written by Hu Maxwell, expert, and dealing principally with beech, birches, and maples, as commercial woods of the United States.

Vitrified Brick as a Paving Material for Country Roads.—34-page illustrated bulletin, No. 23, authorized by the United States Department of Agriculture, and edited by Vernon M. Peirce, Chief Engineer, and Charles H. Moorefield, Senior Highway Engineer, office of Public Roads.

First Aid Instructions for Miners.—A 66-page bulletin, compiled by M. W. Glasgow, W. A. Raudenbush and C. O. Roberts. It is well illustrated, and serves as a guide to miners in rendering aid to injured fellow-workmen. Issued by the Bureau of Mines, Department of the Interior, Canada.

Tide Tables for the Pacific Coast.—By W. Bell Dawson, Superintendent, Tidal and Current Survey, Department of Naval Service, Canada. The Bulletin gives complete tide tables for the year 1914, and includes Fuca Strait, the Strait of Georgia and the Northern Coast. It also contains data for Slack Water in the navigable passes and narrows, with information on currents.

Tide Tables for the Eastern Coasts of Canada.—By W. Bell Dawson, Superintendent of the Tide and Current Survey in the Department of the Naval Service of the Dominion of Canada. The bulletin gives complete tide tables for the year 1914, and includes the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits. It also contains information on currents.

Forest Products of Canada, 1912.—Bulletin No. 40, Forestry Branch, Department of the Interior, Canada, compiled by R. G. Lewis, B.Sc.F. The bulletin contains an account of the quantity of wood manufactured into lumber in the Dominion and the various provinces for the year 1912. Tables are also given showing the quantities and value of the different kinds of wood manufactured into lumber during the year specified.

Arguments for and Against Train Crew Legislation.—A 38-page bulletin, published by the Bureau of Railway Economics, Washington, D.C., dealing with the much-talked-of subject of the regulation of train crews, giving the history and present status of train operation, the provisions of the measures enacted and proposed for "full crew" legislation, and a discussion of the effect that such legislation would have upon the efficiency and safety of transportation.

Working of Steam Boilers.—147-page book, fifth edition, well illustrated, and indexed. Published for those in charge of, and responsible for, the working of steam boilers insured with "The National Boiler and Insurance Company," giving directions essential to safety, and also precautions necessary for satisfactory working and for the prevention of undue deterioration of the steam-raising plant. Issued by Edward G. Hiller, B.Sc., M.I.C.E., M.I. Mech. E., Chief Engineer, the National Boiler and General Insurance Company, Limited, Manchester, Eng.

Mines Statement, New Zealand, 1913.—7½ x 13 inches, well supplied with maps and illustrations, being the mines statement for the year ended the 31st December, 1912, and including statistics, reports relating to metalliferous mines and stone-quarries, state aid to mining, roads on goldfields, prospecting-drills, water-races, school of mines, inspection of mines, examinations for certificates, geological survey, state coal mines, diagrams, maps, and plans. The publication has been compiled by the Hon. W. Fraser, Minister of Mines for New Zealand, and covers approximately 160 closely-set pages.

Forest Protection in Canada, 1912.—164-page book, 7½ x 10 inches, well illustrated, and with map inserted. The publication is subdivided under six main topics, e.g., protection from railway fires; forest fires and the brush disposal problem; the top-lopping law in the Adirondacks; the use of oil as locomotive fuel from a fire-protective point of view; forest planting in Canada; report of committee on forests, Commission on Conservation, 1912. There are, moreover, three appendices—the first, concerning Dominion forest reserve extension in Manitoba, Saskatchewan, Alberta, and British Columbia, and a table of forest reserve areas; the second, memorandum regarding the country between Sudbury and Port Arthur, by J. H. White; the third, opinions on fuel oil.

The report is edited by Clyde Leavitt, Chief Forester of the Commission of Conservation, and Chief Fire Inspector of the Board of Railway Commissioners, and is issued by authority of the Dominion Government Commission of Conservation.

CATALOGUES RECEIVED.

National Metal Moulding.—A 28-page catalogue of mouldings, couplings, outlets, receptacles, bushings, flush-plates, etc., for sale by the Canadian General Electric Company of Toronto.

A Thousand Uses for Gas.—An 8-page well-illustrated catalogue dealing with gas and the various uses to which it may be put. Issued by the United Gas Improvement Company, Philadelphia, Pa.

Standard Class "NF-2" Compressor.—A leaflet descriptive of the important features governing air-compressor selection, and of the vital points of automatic operation. Published by the Canadian Ingersoll-Rand Company, Montreal.

Transformer Drying, and the drying, filtering and testing of transformer oil.—A 16-page bulletin, No. A4134, descriptive of the General Electric transformer dryer and filter. The Canadian General Electric Company, selling agents.

The Morrison Water-Tube Boiler.—A 10-page catalogue dealing with the water-tube boiler as a preventative of costly accidents and delays, the reduction of maintenance and repair expenses, etc. Issued by the Morrison Boiler Company, Sharon, Pa.

Electricity in Iron Foundries.—A Bulletin issued in October by the General Electric Company, descriptive of the electrical operation of cranes, air-compressors, elevating and conveying machinery, etc. The Canadian General Electric Company are the selling agents.

Chicago Pneumatic Corliss Compressors.—Bulletin No. 24D, issued by the Chicago Pneumatic Tool Company, descriptive of their horizontal, cross-compound Corliss compressor. It is well illustrated and furnished with tables of dimensions, and occupies 32 pages.

Improved Forced-Draught Furnace.—A 12-page, illustrated catalog descriptive of the "Meldrum" furnace; another describing their "Koker" and "Sprinkler" mechanical stokers, and a third dealing with refuse destructors. Issued by Meldrums, Limited, Manchester, Eng.

Rotating Hammer Drills.—A 12-page catalogue descriptive of the McKiernon-Terry rotating hammer drills for sinking, stoping and drifting; illustrated and including specifications, weights, etc. The Canadian Allis-Chalmers, Limited, Toronto, are the Canadian selling agents.

Cars, Tracks, Turntables, Switches, etc.—Catalogue No. 900 of the Orenstein-Arthur Koppel Company, Koppel, Pa., descriptive of their many products, comprising rails, portable track, switches, cars, turntables, steam and electric locomotives; well illustrated and tabled, comprising 84 pages. The Canadian Fairbanks-Morse Company are the Canadian sales agents.

Book Catalog.—A new illustrated catalog of scientific, industrial and technical books has been issued and will be mailed post-free by Crosby, Lockwood & Son, 7 Stationers Hall Court, London, England. Among the new books listed are an English and German Pocket Glossary of Technical Terms, and "Screw-Cutting for Engineers," a very practical book for mechanics.

Floating Docks.—A well-illustrated 50-page book descriptive of floating docks, published by Swan, Hunter & Wigham Richardson, Limited, Wallsend-on-Tyne, ship engine and floating dock builders and repairers. The booklet contains 50 illustrations of various docks and an article dealing with the subject in an interesting, descriptive constructional manner. It also contains a lengthy list of docks built by this company.

Willans Rotary Air-Pump System.—This is pamphlet No. 50, issued by Willans & Robinson, Limited, Victoria Works, Rugby, Eng., descriptive and illustrating the Muller-Josse patent rotary air-pump system, showing the two most common applications, viz., the shunt and series system. In either case the air is extracted from the condenser by means of an air-ejector, and the condensed steam extracted by means of a separate centrifugal pump drawing the water from the bottom of the condenser.

Robb's Scotch Boilers.—A Bulletin issued by the International Engineering Works, Limited, descriptive of the Robb Scotch marine boiler, showing changes from the standard design in the interests of better circulation, etc. The boiler is fully described in the bulletin, and details of a special economy test, in which the 200 h.p. boiler, operated a widely fluctuating load, showing an average of 73 per cent. efficiency when working under variable conditions up to 50 per cent. overload. The International Engineering Works, Limited, have sales offices, in Toronto, Montreal Edmonton, Winnipeg and Calgary.

Deutsche Maschinenfabrik, A. G., of Duisburg, Germany, have issued one of the most completely illustrated catalogs that has reached *The Canadian Engineer* office for some time. Its title, "Who We Are and What We Do," indicates the contents. Photographs are shown of the founders and present managers, together with a great many views of the works and offices. In addition, there are over seventy large pages replete with excellent illustrations of installations of the many different kinds of machinery manufactured by this firm. Among their lines are mining machinery, blast furnace plants, steel works and rolling mills, cranes and transporting appliances, ship berths, harbor and wharf-cranes, and structural steel work. The catalog is in English, and is very attractively arranged. It is being distributed by Gerald Lomer, Limited, Fraser Building, Montreal, who are the Canadian agents.

COAST TO COAST.

Dawson, Y.T.—Dawson has still in consideration plans to secure a water service.

Toronto, Ont.—The net profits of the Toronto Hydro-Electric Commission are approximately $150,000 for the past year. Last year's statement showed a profit of $13,000.

Toronto, Ont.—Freight service has been promised by January 1st over the C.P.R.'s short line between Toronto and Montreal—e.g., the Campbellford, Lake Ontario and Western Railway.

Toronto, Ont.—Chairman P. W. Ellis of the civic Hydro-Electric Power Commission, has reported for the first nine months of 1913, an increase over the corresponding period of 1912, in sales, 100 per cent.; and in purchase, only 40 per cent.

South Vancouver, B.C.—The proposal that the municipality should construct and control an electric plant is coming more and more into favor among the citizens, though there is still much divergence of opinion upon the question as to whether such a plant can be run economically or not.

Ottawa Ont.—It is understood that President Wilson of the United States has communicated with the Canadian Government suggesting a conference of representatives from the two governments to consider the question of mutual action and possible means of improving boundary waters either for navigation or for power business.

Vancouver, B.C.—A suburban train service will be inaugurated on the line of the Pacific Great Eastern from North Vancouver to Dundarave by December 31 of this year, according to Mr. D'Arcy Tate, vice-president of the road. Already grading is practically finished between North Vancouver and Dundarave, and steel is now being laid.

Calgary, Alta.—The greatest reform in the railway dispatch system of the world has been practically completed. All the C.P.R. trains in Alberta will now be dispatched by telephone instead of telegraph, with the exception of that district from Crow's Nest to Kootenay Landing. Men from Montreal are putting in the apparatus at each of the stations.

Ottawa, Ont.—The public works department at Ottawa has prepared estimates totalling $50,000,000, an amount exceeding that of last year by about $2,000,000. This outlay is not necessitated by a large program of new works, but rather those already in progress, by extensive constructions proceeding principally in harbor improvements, dredging, and the construction of drydocks.

Victoria, B.C.—The results of the analysis of water in Elk Lake, made by City Analyst Birch, in view of the possibility of its use as a future water supply, are not encouraging. Mr. Birch states that, roughly speaking, there is four times as much organic matter in Elk Lake as in samples taken from the Goldstream supply. Further experiments are to be made by the analyst.

Vancouver, B.C.—Motors for the automatic gates which have been placed by the C.P.R. to protect its level crossings at the North Vancouver Ferry slip and other docks near the foot of Columbia Avenue, are being installed and the barriers will be ready for service in a few days. The gates will slide up and down on the lift principle. They can be governed individually or collectively.

Vancouver, B.C.—The temporary dam across False Creek near the Main Street bridge built in connection with the reclamation operations, has been completed. The barrier is built of rip-rap filled with loose rock and is intended to keep the material deposited by dredging for the channel west of the bridge from drifting back with the tide. It will be replaced later with a permanent retaining wall.

Vancouver, B.C.—Word has been received in Vancouver of a rock slide which occurred at Sea Bend Bluff, near Ruby Creek, completely covering the double tracks of the C.P.R. with rock debris. Rocks, some of which weigh as much as 100 tons, have buried the track 60 feet deep for a distance of 300 feet. Dynamite is being used to remove the blockade, and a temporary track has been built around the slide.

St. Catharines, Ont.—Track laying on the extensions of the Niagara, St. Catharines and Toronto railway from this city to Niagara-on-the-Lake has been completed, and a temporary passenger service will be opened in two weeks. A spur freight line to Port Weller, the lower entrance to the new Welland Ship Canal, is now open, and material and machinery are being hauled for work on the land excavation on No. 1 section.

Winnipeg, Man.—City officials have inspected the new reservoir on Logan Avenue and McPhillips Street, and report the construction in satisfactory condition, and ready for the pumping in of water. The total cost of the new reservoir, which will hold about 18,000,000 gallons of water, will be about $300,000, and with the other city reservoirs it will provide a storage of about 24,000,000 gallons of water, or enough to supply the whole city with water for three days in case of need.

Thorold, Ont.—The Confederation Construction Company, contractors for the Government, in the undertaking of the diversion of the G.T.R. main line, so that it may erect a bridge at a suitable point, are making rapid progress with the work involved. Steam shovels, locomotives and dump cars are busy at the deep cut being made on the eastern side of the town, where houses have had to be removed or demolished. And on the cut south of the town, good progress is also reported.

Rossport, Ont.—The engineers in charge of the now famous sink-hole at Rossport which has been tying up transcontinental traffic from time to time since September, claim that it will be impossible for the ballast to sink further. Many thousand tons of ballast have been necessary to fill up the sink-hole sufficiently to allow of the passage of trains. In the opinion of many, a steel trestle arch will ultimately have to be erected at Rossport to eliminate permanently the possibility of further difficulty or disaster.

Guelph, Ont.—The annual report of the Guelph Street Railway is one of the best in its history, recording increase of traffic throughout the system, and especially since the opening to service of St. Patrick's Ward extension. The total receipts were $49,816.99; total expenditures, $33,771.33; and resulting profits $16,045.66. After an estimate for appreciation was deducted from this amount, the net profit was fixed at $6,391.55. The report recommends that ratepayers be asked for $17,000 to improve the service.

Nelson, B.C.—Constructed entirely by Doukhobor labor, under supervision of a Vancouver firm of consulting engineers, the new steel and concrete suspension bridge over Kootenay River at Brilliant, near Nelson, has been completed at a cost of $45,000. The Government contributed $20,000 of this amount, as the bridge, which saves the Doukhobor community, is on the highway route between Nelson and Trail. The main span is 331 feet in length. Four concrete pillars 48 feet in height support the span and cables.

Toronto, Ont.—The dispute between the Etobicoke Township Council and the Toronto Suburban Railway Company in reference to the protection of crossings, has been practically settled by the Railway Board; and, as a result, work has recommenced on the Toronto to Guelph radial extension, and has advanced to the district west of Islington. The original plans have been greatly improved through the efforts of the railway commissioners, though the council was not entirely successful in its appeal for subways at certain points.

Moose Jaw, Sask.—It is reported that the high pressure mains being laid in Moose Jaw, have been completed, with the exception of a connection at one street intersection; but the system can be operated without this. The levelling of the tops of the trenches is now proceeding, and a final test of the system will be made very soon, when the pressure in the pipes will be raised to the 300-lb. mark. The fire brigade is to be supplied with hose for high pressure purposes when new motor apparatus has been ordered; so that the new system may be available in case of fires.

Niagara Falls, Ont.—The simultaneous peak load of the Hydro-Electric system recently exceeded the 50,000 h.p. mark of consumption, purchased by the commission from the Ontario Power Development Company at Niagara Falls. The breakers automatically cut the circuit and an interruption of five minutes affected the entire hydro-electric zone. As a consequence of the expansion of business, the peaks of the various municipalities overlapped at their maximum. Another interruption has been forestalled, however, by a higher adjustment of the breakers.

London, Ont.—It has been stated by the Hon. Adam Beck that before the end of 1913, hydro-electric distribution lines will be serving the farmers from end to end of the county. The line from London to Dorchester, and thence to Thamesford, is well nigh completed; and three lines—one, from London to Lucan, and thence to Ailsa Craig; another, from London to Port Stanley, using the London and Port Stanley Railway as a distribution main line; and the third, from London to Lambeth, Delaware, Mount Brydes, Strathroy, and Glencoe—are projected.

Estevan, Sask.—Engineer Miller, who is in charge of the C.N.R. grade construction out of Estevan, will have the road bed ready for the laying of track by December 1st. Culverts and grading from Bienfait to Estevan have been completed, and steel has arrived at Bienfait, further consignments being on the way. It is not expected that the work of laying track will exceed two weeks. In connection with the question of the construction of a transfer line by the C.N.R. at Estevan to link its two roads, which is being opposed by the C.P.R., Mr. Spencer, traffic expert of the board of railway commissioners, who was authorized by the board to examine local conditions, has visited Estevan, and has made a thorough investigation. It is quite expected that his report to the commission will result in the immediate order for the construction of the transfer track.

PERSONAL.

H. C. ANDREWS, of Chambers, Limited, Toronto, sailed for England last week on a six weeks' trip.

J. W. PORTER, who succeeded J. B. Armstrong as chief engineer of the Hudson Bay Railway, has assumed his new duties in Winnipeg.

R. O. WYNNE-ROBERTS, consulting engineer, Regina, Sask., has been on a trip through eastern Canada, visiting Ottawa, Montreal, Toronto and London.

A. H. HARKNESS, B.A.Sc., consulting engineer, Toronto, addressed a large meeting of the members of the University of Toronto Engineering Society on Wednesday, Nov. 26th, on the Construction of Modern Skeleton Frame Buildings. The lecture was well illustrated by lantern slides.

F. A. CREIGHTON, M. Can. Soc, C.E., who has been with the city of Prince Albert as manager of the Hydro-Electric Development at La Colle Falls, has opened an office in Winnipeg, where he will engage in the practice of civil engineering as consulting and supervising engineer. Mr. Creighton has had some twenty-two years' experience in engineering work, and has been with the city of Prince Albert since he was appointed city engineer in 1907.

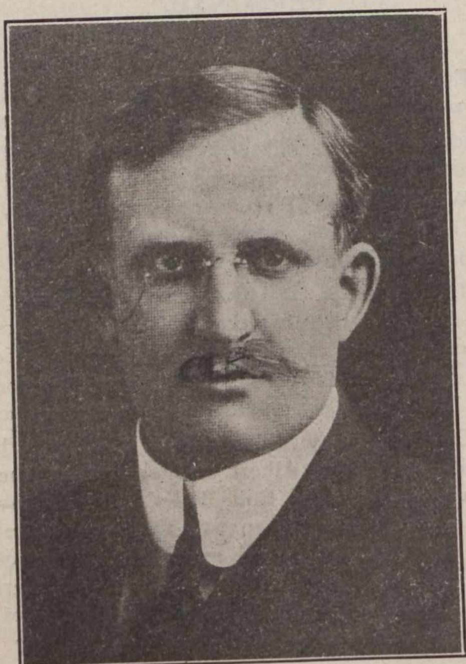
OBITUARY.

The death is announced in Winnipeg of Mr. Geo. McPhillips, a well-known pioneer surveyor and engineer. Mr. McPhillips was a native of Richmond Hill, Ont., and was for many years chief surveyor for the Canadian Pacific Railway, western division. Death, on November 20th, terminated a long illness.

The death occurred at Montreal recently of Mr. A. C. Brady, assistant superintendent of C.P.R. terminals. Mr. Brady, who had been associated with the C.P.R. for 24 years, was a son of Mr. Frank Brady, general manager of the Intercolonial Railway.

On November 17th, Mr. Russell D. Willson, assistant city engineer of Winnipeg, met instant death from contact with an electric current of 13,200 volts. While on a tour of inspection of the well houses of the city waterworks system, Mr. Willson, in company with one of the engineers of the city waterworks department, was making a careful examination of the machinery in one of the units about ten miles north of the city. While testing a lightning arrestor switch, Mr. Willson came simultaneously in contact with an iron railing, thereby causing instant death.

Mr. Willson is a graduate in engineering of the University of Toronto. His first engineering work, carried on during his university course, was in connection with the original surveys of the Toronto-to-Sudbury line of the Canadian Pacific Railway, with Mr. Hugh D. Lumsden in charge. In 1899, he joined the engineering staff of the C.P.R. in Toronto, and became associated later with the Sturgeon Falls Pulp and Paper Company. In December, 1900, he returned to Toronto, resuming his academic course in civil engineering and graduating in the following spring. In May, 1901, he accepted an offer to go to Winnipeg with the Canadian Northern Railway, and spent four years on its engineering staff, leaving to enter the employ of the city, where he was given charge of outside work for the city waterworks department. In February, 1908, Mr. Willson became assistant city engineer, which position he held up to the time of his death, with practically complete charge of the construction and operation of the waterworks department.



Russell D. Willson.

The late Mr. Willson was 34 years of age, and was born at Sharon, Ont. He was a member of the Canadian Society of Civil Engineers and was regarded by the profession generally and all others in touch with his work as one of the foremost civil engineers especially in municipal work in Western Canada.

The death is announced at Montreal of Mr. P. A. Peterson, for many years and until 10 years ago, chief engineer for the Canadian Pacific Railway, and retained by the same road as consulting engineer, after his retirement from active duties.

Mr. Peterson was born at Niagara Falls, 74 years ago. He is a graduate of the University of Toronto. He was associated with the construction of both the Intercolonial Railway, and the Canadian Pacific Railway. He was a member of the American Society of Civil Engineers and of the Institution of Civil Engineers of Great Britain; and was president of the Canadian Society of Civil Engineers in 1894.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Annual Meeting, December 2-5, 1913.

Attention is called to the diversified program of the annual meeting of the American Society of Mechanical Engineers, to be held in the Engineering Societies Building, 29 West Thirty-Ninth Street, New York.

Papers will be presented on the following subjects:—

Boilers and their operation. Cement. Enameling. Fire protection, with special reference to turbo-generators, oils, and the novel use of sprinkler systems. Gas measurement. Gas power engineering. Lineshaft bearings. Machine tools. Management. Properties of steam. Rope drive. Steel railway cars. Textiles, covering mill engineering. Vacuum cleaning.

The professional sessions will be held in the mornings, while the afternoons will be devoted to simultaneous sessions in which special subjects, according to the above list, will be taken up. Excursions will be held at various times during the meeting. Dr. W. F. M. Goss, the president of the society, will deliver his presidential address on Tuesday evening, December 2nd.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

A meeting of the Electrical Section of the Canadian Society of Civil Engineers was held in Montreal on November 20th. Mr. H. B. Dwight, A.M.Can. Soc., C.E., read a paper entitled "The Use of Synchronous Condensers with Transmission Lines." The Mechanical Section of the society will meet on December 4th.

The Vancouver Branch held a meeting on November 25th, at which Mr. R. F. Hayward, M.Am. Soc., C.E., described the Hydro-Electric development at Stave Falls.

The annual convention and dinner of the B.C. members of the society will be held in Vancouver on December 12-13th.

COMING MEETINGS.

AMERICAN INSTITUTE OF ARCHITECTS.—Forty-seventh Annual Convention, to be held in New Orleans, La., December 2nd, 3rd and 4th. Secretary, Glenn Brown.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.—Annual Meeting will be held in New York, December 2nd to 5th. Secretary, W. H. Reed, 154 Nassau Street, New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The Annual Meeting will be held in New York, December 2nd to 5th, 1913.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.—Annual Meeting to be held in New York, December 10th to 13th. Secretary, C. D. Odsen, Polytechnic Institute, Brooklyn, N.Y.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.—Seventh Annual Convention will be held at Great Northern Hotel, Chicago, December 29th to 31st. Secretary, I. W. Dickerson, Urbana, Ill.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.