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The Canadian Engineer

WEEKLY

ESTABLISHED 1893

VOL. 15. TORONTO, CANADA, DECEMBER 4th, 1908. No. 49

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the interests of the

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR

Editor—E. A. JAMES, B.A. Sc.
Business Manager—JAMES J. SALMOND

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year - -	$2.00	One Year - -	$2.50
Six Months - -	1.25	Six Months - -	1.50
Three Months -	0.75	Three Months -	1.00

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HEAD OFFICE: 62 Church Street, and Court Street, Toronto.
TELEPHONE, Main 7404.

Montreal Office: B32, Board of Trade Building. T. C. Allum, Business and Editorial Representative, Phone M 2797.

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Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office by 10 a. m. Monday preceding the date of publication, except the first issue of the month for which changes of copy should be received at least two weeks prior to publication date.

PRINTED AT THE OFFICE OF THE MONETARY TIMES PRINTING CO., LIMITED, TORONTO, CANADA.

TORONTO, CANADA, DECEMBER 4th, 1908.

CONTENTS OF THIS ISSUE.

INDEX FOR 1908.

Special care has been taken with the index of the Canadian Engineer for 1908. It has been cross-indexed, and many of the articles are classed under four heads. This index should make a valuable addition to bound volumes of the Engineer for 1908. It wil be ready about January 6th, 1909, and will only be sent to those applying for a copy.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

On January 28th, 29th and 30th, 1909, the Canadian Society of Civil Engineers will meet in Toronto. There will be an interesting meeting, and just as interesting will be the side trips arranged for the members. Be there.

THE UNFORTUNATE LITTLE ONES.

Strange place this in which to make a plea for charity—but it is not charity, it is simply a request for co-operation. One of the most successful non-sectarian institutions is the Hospital for Sick Children, Toronto. Everyone has a kindly feeling for an institution whose doors are always open, and where the latch is always on the string, and sympathy is in the hearts of all for the suffering little ones. At the Christmas time Mr. John Ross Robertson, chairman of the Hospital Board, would like to receive from you a check, large or small, no matter, so long as you manifest your interest in this work of making some mother heart glad over a child rescued from the life-long misery of deformity.

THE FIFTH REPORT OF THE BRITISH ROYAL COMMISSION ON SEWAGE DISPOSAL.

In this issue we publish an extensive review of the report of the Royal Commission on Sewage Disposal (Great Britain). We think that the subject matter is of sufficient interest and importance to Canada, and no apology is required to our readers for the amount of space we give to it. We also consider ourselves fortunate that we have been able to secure Mr. T. Aird Murray, an engineer with experience in sanitary engineering, to prepare this review. The author of the review deals with the report in such a manner as to bring together in definite sequence those points and deductions which are of real practical value to engineers. He has carefully avoided those questions which may still be considered debatable or open questions, and has endeavored to edit the deductions of the Commission, which bring within intelligent forces what may now be classed as demonstrated facts in connection with sewage disposal. The review is not prepared for the benefit of those who are already sewage experts—such will, no doubt, have already digested the contents of the report; but it will be found of value to the large number who have neither the time nor opportunity to devote to a voluminous report, containing a mass of tables and results of seven years' work of the Commission.

In Canada sewage disposal is really in its infancy as far as practical application is concerned.

It may also be said that, generally speaking, enginers have not up to the present reason to devote much attention to this class of work. The subject of sewage disposal is certainly becoming more and more a live issue in Canada, and the fact that the Dominion has at hand for reference the extensive experience of the older country, which has for years been the centre of this particular branch of science, is a benefit not to be ignored, but of which full advantage should be taken.

THE GRADING OF CIVIL SALARIES.

During the present year there has been a special committee of the Toronto Corporation employed in devoting their time to the question as to the best method of recognizing the services of civic employees.

The committee have several times presented a report recommending advances of salary in certain cases. The reports have invariably been sent back.

At a recent meeting the Mayor stated strongly that he was in favor of some system of grading by which each employee would automatically receive promotion without the necessity of being individually considered.

We consider that some such system would be admirably suited to municipal bodies employing large numbers of servants.

In working for a corporation the average employee is in a difficult position as compared with other trades and businesses in proving his worth.

A salesman proves his worth to his employer by the number of sales made.

A bank manager by the amount of business done. An insurance agent by the number of policies carried through.

An employee of the corporation cannot at the end of a year say to the Council: I have increased the profits of any one department by my energies, and am, therefore, entitled to further consideration in salary.

In a corporation the unobtrusive clerk, who quietly and thoroughly does his duty, is often at a considerable disadvantage as compared with the so-called hustler, who is all talk and flourish of trumpets, and who does as little real work as possible. The work of a whole department is accomplished by some means or another, but how much of that work is due to any individual energy is beyond the knowledge of any alderman.

How, then, can this or that alderman say that any individual servant should have a rise of salary in preference to another.

Each individual post should stand on its merits, and be worth so much and no more.

Promotion should not only mean an increase of salary, but a promotion in position and degree.

The heads of departments are not in a position to advise the Council in this matter. They want to keep down the expenses of their department and shine as economists before the Council at the expense generally of those under them.

The present system of promotion by favor tends to all kinds of mischief. It is here where the question of "pull" come in, with all the unblushing and disgraceful attributes it possesses. The son of an alderman's friend, the relative of the head of a department, and such other outside considerations become more the ruling factor than the true worth either of the position or the person.

In all large organizations, such as the civil service, the army, the navy, and such like, where men are employed who make no profit for their employers a system of salary and position grading appertains.

In the army, for instance, a man as, say, a second lieutenant, cannot get a rise of salary till he rises in rank to the position of first lieutenant. So in the navy we have able-bodied seamen, boatswain, captain, and commander, all positions with their salaries fixed. In the civil service, first, second, and third clerkships, and so on.

Such a system is certainly, we think, required in civic institutions.

A well-defined system such as this should be accompanied by superannuation and an age limit fixed when employees must retire.

We would then have done for ever with the humiliating positions in which several old employees have been put in lately of practically having to beg for a retiring allowance, and rely on the tender mercies and gratitude of the members of the Council, some of whom are not above prying into a man's private affairs as to what is the condition of his banking account, etc.

The more automatic the working of the municipal wheel can be made, the more easily will it work, and the more independent corporation positions are made and less subject to the caprice of the Council, the better work will be obtained from those filling such positions.

ORDER OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

5566—July 14—Authorizing the Walkerton & Lucknow Railway to carry its railway across six streets in the town of Durham, County Grey, Ont.

5567—Oct. 30—Granting leave to the British Columbia Telephone Company to erect, place, and maintain its wires across tracks of the C.P.R. at Haney, B.C.

5568—Nov. 3—Ordering and directing all railways subject to the jurisdiction of the board to install electric bells at crossings for the purpose of protection.

5569—Nov. 3—Authorizing the C.N.O.R. to place its lines or tracks across the lines or tracks of the Grand Trunk Railway Company's spur line to Edward's Mill, at Rockland, Ont.

5570—Nov. 4—Authorizing the C.P.R. to install drawbridge at Whittier Junction, Manitoba, and to operate its trains over drawbridge and through the Junction without being brought to a stop.

5571—Nov. 5—Amending Order of the Railway Committee of the Privy Council, so as to permit the Sherbrooke Street Railway Company to move the derail from the position as approved by said Order, on the west side of the tracks of the G.T.R. where the Sherbrooke Street Railway Company's railway crosses King Street, Sherbrooke, to a point 114 feet 4 inches from said crossing.

5572—No. 5—Authorizing W. J. Curle, Superintendent of the Brockville, Westport and Northwestern Railway Company to prepare and issue tariffs of tolls to be charged for all traffic carried by that company.

5573—Nov. 5—Granting leave to the G.T.P. Ry. to use temporarily for construction purposes crossing of the C.P.R. Company's tracks at Oak Point Junction, near Winnipeg, (Pembina Branch), Manitoba.

5574 and 5575—Nov. 5—Granting leave to the Manitoba Government Telephones to erect, place, and maintain its wires across C.N.R. at Dufresne Siding and point one mile east of Somerset, Manitoba.

5576—Nov. 5—Authorizing the C.P.R. to construct, maintain and operate a branch line to and into the premises of the Rocky Mountain Cement Company Blairmore, Alta.

5577 and 5578—Nov. 5—Granting leave to the Manitoba Government Telephones to erect, place, and maintain its wires across the track of the C.P.R. at P.C. two miles west of Minnedosa, Man., and at P.C. ¾ of a mile west of Minnedosa, Man.

5579—Nov. 7—Granting leave to the Corporation of the City of Ottawa to lay water main under tracks of the G.T.R. where the same crosses Laurel Avenue and Champagne Avenue, Ottawa, Ontario.

5580—Nov. 7—Granting leave to the Caledon Telephone Company to erect, place, and maintain its wires across G.T.R. Company's tracks in the County of Peel, near Caledon East Station, Ont.

LYNHURST BRIDGE.

A. Gillies.

The Lynhurst Bridge is one of four reinforced concrete arch bridges built in St Thomas in the last two summers. This bridge, which has a clear span of 116 feet, is as yet the longest span of the kind in Canada.

The strains on the arch were calculated on a basis of 150 pounds per square foot of live load, the permitting tension in steel being 20,00 pounds per square inch, and compression in concrete 500 pounds per square inch.

The bridge is 22 feet wide, having a 16-foot roadway and 4-foot sidewalk, and contains about 1,470 cubic yards of concrete, including rail, floor, etc. The intrados of the arch is a three-centred circle, having radii of 4 feet, 30 feet and 162 feet. The extrados is a segment of a circle with a radius of 323 feet. The intrados at the crown was 30 feet 6 inches above the footing, the arch having a rise of 18 feet, being 2 feet thick at the crown and 3 feet thick at a point 24 feet out from the crown. The arch was filled in at each end with creek gravel, well packed and rammed before the floor was laid.

Completed Arch Bridge Span, 116 Feet.

The abutments rested on hard pan, and the footings were 4 feet below the bed of the creek. The concrete in the abutments below the line E F (Fig. 1) is composd of one part cement and nine parts gravel. In this part of the work large stones were embedded in the concrete. These stones were separated enough to be each completely surrounded by concrete, and not nearer the face of the work than 3 inches.

The concrete in the arch. spandrel walls, wings, etc., was composed of a mixture of one part cement, two parts sand and four parts screened gravel and crushed stone.

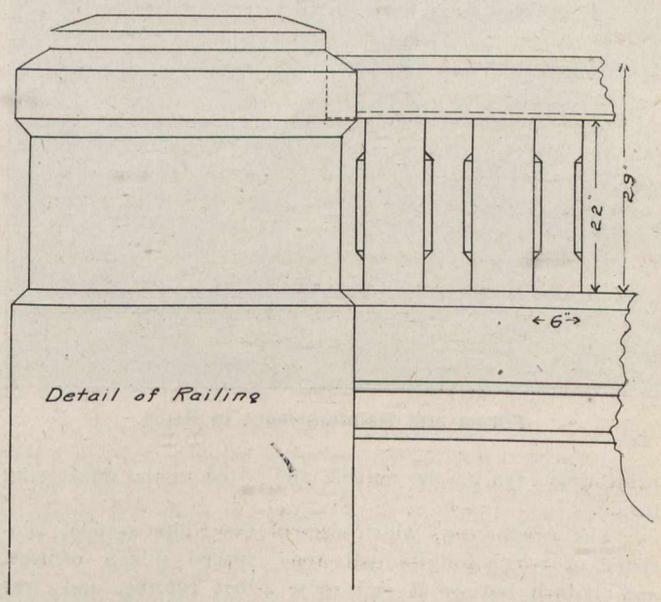
The spandrel walls were battered on the inside from 4 feet thick at the ends to a foot thick just below the level of the floor. The wing walls were 12 feet long and 1 foot thick. They were supported by two counterfort walls running back to the abutment and sloping up to within 2 feet of the top of the wing walls. The tops of the wings and the base of the railing were finished off with a mortar facing 1 inch thick, composed of one part cement and two parts sand.

The railing of the bridge was made separately as shown in Figs. 2 and 3. The small posts were 6 x 8 x 22 inches high, and spaced 14 inches centres. They fit into a groove in the bottom of the cap, and were fastened to the railing base by means of a dowel grouted into holes left in the base. The railing caps were made in 6-foot lengths and joined by means of a steel rod grouted into a groove left in the end. The four end posts and intermediate large posts were 16 inches wide, with a cap which projected above and beyond the railing. These posts were built in place at 25-foot centres, and a receptical left in them for the end of the railing. The end posts were 40 inches long, and the intermediate large posts 16 inches long.

A ½-inch asphalt expansion joint was left, through the railing base, at the crown of the arch. Similar expansion joints were also left in the railing cap and in the bridge floor.

The concrete for the base of the floor was composed of one part cement, two parts sand and three parts screened gravel. The finishing surface of the roadway was 1 inch thick at the curbs and 1½ inches thick at the centre, and composed of one part cement, one part sand, and two parts finely crushed granite. The completed floor was 6 inches thick at the centre and 4½ inches thick at the curbs. The floor crowned from the ends to the centre, the ends being about 18 inches lower than the centre.

A projection, 4 inches thick and 7 inches high, ran the whole length of the bridge, forming a base for the large

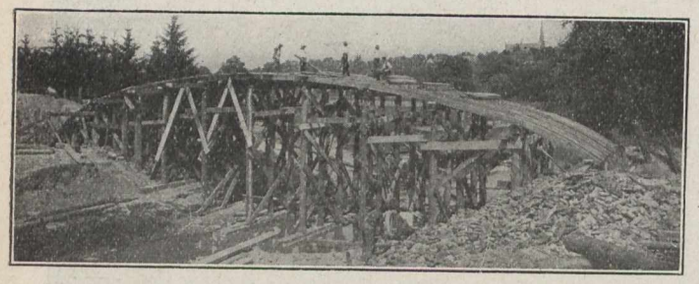


intermediate posts, and relieving the plainness. The panels, which were 2 inches deep, also helped in this way.

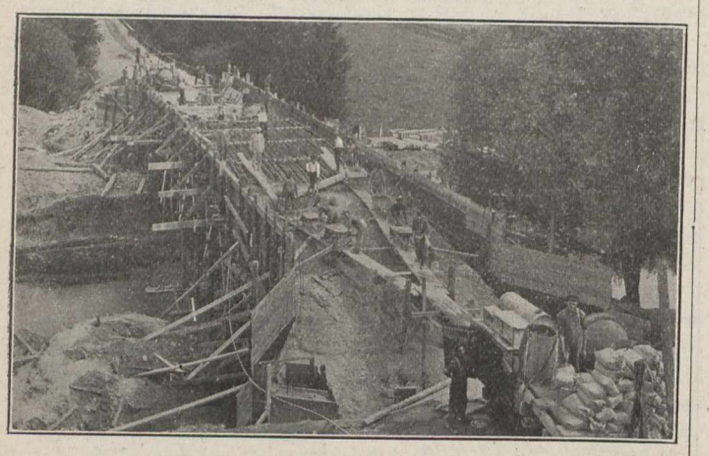
The excavating was done by means of drag scrapers as long as it was possible, and then by hand, the clay being

thrown out and wheeled away. This proved a very costly method, as much time and labor might have been saved by rigging up a derrick.

The creek, over which the bridge was built, was very low at this point at this time of the year. This left exposed a good gravel bed, with hard clay below, so it was not necessary to drive piles to support the falsework. Each bent in the falsework was made up of five posts, mostly hickory and ash, of about 9 inches minimum diameter. The spacing of the bents was as follows: 1 foot, 8 feet and 16 feet from the faces of the abutments, and the rest 10 feet 6 inch centres. The caps for these posts were allowed to project out for bracing for the sidewalls. Wedges, for adjusting the grade and for convenience in striking the forms, were placed between the caps and plates above them. The joists, which were cut to fit the intrados of the arch, were made from 3 x 12-inch white pine plank. These joists were 27-inch centres, and were braced at the middle. The end joists were particularly well braced to prevent all lateral movement. The lagging, for arch and sidewalls, was 2-inch pine, planed on one side and fitted with close joints. The side walls and spandrel walls were braced from the ground where possible. Otherwise they were braced against the projecting caps on the outside and wired to the reinforcing inside.



Falsework in Position.

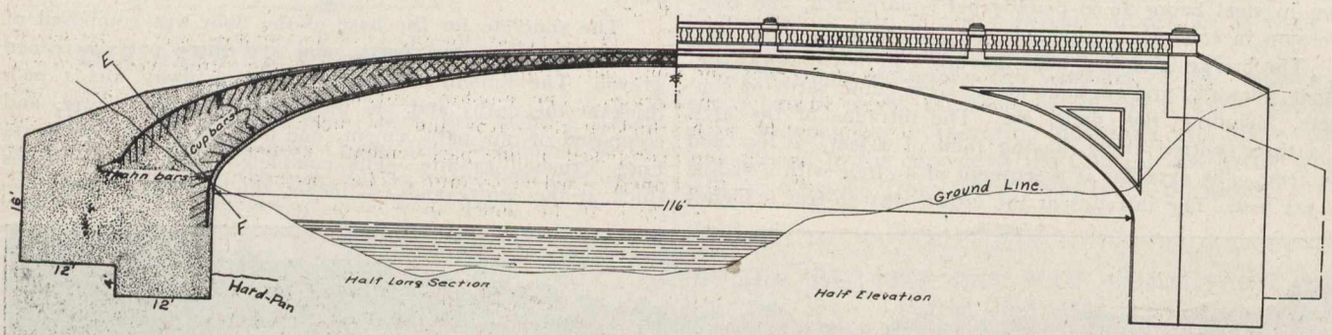


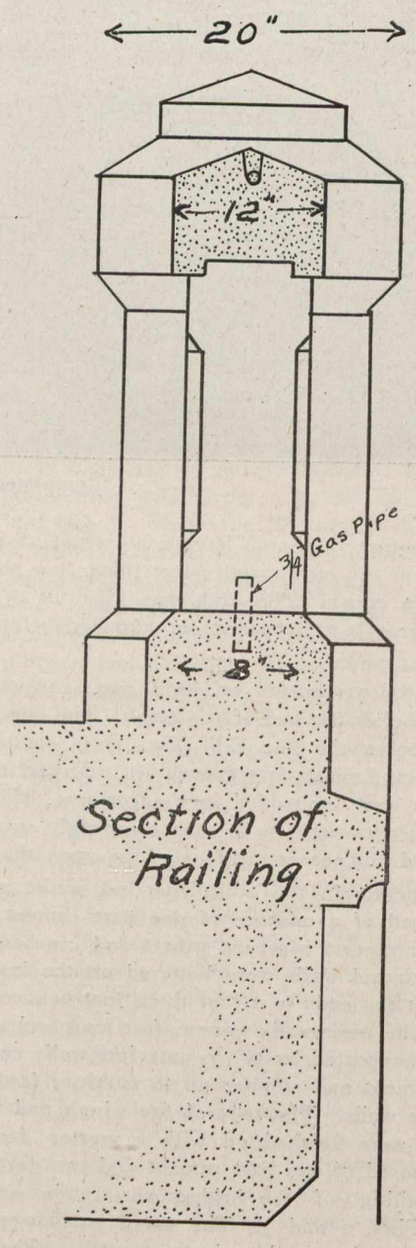
Forms and Reinforcement in Place.

The reinforcing, which was of the Kahn system, consisted of 1-inch longitudinal rods, spaced 9-inch centres, and ½-inch horizontal cup rods, 4-foot centres, and was placed 3 inches from the intrados and from the extrados of the arch. The reinforcing, in the spandrel and wing walls, consisted of ½-inch vertical and horizontal cup rods, spaced 18-inch centres It was put in well in advance of the concrete and blocked up and spaced so as to be perfectly rigid. The blocking was taken out as the concreting advanced.

For convenience in stripping the forms and in order to get a smooth surface the forms were well oiled before concreting commenced. Lehigh cement was used, the tests given by the company and the pat tests performed on the work all proving satisfactory.

Two mixers were used, a Smith and a Chicago Cube, both giving very satisfactory results. The concrete was brought up evenly on either side of the arch in order to prevent any distortion of the forms. At the end of a day's work the concrete was left as nearly as possible radial to the intrados, and before beginning concreting on the following day the forms and old concrete were well cleaned and washed and the concrete sprinkled with cement. The concrete was run fairly wet in order to form a good bond with the reinforcing and to insure a good surface on the concrete.





Measurements taken for settlement and displacement during concreting showed very little, if any, movement of any kind. Settlement readings, taken for the settlement of the arch when the falsework was removed showed less than 1-16-inch. The falsework was left up for five weeks after the arch had been crowned. The bridge was entirely finished and filled in in the meantime.

Gravel of a very good quality was hauled from a pit about 1½ miles distant, and was worth 25 cents per load of one-third cord. Lumber for lagging cost $30 per M. Most of the bracing and a good deal of the falsework was taken from the old bridge. Cement cost $1.70 per barrel, and labor was as follows:—

Laborers. . . .. $1 50 per day of 10 hours.
Carpenters. . . ...1 75 to 2 25
Teams. . . . . 3 50 "

The contract price of the bridge, exclusive of the steel, was $9,399. The steel was supplied by the city, about 18¼ tons being used, costing $1,453.

The bridge was designed by Jas. A. Bell, city engineer, St. Thomas, and the writer was inspector-in-charge.

TORONTO'S ASPHALT PLANT.

The city of Toronto has over eight miles of asphalt pavements, and most of the repairing is done by day labor by the city. During 1907 they let the contract for the construction of an asphalt plant of a capacity of 1,500 square yards per day of nine hours. The contract price was $28,575.

The buildings containing and enclosing the plant are built of steel, the walls and roofs are covered with galvanized iron, and the floors are of reinforced concrete. The plant consists of:—

Two self-contained rotary driers, manufactured by Warren Asphalt Paving Co., the revolving cylinders being 40 in. diameter and 19 ft. 6 in. long; draft is supplied by a 50-in. exhaust fan, which discharges into a Cyclone dust collector; the driers are fed by two chain elevators, and the hot sand or stone is discharged into an enclosed elevator and conveyed to steel storage bins (capacity, 10 cubic yards each), situated on the second floor, the stone bin being fitted with a rotary screen. There is also a storage bin for limestone dust provided on the second floor, having a capacity of four cubic yards and fed by a dust elevator. The hot material and the dust are drawn by gravity into their respective weighing boxes, which discharge into the mixer; the mixer has a capacity of 1,100 pounds of topping mixture.

The asphalt cement is prepared in three enclosed melting tanks, provided with mechanical agitation, and having a capacity of 2,000 imperial gallons each. The asphalt cement is elevated by air pressure to the asphalt weighing bucket, running on an overhead trolley to the mixer.

The storage tank for flux has a capacity of 10,000 imperial gallons. The flux is blown from it to the weighing tank on the first floor and drawn by gravity into the kettles.

The asphalt barrels are hoisted to the charging floor by a barrel elevator. Power to the main portion of the plant is supplied by a 10 in. x 12 in. automatic cut-off centre crank engine, manufactured by the Erie Engine Works, and to the agitating tanks and barrel elevator by a 5 in. x 5 in. vertical automatic cut-off engine, manufactured by the Sturtevant Blower Works. Compressed air, used for forcing the asphalt cement out of the tanks and for other purposes is furnished by a 6 in. x 8 in. x 12 in. Knowles direct-acting air compressor. Steam is supplied to these engines by a 60 horse-power Star water tube self-contained boiler. Street and plant tools, including an 8-ton and 5-ton steam asphalt rollers, five wagons, hand rollers, pitch kettles, etc., and 12 Wilkinson asphalt dump wagons complete the equipment.

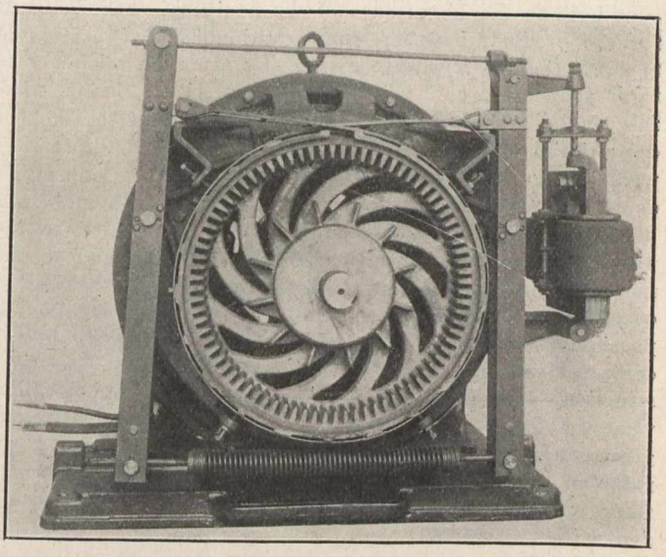
The plant was constructed under supervision and direction of City Engineer Rust's office, Mr. G. G. Powell, A.M. Can. Soc. C.E., assistant engineer, having direct charge of the work.

A NEW MOTOR FRICTION BRAKE.

In many applications of electric motor drive the quick and accurate stops necessary could not be made without the use of suitable brakes. Brakes also serve to prevent accidents by automatically stopping and holding the load in case of failure of the current supply from any cause. A number of magnetically operated direct current motor brakes have been designed, but electro magnets using alternating current require a considerably greater expenditure of energy for a given braking effect than those using direct current. Moreover the flywheel effect of the rotors of alternating current motors is greater than that of direct current motors of corresponding capacity. Again, the magnet core must be laminated when alternating current is used, and the cost of construction thus increased. It is largely due to these facts that there are so few successful alternating current motor brakes.

A type of alternating current brake which satisfactorily overcomes these difficulties has just been placed on the market by the Westinghouse Electric and Manufacturing Company. This brake is characterized by simplicity and strength in construction and reliability in action; it is self-contained, and is readily applied and easily adjusted. It is operated by electro-magnets.

The brake referred to, designated as the "PB" type, is intended for use on Westinghouse two and three-phase induction motors of from 5 to 100 horse-power, 25, 40 and 60



cycles. The braking action depends on the contraction of a coiled steel spring.

The advantage of this construction is that the brake will operate equally well with the motor tilted at a considerable angle from the horizontal position, as on roller lift drawbridges. The construction is shown in the illustration. The cast-iron brake shoes are held against the brake wheel by steel bands. The two vertical pivotal brake beams are connected at the top by a tie rod and at the bottom by a coiled steel spring, and a polyphase solenoid operating magnet is attached to the brake beams by a lever. The ends of the brake bands are attached to the beams above the pivots; the spring tends to draw the lower ends of the beams together, thus drawing the band and shoe against the wheel.

The friction of the wheel against the shoes tilts the beams through a small angle until they strike against lugs on the framework. These lugs are above the pivots, and are so placed that when the beams press against them the tops are separated and the brakes more firmly set by the motor itself. A very heavy breaking action is thus obtained with a comparatively light spring and magnet. When the motor is operating the current passes through the coils, the core is pulled down, the brake is released and the spring elongated. On stopping the motor the brake circuit is opened, allowing the spring to contract and apply the brake.

THE PROPER CONSTRUCTION OF BRICK STREET PAVEMENTS.*

Will P. Blair.

The use of vitrified brick or block for streets and roadways is an American idea, which originated about thirty years ago. It was developed from the use of brick made from the ordinary surface clays for such purposes in a few of the smaller cities of Indiana and Illinois. Shortly afterwards brick made from fire clay in the upper Ohio valley were used for a like purpose.

It will probably never be established as to who made the first vitrified brick from shale in this country. One thing is certain, that the first stiff mud brick made from a mixture of shale and common clay were produced in central Illinois. These were used for street paving purposes, and naturally followed the use of the common brick for street paving, and thus, more by accident than design, such brick were found to resist the wear of travel with greater success than the brick made from the surface clays, and thus the value of vitrified brick for paving purposes was established. In like manner it may be truthfully said that for many years following the earlier manufacture and use of paving brick progress toward betterment was, to a very great extent, merely incidental. The extended us for street paving purposes was slow. Few of the earlier manufacturers, if any, realized the development about to take place, and very few of the manufacturers had any concern of the relation their uses bore to the importance of the business. The demands for the product, however, grew continuously, regardless of the fact that so few were giving any attention whatever to their proper use as a street paving material. Finally, some few of the manufacturers began to realize that the lack of appreciation of brick streets was due to the fact that they were almost universally built without consideration either as to the physical advantages insuring durability, or in a manner making possible the greatest satisfaction to the user. The few, however, whose eyes were opened to the facts began a careful study and inquiry into the methods of construction promising to afford the greatest satisfaction possible from every standpoint. A few engineers in the central West early realized the importance of proper construction, and appreciated more than the manufacturers what the future had in store for vitrified brick. These engineers and these manufacturers, while still maintaining the value of the use of a good quality of vitrified brick for street construction, were convinced of the utter folly of depending upon that alone, and saw that other elements were equally necessary. It is not too much to say that even now the brick are too often required to bear the burden for a satisfactory street. Neither is it putting it too strong to say that the criticisms offered against brick streets are due, in nine cases out of ten, to other causes than the quality of the brick.

In the month of July of this year we had the opportunity of examining the brick streets in more than fifty cities east of the Allegheny Mountains. We were greatly surprised that in but three cities did we find the essential details of brick street construction at all complied with. Many of the details of a properly constructed brick street seem not to have found lodgment with those who are charged with their construction as being in the least degree important; they are, nevertheless, absolutely necessary for the construction of high-class brick pavements. It is, therefore, the purpose of this paper to point out the essentials which are often overlooked, ignored, or in some way or on some account neglected rather than to follow out all of the directions necessary from foundation to finish. I wish, however, to emphasize one thing, that, while a compliance with the details of construction that may be here suggested is vital in their importance to the value of the street, nevertheless, not a single suggestion here made is difficult in the least degree; neither adds greatly to the cost. If neither difficult nor costly, why are they not complied with? Practically all of these requirements are suggested in the directions for laying brick street pavements which are promulgated by the National Paving Brick Manufacturers' Association. These directions or specifications have been adopted by practically all of the progressive engineers of this country. We wish, therefore, to give a brief answer to this question later on in this paper. The preparation of the sub-grade for brick streets does not differ essentially from that necessary in case of streets constructed with other materials. It must be drained, graded, compacted, and established in conformity with the grade of the finished street. This must be accepted as necessary by everyone. A depression here and there in the grade, a spot of loose earth, a lack of thorough compaction, or a wet condition improperly drained must, without question, be followed by conditions of the street that will bring disaster to the street as a whole. As to the quantities of the mixture that enter into the concrete foundation, so much depends on the quality of the cement to be used, the quality of the sand, gravel, stone, etc., that we will not undertake to say what proportion of cement, sand, broken stone, or gravel shall be used. Suffice it to say that the quantities must be such as will make absolutely sure the quality. There are, however, some fixed and well-known conditions in the preparation of the mixture of the concrete foundation that, in order to insure the quality of the concrete, must be observed, whether or not the concrete be machine or hand-mixed. In order that it shall be its maximum strength it must be mixed dry in the first instance, and then thoroughly mixed after the water is applied. Either in the machine or hand-mixing an intelligent supervision is worth while at all times. I have observed very often the value of the concrete reduced at least fifty per cent. by carelessness, by ignorance or indifference, by the application of too much water or by the application of too little water, by the lack of a proper proportion of some one or another of the other ingredients composing the foundation, resulting in a square yard, two square yards, or three square yards of the concrete foundation being of no more value to the street itself than a loose pile of broken stone or gravel. The manner of making the concrete foundation thus absolutely insures its failure, such concrete being so mixed that if it were in a building the building would fall of its own weight, as has happened in many instances. Such conditions obtaining in a street, while not insuring a fall, does insure a failure. This concrete as it is put in place must have a uniform surface with the grade of the finished street. Just at this point are found conditions of very great frequency which insure the failure of the street. We have said it must have a grade uniform with the grade of the finished street. The surface of it must be smooth. This cannot be accomplished by depending upon the eye; the grade stakes should be set at no greater distances apart than four to five feet. If any stone used in the concrete exceeds in size two inches in its largest dimension, it will be next to impossible to accomplish the condition desired. Sufficient water should be used in the mixture so that one man can smoothe the top with an ordinary dirt shovel—never should it be so stiff as to call into use a rammer.

It has been an interesting study from the viewpoint of both the engineers' and contractors' experience in this matter as to what a uniform and smooth surface means when applied to a concrete foundation. With some a range of grade from two to three inches furnishes a fine job. We wish to emphasize that a greater variation than one inch is utterly inexcusable in the matter of a concrete foundation for brick streets.

The sand cushion must be two inches in thickness. If less than two inches, it will not afford a sufficient relief from the vibration created by the impact of travel. If more than two inches it cannot be sufficiently compacted to afford a support to the load coming upon the brick street, and prevent cracking and crushing of the joints of the cement filler which is required in finishing the street. Thus, this cushion must be of such a thickness that will afford a relief from the impact and weight, slight though it be, yet sufficiently un-

* Read before the American Society of Municipal Improvements.

yielding to furnish the support for the load it must bear. But why do we lay down the hard-and-fast rule of two inches as meeting these physical conditions? The best answer that we can make to such a question is not theoretical, but an absolute fact, thoroughly demonstrated, that under such other conditions here required neither bond or brick has ever broken in any place, under any condition of traffic, in this country. The best brick made is easily broken by a blow much less in force than that made by the 1,000-pound horse if such brick rests directly upon any rigid surface, and no reason exists why such brick will not be broken by the 1,000-pound horse if thus exposed, uncushioned and rigid. With the sand cushion properly spread upon the concrete foundation, the next thing to be considered is the provision for the expansion cushion. This must be provided for by placing next to the curb a board of sufficient width to extend above the height of the brick, which is generally four inches. In order that they may be readily drawn, it is advisable that a wedge be dropped at intervals of three to four feet behind this board and extending above it from three to four inches. The wedges should be ½-inch in thickness at the top. The thickness of this board should vary according to the width of the street, always favoring the safe side by providing sufficient thickness, ranging from 1 inch to 1½ inches. Need I expressly urge this provision? It will eliminate the longitudinal cracks, preserve the curb, and prevent the pinching from which much chipping and crushing of the brick result, as well as permitting the brick to lie thoroughly impacted into the sand cushion underneath them, so doing away with the excessive noise which brick are reputed to posses, but of which they are innocent when combined with proper elements of construction. In other words, let the brick street lie with its own dead weight upon the sand cushion, and it will neither rise up nor make a noise.

Next in order is the laying of brick in the street. Much money is often wasted to the contractor, and in some cases to the brick men by practices that are wholly bad from an economical point of view, as well as lacking in methods assuring the best results. It is necessary that the brick be placed in the street with the best edge up. This is a rule universally required of brick construction in masonry work. In order that this shall be done the brick should be delivered to the person who drops them into the street with the face placed to suit the hand operation of such person, who may be called the bricklayer. This is best done by the men either bringing them in by board or by the use of a gravity carrier. The edge of the brick that is most subjected to the action of the flame and the chemical influence wrought in the burning, the chipped corner, the warped edge and the extreme kiln mark should go down and not up. Any intelligent person can soon train a whole gang of workmen as to which the face edge of a brick be. It is determined by several little factors as easily contra-distinguished as the countenance of one man is from another. The wheeling of brick over those already laid, the dumping of brick, depending on a process of turning over those not faced ought never be tolerated.

The brick should not be placed in the street in close contact one with another. A few days since we saw a man with a forty-pound sledge and a short piece of 2 x 4 driving the brick as close together as was possible to do. The specifications for this work provide for the interstices to be filled with sand. It seems to me that the observations of a child would put such methods upon serious inquiry. Such practice will necessarily result in the brick being chipped and the street ruined long before it is possible to fill the interstices with the sand sufficiently for the purpose for which sand is ever put between the brick, whatever that purpose be. I have read specifications requiring the same thing to be done where other provisions of the specifications required a cement filler. With the brick driven so close together it is impractical, if not to say impossible, to put the cement filler in the interstices.

After the brick are placed in the street it is necessary that they should be inspected before they are rolled, for the reason that as few brick as possible should be disturbed after the rolling. The roller with which this is done must be a light one, weighing from four to five tons—one that is easily handled and can move rapidly upon the surface of the brick. The rolling should proceed from each side along the curb, working toward the centre of the street; then cross-rolling at angles of 45°; again rolling longitudinally and cross-rolling as before, continuing this process until the brick are thoroughly compacted into the sand, so that the grade of the pavement shall be as intended and the inequalities of the cushion ironed out by the sand being pushed up in the interstices of the brick, a condition always found in the case of properly rolled streets by an uneven amount pressed upwards in the interstices running from one-half to three-quarters, and possibly as much as one inch in depth in some cases. The rolling is often attempted with either a horse roller or an eight to ten-ton steam roller. With such rollers you cannot roll the street at the angle required, and invariably, both with the horse roller and the heavy steam roller the brick will crack, and as the one edge rises an excess of sand falls in the space. As the roller comes back in such cases the brick ride the sand, and instead of the pavement becoming smoother and smoother, it becomes rougher the more it is rolled.

In case of an excessive weight coming upon the brick they will rebound, and never can be compacted, and yet both of these bad practices have, in many instances been insistently resorted to, to the utter spoiling of the street. But after the brick are properly rolled and compacted, of course those that have proved bad under the pressure of the roller should be removed and taken from the street. The street should then be swept clean and the brick wet down. However, this wetting down must be done only in one way, and that is by the use of a nozzle, either upon a sprinkling can or a hose, which will permit but the finest spray of water to come upon the street.

In the application of the cement filler more incorrect and faulty means and methods are resorted to than in any other portion of the work. However, it is true that the proper method is a simple one, easily followed, and absolutely without any hazard to the street. In order that we may understand why certain directions are insisted upon in the application of the cement filler we must keep in view the requirement necessary to the greatest strength of the filler, and that is that it must be put in place in the proportion designated in the specifications; that is, one part cement to one part sand in the first course, and two parts cement and one part sand in the last course. It is as necessary for the sand to be clean and sharp as it is that the Portland cement shall be a good quality. Too much water in the mixture is as harmful as too little. There is only one method —one practical method—that I know of for the application of this cement filler, yet many contractors will resort to other means if allowed, and rebel against the only method which is carefully laid down in the National Association's specifications numbered 1, which is as follows:—

"The sand should be dry. The mixture, not exceeding one-third bushel of the sand, together with a like amount of cement, shall be placed in the box and mixed dry, until the mass assumes an even and unbroken shade. Then water shall be added, forming a liquid mixture of the consistency of thin cream. From the time the water is applied until the last drop is removed and floated into the joints of the brick pavement, the same must be kept in constant motion. The mixture shall be removed from the box to the street surface with a scoop shovel, all the while being stirred in the box as the same is being thus emptied. The box for this purpose shall be 3½ to 4 feet long, 27 to 30 inches wide and 14 inches deep, resting on legs of different lengths, so that the mixtures will readily flow to the lower corner of the box, which should be from 8 to 10 inches above the pavement. This mixture, from the moment it touches the brick, shall be thoroughly swept into the joints. Two such boxes shall be provided in case the street is twenty feet or less in width; exceeding twenty feet in width, three boxes should be used. The work of filling should thus be carried forward in line

until an advance of fifteen to twenty yards has been made, when the same force and appliances shall be turned back and cover the same space in like manner, except to make the proportions two-thirds Portland cement and one-third sand. To avoid the possibility of the thickening at any point there should be a man with a sprinkling-can, the head perforated with small holes, sprinkling gently the surface ahead of the sweepers. Within one-half to three-quarters of an hour after this last coat is applied and the grout between the joints has fully subsided and the initial set is taking place, the whole surface must be slightly sprinkled and all surplus mixture left on the tops of the brick swept into the joints, bringing them up flush and full. After the joints are thus filled flush with the top of the brick and sufficient time for evaporation has taken place, so that the coating of sand will not absorb any moisture from the cement mixture, one-half inch of sand shall be spread over the whole surface, and in case the work is subjected to a hot summer sun, an occasional sprinkling, sufficient to dampen the sand, should be followed for two or three days. The first application should be thin in order that it may flow to the depth of the joints of the bricks, thereby insuring a substantial bond, and should be kept in constant motion while being applied, otherwise the sand will settle, and you will have water and cement instead of water, sand and cement. The water and cement wouldn't be objectionable, but the sand by itself is wholly so. It must also be mixed in small quantities, as it is next to impossible to keep the sand in suspension when more than a common water pail of each, sand and cement, is used, and unless it is deposited upon the pavement with the sand in combination with the solution you will get the cement and water in the lower portion of the joints between the bricks and the sand without the cement in the upper portion. It is preferable, after the sand and cement have been mixed dry, to apply sufficient water and mix slowly, first to a good mortar, then add sufficient water to bring the mortar to the required consistency. By this method a more thorough adhesion of the cement to the sand can be obtained."

The following practices have come under my observation:—

I have seen the filler dipped from the mixing-box with a bucket and carried many steps. In such case the sand was on its way to the bottom of the bucket and the cement was making for the top. I have seen the mixture placed in a cradle or rocking-box and in the time intervening the turning of the box the sand and cement were undergoing a like separation, and as the box was turned the richer mixture of cement flowed ahead and the weaker and sandy portion remained near the box. I have seen the water applied before the mixture in a dry state reached an even shade, thus preventing the proper adhesion of the particles. To remedy the thickening of the mixture I have seen it entirely ruined by throwing upon the street the water from an open nozzle, which served only to float the cement away from the sand. I have seen the mixture put upon the street much faster than it could be swept in. I have seen the mixture prepared in a dry state in large quantities at intervals of a few feet upon the brick, and the water applied and the sweeping-in process undertaken simultaneously. I have seen the mixture made up in such large batches that it required a sweeping of several feet before it could be made to disappear in the interstices. In such cases the last that went in was but very little better than pure sand. I have taken a quantity of sand from the supply to be used for filler purposes and found that it contained 33 per cent. of soil. Thus, I might enumerate for hours the manner, method, and means of applying the cement filler in the interstices of a brick street, each and every one of which was but to insure a failure, and in none of which is economy to the contractor subserved.

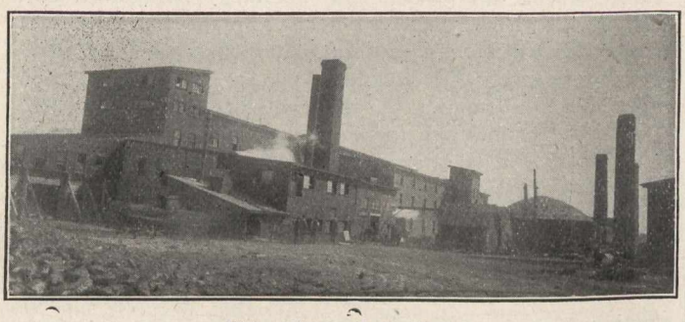
By the proper method, here insisted upon, the hoes are drawn by two workmen to the upper portion of the box, and the backward flow agitates the mixture equally with that of the stroke. The lift of the scoop immediately following, the box sufficiently adjacent to the work, so that instead of a motion which pitches it is rather a quick motion on the part of the workmen that pulls from under the mixture the scoop, allowing the mixture to strike the surface of the brick in proper proportion, thus most nearly insuring it in place in proportion than by any other known method. By the use of three boxes and a systematized force, the greatest economy to the contractor is subserved and the greatest possibility of the cement filler is attained.

The boards in place providing for the cushion should, after a lapse of twenty-four hours and sooner than thirty-six hours, be withdrawn and the space filled two-thirds with a pitch filler. Then, finally, a covering of sand sufficient to hold moisture and protect the cement filler from extreme heat while setting is imperative. The street having been finished in all respects with great care and skill is sometimes entirely ruined by using it before the cement filler is sufficiently set. That this is done seems inexcusable, yet it is done sometimes by the very person who is taxed to pay for the street. We stand for the cement filler because it meets fully all the requirements. It forms a part and parcel of the ideal brick street, which no substitute can supply. If these conclusions are correct, that our manner, method, and practice is the best, and that they do not add greatly to the cost, neither are they difficult, why are they not generally complied with? But in asking this question again please do not misunderstand or infer it is coming from a pessimist. On the contrary, I am exceedingly optimistic in this whole matter. In many cities and smaller towns of the middle West the public have long since understood what they can have, and they will only have brick streets at their best. In certain cities of northern Ohio, Michigan, parts of Indiana and Illinois are found the best examples. To such an extent is this true that at least 80 per cent. of all the pavements laid in the last two years have been brick. Nor do I believe that the municipal engineers of the country are to blame for a non-compliance with these directions in brick street building.

One reason why a compliance with the specifications and directions are not observed is that the performance of each particular step in the construction of a brick street is left to a foreman chosen by the contractor. It is almost universally so that such foreman has his set way of doing this or that particular thing he is charged with, and rebels against an innovation in his practice. We sincerely believe that progress for betterment in this particular may be accomplished by embodying in the contract between the municipality and the contractor, as part of the requirement, that the contractor be obliged to supply his foreman with particular specifications and directions covering such portions of the work with which such foreman is charged. This suggestion, however, is only remedial to a degree, and does not, of course, meet the difficulty in full. Another reason is that, in some localities the results of a properly constructed brick street are not appreciated, because not believed in. But the question becomes interesting in the face of the fact that these specifications have been adopted in the main by practically all the progressive engineers of the country. But the principal reason why we cannot get a more universal compliance with the approved methods of constructing brick streets is due to the American political practice of awarding minor political service by the dearest compensation possible to lay hands upon. In many cases the man secures an inspectorship because he is fit for nothing else. The miserable practice should cease. More money is expended for streets and roads than for any other public purpose except only for the education of our children. The architect who plans, designs, and specifies concerning the expenditure of $50,000 in a building is permitted to hire, train, and direct his superintendent. It is the exception to the rule if the municipal engineer in this country is permitted to do this thing. It should be part of the engineer's business as much to select his superintendent and inspector as it is to design and specify. This question is one that does not relate alone to the construction of brick streets, but it permeates, relates to all municipal work, and is the one objectionable feature in the prevailing American municipal system toward accomplishing the elimination of which every broad-minded citizen and taxpayer should lend his influence.

A SEWER PIPE FACTORY.

The works of the Standard Drain Pipe Company at St. John's P. Q.. have recently re-opened, having been completely re-built since they were destroyed by fire December, 1907. The accompanying illustration will give some idea of the external appearance of the works. The potteries are situated on the western outskirts of the town, adjacent to the junction of the G.T.R. and C.P.R. tracks, where the company owns 48 acres of land. The main building has a frontage of 275 feet and a depth of 100 feet. It is three storeys high, though at one end the roof rises



Side View of Factory.

higher to permit the passage of the clay-carrying elevators, which run up from the ground floor to a height of 60 feet. The structure is of brick. It is perfectly equipped with the best modern machinery and appliances, all designed to secure the maximum of output with the minimum of hand labor, while simultaneously assuring absolute safety to employees.

To furnish an illustration of the extent of the plant it is only necessary to say that in the rebuilding of it over two million bricks were laid. There are ten kilns built of fire-brick and eight chimneys built of ordinary hard brick lined with fire-bricks. The kilns are 37 feet in diameter and have a capacity of over 100 tons each. Each kiln required 150,000 bricks in its construction.

In the main factory the ground floor is of solid concrete. One flat is a huge drying room, where the pipes and other ware are placed after pressing, and prior, of course, to burning. The drying floors are heated by a perfect network of steam pipes which run underneath the floors.

The main factory is operated by a 200-h.p. Cross compound condensing engine, the belt from the fly wheel of which is 26 inches in width. This engine is in a room of its own, built of brick, and covers an area of 40 x 30 feet. Annexed to this is a boiler room, where three 16 x 16 longitudinal boilers are placed, while nearby is a machine shop thoroughly up-to-date in its appliances, consisting of two lathes, drills, planer, etc., and here all the dies and machinery are made and repaired. In close proximity also is a steam fire pump capable of discharging 800 gallons of water per minute and throwing three streams of 2 1-2 inches each. It was this pump during the fire of last winter that materially helped to prevent the total annihilation of the factory.

On an average of 100 tons of clay are used every day. The clay is partly from New Jersey and partly from the company's own grounds in the rear and at the sides of their plant. The clay is skilfully mixed, but in what proportions or exactly what method is only known to the initiated. It is of vital importance that this should be done skilfully and with exactitude, otherwise, failure in the output is the penalty.

In close proximity to the manufactory is an auxiliary concern distinct in many essential features, but under the same ownership and management. It is a pottery for the manufacture of fire-brick stove linings and locomotive arch blocks, which in itself is a business of no insignificant proportions. The company annually turns out large quantities of these fire-clay goods, which in consequence of their excellence are in continual demand. This branch factory is operated by a 60-h.p. engine, while in the same building is also a third engine—a little fellow of 6-h.p.—which is utilized for the fan system of drying. In the manufacture of fire-clay goods, care, skill, and attention are essential to success. Any imperfection in mixing, moulding, or burning, is apparent. In drying, a temperature of 125 degs. Fah. to absorb the moisture is required before putting ware into the kilns, the heat of which has to be brought up to 270 degs. Fahr. It takes 12 days to fill, burn and empty a kiln.

The factory manufactures on an average into pipes, or other goods, 100 tons of clay per diem and the clay storage bin holds four days' supply. There art three elevators in all, three wet pans, two dry pans and a grog pan and pulverizer.

The plant rests on solid concrete piers, and all the machinery connected with it is controlled by clutch pulleys, which system is a great factor in the prevention of accidents.

The clay is first pulverized, then passes through the dry pans to elevators that carry it to the clay storage bin, from which it is fed as required to the wet pans. It is then elevated to the press feeders and thence into the pipe presses, from whence it emerges in pipes of various dimensions, which are placed upon the drying floors until dry enough to set in kilns. The heat required to produce vitrification and salt glaze in the kilns is about 2,100 degs. Fahr.

The capacity of a kiln is over 100 tons, and it requires ten days to fill, burn and draw the ware therefrom.

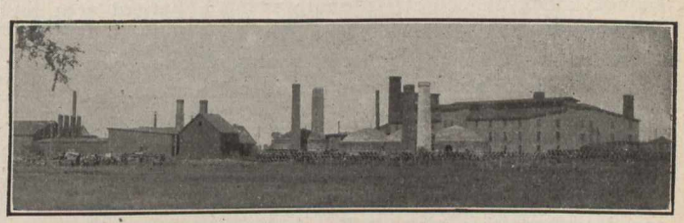
The pipes made in this estalishment range from 4 inches in diameter to 30 inches. The weight of one of these huge pipes is 750 lbs. The other goods manufactured are culverts, pipes, inverts for brick sewers, chimney pots and large fancy flower vases.

About 30,000 tons of clay are used annually in this establishment, and this amount it is soon expected to increase to 40,000 tons.

The consumption of coal, which comes both from Cape Breton and Pennsylvania, figures up to 7,000 tons a year.

The company has practically no expense for water—large quantities of which are indispensable to the manufacture of clay goods. It receives an abundant supply from a score of artesian wells sunk on its own premises. To reach water it was only necessary to bore to a depth of from 50 to 60 feet. The water, which is remarkably pure, and causes little or no encrustation of the boilers, flows freely to the surface and is then pumped and distributed as required. On a rough calculation it is probable that the Standard Drain Pipe Company uses about 10,000 gallons of water in 24 hours.

In March, 1884, the Standard Drain Pipe Company was inaugurated by Major Trotter, who bought out the little



Rear View of Factory.

struggling pottery operated by Mr. Capel, which was not a paying concern at that time, and had met with many reverses in its brief career, but the purchaser had faith in the future of the business. The trade in drain pipes then was almost exclusively in the hands of importers, who handled Scotch pipes. The S. D. P. Co.'s first factory was 80 x 120 feet, with one small kiln, and had a capacity of 18 tons output per week. To illustrate how the business has developed it is simply necessary to say that the output of the factory which was burnt in December last was 80 tons per day. The capital of the Company is $500,000. Mr. W. C. Trotter is General Manager of the Company.

AN ANALYSIS OF CANADA'S TIMBER WEALTH.*

A Preliminary Study by B. E. Fernow.

The vast territory of the Dominion of Canada, with over 3.5 million square miles, covers an area larger than the United States and not less than the whole of Europe, extending over 20 degrees of latitude from the 49 degree, that of Rome, to the North Pole, and through 85 degrees of longitude, over 3000 miles across the continent along the boundary line. With only about six millions inhabitants, more than five-sixths living in the Eastern Provinces, it is natural that large areas remain still entirely unexplored, and other areas are still so little known that it would appear hazardous to venture very definite statements as to the timber resources of this large territory. If the writer, nevertheless, attempts this task after only a brief year of occupation with the subject and a few hasty reconnaissances, he does so with the full realization that the detail of his conclusions may have to be modified on closer acquaintance. He has, of course, utilized what information is available, which is very scanty and often tinged by patriotic tendencies to magnify, but he realizes largely on a study of the geological and climatic conditions, which are either of record or can be readily conjectured, and which predicate forest types and forest conditions.

Comparing Canada with the United States in their forest conditions two facts at once impress themselves, namely the greater variety of forest types and the greater extent of continuous valuable timber areas in the latter. No such thing as the extensive southern pineries, in which almost every acre contains merchantable material, is to be found in Canada, and no such variety of species of value is to be found as the forests of the United States offer.

Everything is simpler in Canada as its geology and topography and its entirely northern climate would lead one to expect, and her limited areas of merchantable saw material are distributed through a large area of inferior growth: the commercial timber occurs mainly in "patches". And we may say at once, that while perhaps a larger area than of the States exhibits woodland conditions, the commercial timber area, actual and potential, is decidedly smaller.

Floristically, we may differentiate, as in the States, the Atlantic and Pacific Forest, but while in the States the prairie and plains country separates these two types effectually, in Canada the forestless country extends only 300 miles from the boundary north with a base of 800 miles at the boundary, narrowed to 400 miles in its northern limit, and the Atlantic forest extends beyond about the 52° across the continent to the Rocky Mountains and to the mouth of the Mackenzie River, and beyond into Alaska. Indeed, along the Rocky Mountains on a limited area the boundaries of the Eastern Pinus divaricata and the Western Pinus contorta murrayana overlap and other species of the two floras associate here over considerable areas.

Towards the north, the number of species as well as individual development is more or less gradually reduced, and finally, another treeless or forestless area is reached, the "barrens" or "tundra"; the northern limit of trees being described by a sinuous line from Fort Churchill to the mouth of the Mackenzie River, and, on the Ungava side of Hudson's Bay, by a line running close to the 58° from Nastapoka River to nearly the south shore of Ungava Bay and along the treeless coast of Labrador.

Forest Flora.

A census of the tree species of Canada develops in all precisely 150 species and varieties as now recognized, of arboescent form, of which 32 are conifers, namely, 10 pines 5 spruces, 4 firs, 3 each hemlocks and larches, 2 each Juniper and Cedar, and one each Yellow Cedar, Red Fir and Yew. Twenty of these conifers belong to the Pacific flora, while of the broadleaf type only 25 of the 118 are found there. All of the species, except a few minor ones, are also found in the United States.

Altogether, coniferous growth is prevalent, even in the Atlantic Forest, most of the hardwood species finding their limits in the southern portions of the eastern Provinces, and only a few species growing northward.

The importance of the species is, to be sure, an uncertain character. As timber producers, on the west coast Douglas Fir and Giant Cedar, with Hemlock, Yellow Cedar and Sitka Spruce and some Fir and Engelman Spruce are at present only serviceable. In he Rocky Mountains, Bull Pine and Larch are most prominent. In the East, the finer hardwoods are mostly cut out, Elm, Basswood, Yellow Birch, more rarely Ash and Red Oak are still plentiful, and Paper Birch abounds. Of the conifers, White and Red Pine with Hemlock are the main producers. White Spruce and Balsam Fir in large amount form the main value of the Eastern forest. Such species as Pinus Murrayana, and in the west, Pinus divaricata, Picea Mariana, Populus balsamifera and tremuloides are important because they cover vast areas and form a not insignificant source of local supply of wood. Balsam Poplar, and the two Jack Pines mentioned seem to develop better in the more northern field of distribution, indeed their center of distribution seems to be found in the upper Mackenzie Valley.

The two eastern spruces are the most northern species up to timberline, and the White Spruce extends its field into the Rocky Mountain flora, while the Lodgepole Pine covering large areas of dry slopes, enters the field of the Eastern flora in its extension into Alaska. The Alpine Fir (A. lasiocarpa) and Patton's Hemlock, with Larix Lyallii are the main alpine trees of the Rockies and Coast range. Engelman Spruce and Abies grandis are found only scattered, but Abies amabilis is forest-forming in the higher altitudes of the Coast Range, while Sitka Spruce and Tideland Hemlock form almost by themselves the northern coast forest.

Forest Types.

Taking together, into consideration, geological formation, soil, climate, and floral composition, we may conveniently divide the whole wooded area into 11 broad geographical types, which again may be divided into 12 regional types, within which, of course, mainly local types may be recognized.

The Height of Land, a low ridge or succession of ridges rarely over 150 feet in height, the watershed between Hudson's Bay and the St. Lawrence, including the Great Lakes—forms for the most part the northern limit of the Eastern forest, and within this area is confined the commercial timber of the East. The Northern forest forms the second type and extends north and west of this line to the Rocky Mountains, which form the third geographical type, from which the Coast timber is differentiated as the fourth type.

The Eastern forest may be subdivided into five regional types, which we may designate as the Acadian, the Upper, Middle, and Lower St. Lawrence, and the southern Laurentian.

The Acadian type comprises the Maratime Provinces with the Eastern townships of Quebec south of the river added. This area, being geologically a continuation of the Appalachians, the forest represents the same type as the Maine or northern New England type, a birch-maple-beech hardwood base with coniferous admixture, which on the higher slopes and plateaus may become pure. Originally White Pine, at present White and Red Spruce with Balsam Fir, form the valuable part of the composition.

The St. Lawrence valley can be distinctly divided into three types. The peninsula of Ontario, located between Lakes Huron and Erie, to the west of Lake Ontario, enjoys on account of the Lake influence a milder climate than other parts of eastern Canada. and besides, being formed by glacial deposits upon limestone formations, excels in fer-

*Abstract of an article to appear in The Forest Quarterly Vol. VI. No. 4.

tile soils, abe to support a rich hardwood forest. Here we find an extension of the southern hardwood flora of oaks, hickories, Tulip-tree, Ash and Black Walnut, besides Elm and Maple, all in magnificent development, where any of them are left, and a number of other species like Sycamore, Sassafras, Kentucky Coffeetree, Honey Locust, Chestnut, which find their northern limit here. The absence of spruce and balsam and the minor occurrence of pine and hemlock reminds one of the Ohio forests. Here is the garden spot of Canada, here on an area of 18,000 square miles lives half the population of Canada, and practically all the commercial timber is cut away to give room to farms, and many farms being even without woodlots, so that a few years ago, in consequence of the anthracite coal strike, a fuel famine was experienced.

The Middle St. Lawrence Valley includes the shore of Lake Ontario, east of a line drawn from Toronto to Midland on the Georgian Bay, and towards the north limited by a line drawn from Georgian Bay to the Thousand Islands, and the river valley, east of a line from Belleville to Arnprior, narrowing from a width of 75 miles to less than 30 miles at a point south of Quebec. This is also glacial and river deposit, perhaps not quite so rich as the peninsula and certainly different in climate, the influence of the large continental area to the northwest, being felt in a wider range of temperatures and lower rainfall and humidity.

It is still a hardwood type, but reduced in variety, the species mentioned before as finding their northern limit on the peninsula, being ruled out by the climatic change. This region, too, is nearly cut out to make room for farms.

The lower St. Lawrence valley from Quebec north narrows down to still smaller width, the fertile land extending from 6 to 20 miles at most alongside the river. The climate, still more rigorous, rules out again a number of species, among which the White Oak, Bur Oak, Beech, Basswood and Butternut, and soon also the Hemlock and Red Pine disappear. The characteristics of the Acadian conifer type on one side and of the northern forest on the other are more and more approached.

North of the St. Lawrence valley drift, there extends a vast area formed of the Archean rocks of the Laurentian period—the Laurentian plateau—the oldest land of this continent, a rocky country, topographically little diversified, the thin soil collected in pockets, only occasionally of sufficient depth and richness for farm use.

On the southern slope of this "Laurentian Shield," south of the Height of Land is located the true commercial forest area of Eastern Canada, a country fit mainly for forest use. If we take the White Pine as the most important timber, this area is still further confined in its eastern portion, for while in the Western portion the northern limit of this pine very nearly coincides with the Height of Land, in the east, the limit of its occurrence is climatically still further limited, and lies far south of the Height, namely on a line from the head waters of the Gatineau to Seven Islands, on the Gulf of St. Lawrence.

This is a country of lakes and swamps, alternating with low hills and plateaus, most variably forested, although the flora is limited to few species. It would be difficult to pick the leading species in this territory of approximately 150,000 square miles extent. There is still a hardwood basis, in which Maple, Elm, Basswood and Paper Birch, with Beech, Red Oak, Yellow Birch, Ash, Balm of Gilead, besides the ever-present Aspen on burnt areas, play a part. Of the conifers, Balsam Fir is probably numerically the most frequent, with White Spruce a close second, and in the swamps the almost useless Black Spruce is prominent, with the more valuable White Cedar and Tamarack according to the character of the swamp. White Pine and Hemlock, the two most valuable species and the Red Pine occur much more localized, mainly along the waters and on the better drained sandy hills. A century of logging has removed the accessible pine very nearly; and, while it is impossible to make even a guess of the amount still standing, the fact that hemlock is cut in ever increasing amounts sheds light on the situation. The Ontario portion of this area has always been reputed to be better stocked with this class of timber than the Quebec portion. Yet, the government officials, claiming on the unlicensed territory—which by the way, in Ontario, comprises still 140,000 square miles —10 to 12 billion feet of standing White Pine (or one third of the annual consumption of coniferous material in the United States) seem to think this is a large amount.

Those who realize that the commercially available and accessible saw timber is near exhaustion point to the enormous amount of pulpwood material as the value for the future. There are undoubtedly large and for the present unmeasured amounts, but it should also be realized that a large portion of this, perhaps more than 50 per cent., is Balsam Fir, which, although according to the writer's contention superior to spruce for pulp, is not advantageously floated, and since the rivers are the only means for getting it out at present and probably for a long time to come, it will remain unavailable until other values invite railroad development.

The cutover lands are treated no better or worse than in the States. Fire sooner or later ravages them, and on the thin siliceous soil destroys not only the young growth but the mould; the waters soon wash the soil and the bare rock comes to view. Thousands of square miles have been and are being burned over repeatedly, and, while the Aspen and the Banksian Pine struggle to keep a forest cover, the value is gone. The characteristic attitude of the authorities to this spoliation policy is exhibited in the declaration of a high official in charge of timberlands, that the extensve fires of the last season did not do much damage since they occurred mostly on cut-over lands.

Beyond the Height of Land, the Northern or Subarctic Forest begins. Although White and Red Pine are still found, overlapping along the upper river course, and, although Aspen, Balsam Poplar and Paper Birch are frequent accompaniments and sometimes sole occupants of the soil, the general type may be described as spruce forest, the White and Black Spruce being by far the predominant species. While the eastern portion of this region lies on the old granite rocks, its western extension lies on limestone formation. With a climate still more rigorous than in the last described region, and with still less topographical differentiation, it stands to reason that on this northern slope of the Laurentian plateau, not only a reduction in the number of species to eight—besides those just mentioned only the Banksian Pine, Balsam Fir and the Tamarac take part in its composition—but reduction in development of individuals and of the whole forest is experienced.

This vast territory, comprising about 1.5 million square miles, has for the most part been only superficially explored, and the explorations have followed mostly the river courses. Recently, a compilation of the meager reports on timber conditions by the explorers, from Hearne (1770) to Tyrell (1898), has been made, and the results as far as practicable have been mapped. The writer is indebted to Mr. R. E. Young, Superintendent of Railway Branch, Department of Interior, Ottawa, for a copy of this unpublished report.

It is a plateau region or rolling plain dotted with thousands of lakes, large and small, and swamps or mossy muskegs in the shallow valleys, with only here and there better drained sandy or rocky areas. Temperature conditions are of greatest importance here, and it is likely,—this is only a suggestion by the writer,—that different exposures as well as soil depth account for the observed striking local differences of development. The different species occupy different localities, although the species are perhaps nearest to being ubiquitous. The Black Spruce occupies the boggy ground until, farther north, it too prefers the drier situations, and joins the White Spruce to the very limit of tree growth. Balsam Fir is not common, and, with the Tamarac, at its northern limit leaves the muskeg borders and swamps for drier ground. It is the first species to disap-

pear from the composition in going northward. The Banksian Pine seems to be the tree to the manor born for it is the tree of the rocky and sandy situations and yet becomes of better size in its northwestern extension, than it is known to attain in its more southern range, trees over 100 feet high and 12 to 20 inches in diameter having been observed along the Beaver, English, Athabasca and Clearwater Rivers, between latitude 53° and 58°. It, too, gives out in the northern extension of this belt. The Balsam Poplar and the Aspen, which latter occupies a wide belt around the prairie region almost exclusively, are both an accompaniment of the more northern conifer forest

Both of them also improve in habit in their northern field. The Aspen, in the Riding and Porcupine Mountains and westward, to Prince Albert and Edmonton, becomes a fine tree, of 50 to 100 feet in height, with diameters up to 18 inches and is considered an indicator of good soil. The Balsam Poplar, too, reaches its greatest perfection on the Athabasca, Slave, Peace, and especially the Lower Liard rivers. Perhaps because they are allowed here to occupy the better soils, their development is improved, or else, as analogous observations in the alpine region of Colorado lead the writer to think, at least Aspen and Banksian Pine find their center of distribution in this northern climate. Paper Birch is not plentiful, and irregularly distributed, but has a wide range. An interesting island of this species in nearly pure stand occurs near the head waters of McLeod and Athabasca rivers, after an almost total absence of the species in the more eastern districts.

Looking at the economic value of these northern woodlands, everybody must agree that their timber, although of inferior character is of utmost value for home use by the prospective settler and miner, and of no commercial value to our eastern civilization, especially as the direction of down grades is in another direction. That vast areas probably 50 per cent., are destroyed by fire and are annually burned over must be considered an incalculable loss for the future.

If an attempt were made to further differentiate this Northern Forest, we might recognize a northern and southern section, the limit between the two being formed by the northern limit of the Balsam Fir, which coincides for most of its trend closely with the division line of the "Hudsonian" and "Canadian" life zone, lately established by the U. S. Bureau of Biological Survey.* South of this line we may assume, and we know in part, that a better development of forest growth is found more frequently than in the northern section. in which the Balsam Fir is absent, and Balsam Poplar and Banksian Pine are rare.

As the foothills of the Rocky Mountains are reached by this northern forest, beyond the 52° it still continues north-westward into Alaska and to within a short distance of the Behring Sea and Arctic Ocean.* There is however, a change in the composition, two western species relieving two eastern. The Balsam Fir is supplanted by Abies lasicarpa and the Banksian Pine by Pinus contorta murrayana.

These latter also mingle in a narrow limited area southward, and the White Spruce and American Larch also invade the Rocky Mountain flora, while even the Douglas Fir from the West descends the eastern slopes for some 30 to 50 miles, joining the eastern flora.

The Pacific Forest may regionally and in part florally be divided into four types, and topographically at least six types can be diffrentiated, namely, the northern and southern Rocky Mountain type, the northern and southern Coast type, and within each of these the wet and dry slopes and the alpine type.

Temperature conditions divide the British Columbia forest into the two northern and southern, and the alpine types. Humidity is the determining factor for the dry and wet types in each of these; and humidity, of course, is predicted by topography.

The topography here being extremely diversified, changes in composition and development are as diversified. West slopes and valleys opening to the west under the influence of the winds from the Pacific Ocean, are humid. East slopes and valleys withdrawn from the influence of these winds are dry to arid. An arid interior plateau similar to that east of the Sierras in the States, divides the Rocky Mountains proper from the Coast ranges.

The southern Rocky Mountain type is an extension of a southern flora, with the Bull Pine (Pinus ponderosa) the Silver Pine (P. monticola) Engelman Spruce and Western Larch as representative timber trees with Douglas Fir, Cedar, Hemlock, and Lodgepole Pine in minor occurrence, to which the Eastern White Spruce may be added. This type varying somewhat in composition and development extends to nearly the 53° latitude, then to change into a type of simpler composition in which the Lodgepole Pine plays a prominent part, covering the dry slopes and plateaus northward as far as they are wooded. Larix Lyallii, Pinus albicaulis and Abies lasiocarpa are the species of the alpine zone, above 4000 to 5000 feet up to timberline, which is found at 7,000 to 75,000.

West of the Coast range, the celebrated Coast forest, also an extension of a more southern flora, is found in a belt running for 200 miles north, and rarely broader than 50 miles at most from the shore, except at the southern boundary, where it reaches 150 miles inland, crossing the Canadian Pacific a few miles east of Yale. The large island of Vancouver is for the most part wooded in a similar manner. Here the Douglas Fir in magnificent development with the Hemlock and Giant Cedar are the main timber trees. Abies grandis, Picea sitchensis, and Chamaecyparis Nootkatensis adding locally to the values. The finer timber with diameters sometimes up to 12 feet and 300 feet in height, is, to be sure, not to be found in a continuous body, but according to topography varies with timber of poorer development. Generally speaking the bottoms, benches and gentler slopes exhibit the heavy timber up to altitudes varying between 1,500 and 2,500 feet. Above this elevation there is found in some parts for another 1,000 feet or so, another type, still of commercial value, mainly of Abies amabilis. Above the 3,500 foot level only the scrubby or stunted growth of the Alpine type is found.

Along the coast and on the islands north to Portland Canal, the northern coast forest changes in composition to the simpler Hemlock-Spruce type, which continues all the way along the Alaska shore to Cook's Inlet. It is mainly composed of Hemlock, Sitka Spruce, and Yellow Cedar, occasionally where soil depth is favorable, developing to good size, although mostly branchy and really much of it of inferior quality.

The Coast range being a series of low, broken hills, rather than a continuous range, this type continues into the valleys of the rivers for a considerable distance from the Coast.

Timber Areas and Standing Timber.

Actual knowledge regarding commercial timber areas is scanty, and the scattered knowledge has not been systematically collected. We have to rely on very much generalized estimates.

Of the vast territory of British Columbia, estimated at 370,000 square miles not more than 30,000,000 acres or 12 per cent. is by well informed land lookers, considered merchantable, according to present standards, and it is doubtful whether under any change of standards the acreage of actual and potential commercial forest could be increased beyond 50,000,000 acres. At present, to be sure, the lowest standard at the Coast mills is, as a rule, 14 inch in 32 feet logs, and, as a rule, no trees under 26 inch d.b.h. are cut. Of such timber, now pretty nearly all located by timber licenses, not more than six million acres are supposed to exist, which may be swelled to 15 million of commercial character when standards are lowered, and both the north-

*North American Fauna, No. 27, Oct. 266, 1908.

*See the writer's article on Alaskan Forests in Harriman Alaskan Expedition vol. I.

ern extension and timber of higher altitudes are added, which, at 15 M feet average, may indicate a stand of over 225 billion feet.

In the mountain mills the average log sawed at the mill is 12 inch, and another 15 million of this description may be found in the southern Rocky Mountain type, which figured at 5 M feet, gives another 75 billion feet, or altogether for the western Canadian forest 300 billion feet. One might easily double these estimates without finding the supply inexhaustible. Every effort is being made to get rid of this valuable limited asset of the province. The Government has disposed of at least two-thirds of the coast-timber and of one-half of the mountain timber, and only six million acres, believed to be good timber, are not disposed of.

The mill capacity so far established is, to be sure, still small, hardly one million feet, the value of the log products of the Province being by the Census of 1905 placed at $11,000,000.

Fires, as everywhere, have made great havoc, especially in the mountain timber. While on the western humid slopes in the heavy timber fires do not do much damage, the drier mountain country has suffered severely, not only along the line of travel, but wherever prospecting could be facilitated by the destruction of the forest cover. The northeastern section, but little explored is probably without timber of other than local interest.

Of the Northern Forest, so far as known, not much of commercial value, especially for sawmill use, except for local consumption, may be expected. Those who figure on pulpwood values will have to keep in mind that for such use too qualitative development as well as quantity per acre in accessible situations are required, and that these conditions are mostly not met here. Besides, not only the distance from centres of consumption, but the fact that river transportation is for the most part impracticable, the rivers running mostly in the wrong direction and their use being otherwise beset with difficulties.

The Southern Laurentian forest is destined to be the permanent forest reserve of the Eastern civilization, for most of it is not fit for other use. Agricultural lands do not abound, but pasturage could probably be established over wider areas and the writer expects eventually a large cattle industry to be developed on the better soils now occupied nearly exclusively by hardwoods.

As intimated before, soil conditions vary considerably and hence local forest types vary from the almost pure hardwood growth in which Birch, Maple, Elm, and Basswood are prominent with Black Ash, little Red Oak, and Beech of more local distribution, to the pure coniferous forest of pines, or Black Spruce in the swamps. The good saw timber is so irregular in its distribution, that one can travel hundreds of miles without seeing any of it. Banksian Pine occupies long stretches. It is the "fire pine", being serotinons and opening its cones preferably under the influence of the heat of forest-fires. While this pine is useful enough for mine props, railroad ties, and fuel, it rarely reaches saw timber size. Outside of Spruce and Balsam Fir, the White Pine, Red Pine and Hemlock are the commercial trees, and the northern limit of the White Pine circumscribes this area of 150,000 square miles, or say 100 million acres. Little, if anything, is known of the total stand of timber remaining, but if, for the sake of getting at some reasonable figure, we assume an average stand of 2,000 feet per acre, we would probably estimate too high. In other words a stand of 200 billion feet of saw timber must be considered an ample allowance.

The St.Lawrence Valley sections are, as stated before, practically cut out and may only be considered as helping to eke out the over-estimate for the previous section.

Taking Ontario alone with a total land area of 126 million acres, of which 80 millions are still unsurveyed, we find that the distribution of these lands among the three types of forest country occupied by the Province, gives 30 million acres to the southern hardwood type, 50 million acres to the central southern Laurentian type, and 46 million acres to the Northern Forest. Not quite 25 million acres are disposed of to private owners. From the assessment lists we learn, that of these, 14 million acres are cleared, of which 12.4 million in the peninsula, on Lake Ontario and in St. Lawrence valley, and 1.7 million in the Southern Laurentian plateau. The wood-lots on these farms are assessed at 5.5 million acres, nearly 2 million acres are reported as slash, and 2.8 million as swamp and waste (2.4, 2, and 1 million of the latter respectively in the three sections).

Applying a general experience figure for waste land incapable of recuperation, we would come to the conclusion that 85 million acres or two-thirds of the Province will always remain in woods except so far as it may be turned into grazing lands.

Mr. Whitson, of the Crownlands Department, one of the best informed men on these matters, places the figure as at best 70 million acres productive forest area, and the stand of pine outside of licensed lands (12.5 million acres are licensed and were some time ago estimated to contain 24 billion feet, the annual cut being around 800 million feet) and of forest reserves (10 million acres) at 10 billion feet B. M., and the pulpwood at 288 million cords. He also states that of the Jack Pine not 10 per cent. are fit even for railroad ties.

For Quebec the distribution of land areas may be made as follows: Of the 218 million acres (342,000 square miles) around 144 million acres belong to the Northern Forest, 50 milion, the same amount as for Ontario, to the southern Laurentian; the St. Lawrence valley with 5 million acres represents mostly farm area, and the balance of 19 million acres may be accredited to the Acadian region. There are about 9 million acres in farms, of which 7.5 in crop, 1.5 million in waste land, hence the total forest and waste land area is over 210 million acres. An estimate by Langelier, Superintendent of Forest Rangers, places the standing timber of the White and Red Pine at less than 40 billion feet, and Spruce sawlogs at over 100 billion, all other saw material (including Jack Pine) at about 18 billion feet, or altogether less than 160 billion feet.

The Maritime Provinces with somewhat over 57,000 square miles, together with the Eastern townships of Quebec, south of the river, (30,000 square miles) belongs to the Appalachian or Acadian forest type. This area is practically cut out as far as pine is concerned, and relies now mainly on Spruce for saw timber.

In New Brunswick 12 million acres are estimated to be under wood, the composition of which, by good authorities, is figured at 60 per cent. spruce, 10 per cent. pine, 5 per cent. hemlock, 5 per cent. cedar, 20 per cent. hardwoods. Here the larger portion is owned privately, some 10.5 million acres. Of the 7.25 acres of crown lands all but about one million acres is under license, the latter area being barrens or burnt.

The small remaining area of timberland on Prince Edward Island is, in calculations like these, entirely negligible. New Brunswick, together with Nova Scotia, which represents an area of some 14 million acres, may round off the total stand of saw timber in the Eastern Provinces to 300 billion feet and for the whole of Canada to 600 billion feet. We might readily double these estimates and still remain within reasonable limits of the truth, if a closer utilization, especially on the Pacific Coast, and more careful lumbering generally were practised, and if the fires running with tolerable regularity through the slash did not destroy much of the growing timber besides the young growth.

Considering that the above estimated stand of saw timber, which others have considerably reduced, would not suffice to supply the present annual consumption of coniferous material in the United States for more than 15 to 20 years, and the import into Great Britain of this class of material for more than 60 to 80 years, the need of securing better knowledge of the conditions of this resource and of employing conservative methods in its use are apparent.

STONE RETAINING WALL.

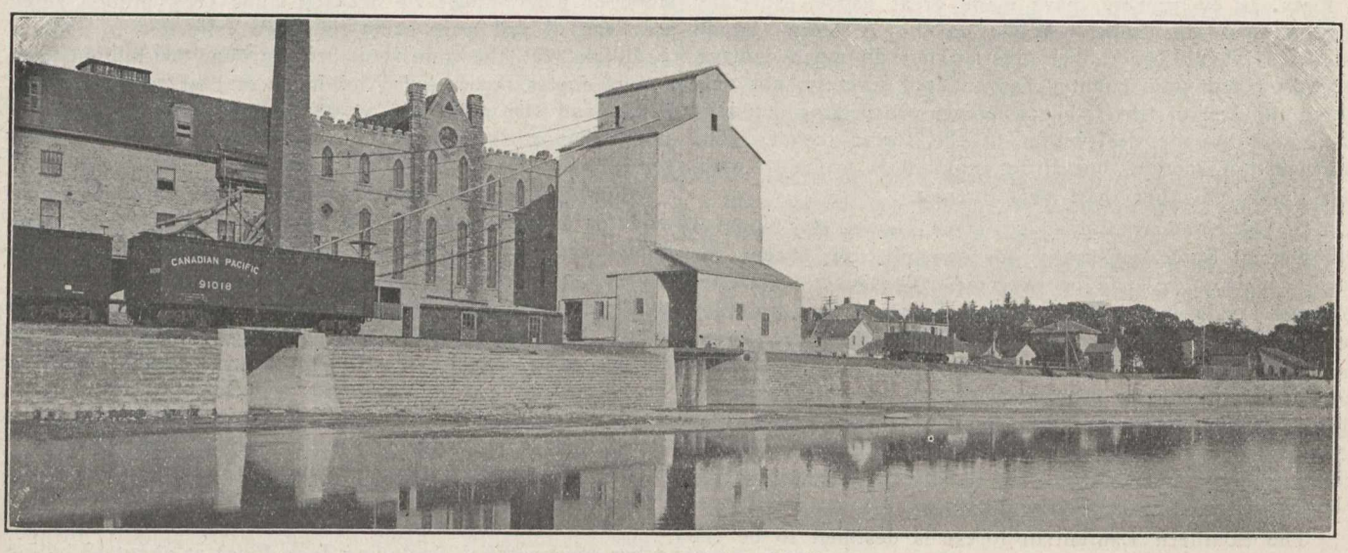
The St. Mary's and Western Ontario Railway recently completed from Embro Junction to St. Mary's, enters the town of St. Mary's along the left bank of the St. Mary's River. The main part of the town lies in the river valley and the business blocks, mills and factories crowd close to the river's edge, and to get the railway in on safe ground between the river, and without removing buildings it was found necessary to build a retaining wall.

The accompanying illustration shows the wall between the river and the G. Carter Son & Company mill property.

This wall is 687 feet long and varies in height from 6 to 14 feet. In all it contains 900 cubic yards of dry masonry. At the bottom it is 6 feet wide and at the top 2½ feet the face being run up with a batter of 1 inch to the foot. The stone was laid dry.

The rock formation at St. Mary's is limestone and is found in beds or layers running from flagging up through 3, 4, 5, 6, 7, 8, 9, 10, 11, 13 14 and 16 inch beds. The stone for this wall was taken from the 8 and 11-inch beds and were quarries out of the river adjoining the wall. As a matter of cost it is interesting to notice the contract pieces. For the dry stone wall the price was $5 per cubic yard and for the concrete, which was used in the facing of the spillway and tail-race and which shows in the illustration $8.50 per cubic yard. Taking a ten-foot section of this wall and a ten-foot section of a concrete wall of usual design for such work it will be found that the concrete is the cheaper so that the fact that the stone removed improved the tail race, for the mill must have been a consideration in letting the work. The railway ticket office and waiting rooms are in the stone building shown in the centre of the illustration, and the station yards are to the right of the elevator.

The G. Carter Son & Company were the contractors for the retaining wall.



Dry Masonry Retaining Wall.

STEEL TIE AND CONCRETE TIE CONSTRUCTION.*

By Charles H. Clark, Chief Engineer, New York & North Shore Traction Company.

The railroads in the United States have been and still are using enormous quantities of timber in their construction. Year after year they have been paying more and more and receiving poorer and poorer timber for ties. There was a time when the farmers around the outskirts of the cities could be depended upon to furnish white oak ties at a price between 30 and 50 cents for a 6-in. x 8-in. x 8-ft. tie of the choicest quality; none of these can now be purchased, except at a price prohibitive for use as tie timber. Only a few weeks ago the writer had occasion to order some oak stakes, for which the manufacturer wanted $90 per thousand for the wood alone. It suffices to say that a cheaper wood was purchased. Then, again, when white oak is specified, chestnut, burr oak, port oak and rock oak, together with the red oak, black oak, elm, sassafras, cherry, walnut, etc., are furnished. These woods can be smuggled in covered with mud and slime making the timber unrecognizable even to a timber expert, of which, by the way, there are but few not already retained by the tie and lumber companies. Timber purchased as long leaf yellow pine will be found to be mixed with loblolly or Virginia pine, the life of which is probably less than half that of the long leaf pine. These are some of the troubles incurred in trying to get the quality of timber which is asked for, and for which the specifications call.

Not so with the steel tie. The principal trouble with this tie is the shape, the difficulty of getting the maximum strength for the minimum weight, or the greatest service for the cost of the tie.

The earlier forms of steel ties for electric railways consisted of a 7-in. channel 7 feet long, which was placed on top of a 6-in. bed of concrete. This form had little more strength per unit of weight than a flat piece of steel. A comparison of the properties of channels with I-beams of the same weight for standard sections shows that the moment of inertia for the channel on its longtitudinal axis is for a 7-in. channel weighing 14¾ lbs. per foot, 1.40; whereas a standard 5-in. I-beam has a moment of inertia for the same weight beam of 15.1, showing 10 times the strength when used as a beam. It may be claimed that the channel lies flat on the concrete, and is not, therefore, used as a beam. This might be true theoretically, but experience has taught us that the continual pounding of the heavy cars has broken the concrete under the rail, and the steel tie has buckled up and thrown the track into a wide gauge, which it is almost impossible to correct without complete reconstruction. This has only been true of the old type of steel channel tie.

With steel ties the usual construction for paved streets is generally as follows:—The spacing of the ties usually decided upon is from 4 feet to 6 feet centres. The old pavement is removed and an excavation made to the required depth for the pavement, sand cushion and concrete, generally 15 inches deep. Cross trenches for the ties are dug; these are made about 5 inches or 6 inches below the bottom of the tie and about 12 inches wide. A trench 10 inches deep and 15 inches wide is then excavated directly under the rail; the ties are placed in the tie holes and the rails laid upon the ties and clipped, and then surfaced and lined as usual. The ties must be blocked up with pieces of old wooden ties placed under the rail, but not under the ties; the alignment is held by wedging the ends of the steel ties against the bank. The concrete is then placed under and around the tie and under the rail. This concrete should be of the very best composition, and, preferably, 1:2¼:5 for the ordinary run of stone. If gravel is used, 1 part cement

*Paper read at the quarterly meeting of the Street Railway Association of New York.

to 6 of gravel is a good mixture. For the concrete under the pavement alone a leaner mixture can be used at a reduced price per cubic yard. When the concrete is mixed by hand it is more economical; the work can be carried along systematically by organizing two concrete gangs. The concrete is thoroughly mixed and tamped under the ties and rails with the ordinary tamping bar. The part under the pavement only is rammed thoroughly into place and kept to a templet. With this method of construction and using an I-beam steel tie 5 inches deep, 7 feet long, and allowing for concrete 9 feet wide over all, it requires an average of 0.116 cubic yards of concrete per running foot under the ties and rail and 0.06 cubic yard per foot for the balance, making 0.176 cubic yard of concrete per foot of track, allowing for the concrete coming only to the top of the tie. The cost of this work varies in all localities and with all weather conditions.

The Carnegie Steel Company has developed a steel tie which meets most of the requirements of the track engineer. It is a tie which will give the greatest strength and holding power for the least weight of material. This tie is made in three weights:—Sec. M-21, weighing 20 lbs. per foot; Sec. M-25, 14½ lbs. per foot, and Sec. M-24, 9.5 lbs. per foot. The largest section, M-21, has a depth of 5½ inches with top flange of 4½ inches, and bottom flange of 8 inches; section M-25 has a depth of 4½ inches, top flange 4 inches wide, and bottom flange 6 inches wide; section M-24 has a depth of 3 inches, top flange 3 inches wide, and bottom flange 5 inches wide. It has been the general practice to lay these ties with the wide flange on the bottom, the idea being that the greatest bearing resistance was obtained. The writer does not believe this to be true. The Chicago Board of Supervising Engineers conceived the idea of reversing this method, and laid the ties with the wide base on top. If the tendency of a tie is to buckle, all other strains being equal, the tie laid in this position, with the wide flange on top, has the greatest resistance to buckling on account of the increased area of the wider base. Then, again, the concrete can be placed and tamped more thoroughly under the flanges.

The most common fastening is the steel clip with a bolt. This is a very simple construction, and so far has proved satisfactory. However, the Chicago roads have deviated somewhat from this mode of fastening and are using a tie plate ¼-inch thick, with special punching of the tie and special bolts and clips, which can be removed from the top when it becomes necessary to renew the rail. This removes the objection raised by some engineers to steel ties on account of the difficulty of renewing rail. The steel tie has not been in use long enough to form an opinion of its ultimate durability. The writer had occasion in Cleveland to remove some track, where the franchise had expired, which was laid with Lorain steel ties, spaced 10 feet apart and alternating with wood ties spaced the same distance apart, with 10 inches of concrete under the rail. This track was in perfect condition. The concrete was perfect, and no pulverizing of concrete was found under the rail. The track was laid under the writer's supervision in 1903, and removed in 1907. The concrete was a 1:3:5 Portland cement mixture of best quality. In removing the ties the nuts had to be cut from the bolts. In contrast with this, the writer had occasion within the last year to repair track laid under similar conditions, but with only 4 inches to 6 inches of concrete under the rail. This track was badly out of surface, the concrete was broken and the rails were corrugated. This condition may be attributed to the poor workmanship when the track was laid and the racing of the gangs to cover the most distance in a day. The engineer must evolve, first, a correct design, then see that it is carried out. Quality and quantity of concrete tell how much work a gang is doing, not the number of feet of track laid per day, for the unscrupulous foreman will skimp his measurements and get over the distance with the least amount of concrete. Track built to stand the pounding of heavy cars must be given close attention in every detail. It costs money in the beginning, but the saving in maintenance of track and pavement comes for each succeeding year, and the capitalized cost of the roadway is a great deal less.

The following is a comparison of the original cost of oak tie construction with steel tie construction.

For 100 feet of track, all labor being the same, for oak ties:—

50 oak ties at 80 cents delivered	$40.00
200 spikes	2.00
Extra excavation, 5 yards at 40 cents (low)	2.00
24 cu. yd. concrete under and between ties, at $5	120.00
Total for 100 feet	$164.00

For steel ties for 100 feet track:—

26 steel ties at $1.80 (average)	$45.00
17.6 cu. yd. concrete at $5	88.00
Total for 100 feet.	$133.00

This shows a saving by using steel ties of 31 cents per foot of track, or a saving of $1,636.86 per mile. Of course, this saving will vary for different localities, and by using local unit prices exact comparisons can be made.

Steel ties of every shape imaginable have been devised, but the one great fault of most of them, in general, has been the amount of work needed to make them and the insufficient strength attained, together with the complex fastenings devised, which have prevented their manufacture as practical commercially. The writer believes steel ties have come to stay. They will stand the severe tests placed upon them. It is only necessary to look at the old cable construction for an answer as to the durability of metal in track. The Superior Street and Payne Avenue lines of Cleveland, Ohio, which were laid in 1890, still have the original rails and foundation in use.

Some engineers believe that corrugated rails are caused by rigid foundations. In answer to this the writer would point to Niagara Street, Buffalo, which is laid upon and tamped with the dirt excavated. Here may be found the worst case of rail corrugation in Buffalo. On the concreted track the corrugations are found where the concrete was poorly laid. The conclusion may be drawn, therefore, that rigidity does not cause corrugation. Look after joints, which are the weakest parts of the track. Do not be led to believe that the common splice bar, with 12 bolts, is good enough. It is not. Use 2-in. x ⅜-in. tie rods, spaced not more than 5 feet apart; or, better still, a tie rod over every steel tie. Do not depend upon brace chairs, as they work loose and corrode under the rail. Do not use the girder rail unless absolutely required and compelled to do so. The best track for city streets to-day is laid with T-rail. In Minneapolis, St. Paul, Milwaukee, Syracuse, Utica, Auburn, Lockport and other cities where T-rail is used will be found the best tracks in the country. Do not be misguided by those who advise that city streets cannot be successfully paved where the T-rail is used They can and are being paved, and with the best results.

Concrete beam construction has not been very successful, judged from reports of the few engineers who have used this method. The difficulty has been in keeping the track to gauge and surface. Soft spots in the foundation of the beam cause wide gauge and bad surface. The pavement breaks away from the rails, and its use is not to be recommended.

Concrete ties may perhaps come into use, on account of the ease of making them. The Correll tie, made in two sections and connected with a tie bar, is a good example. Sixty of these ties were placed in the suburban tracks on the Lockport line at Buffalo, N.P., early this spring. They were tamped with ordinary loam and gravel. The writer has not examined them since August, at which time, after having been in the ground only about four months, they were in fine condition. By using concrete ties certainly no trouble will be experienced with ties rotting for want of good drainage, and the material for tamping need not be of the best.

DUST LAYING IN BARNSLEY.*

In accordance with the authority given to me, I have treated most of the main roads in Barnsley either with tar by tar spraying or with chloride of calcium and water.

The operations lasted from June 23, 1908, up to September 1st, and during that time I have tar sprayed about two miles in length of roads—namely, part of Huddersfield Road, the whole of Victoria Road, part of Church Street, part of Doncaster Road, Peel Street, part of Sheffield Road—the total cost of which has been $585. The effect of tar spraying the roads saved a considerable quantity of street watering, the estimated cost thus saved being $120, leaving the net expenditure $465, or $232.50 per mile of road treated. These roads are generally on flat gradients. The effect upon the roads has been good, but unfortunately we were delayed by the contractors for the tar spraying, who were unable to start work at the time agreed, and as the hot season had become advanced the tar which had been sprayed did not set hard so quickly as if it had been completed by the time appointed; but notwithstanding this drawback, I consider that the improvement of the roads has been well worth the expenditure. Not only has it reduced to a large extent the dust, but, in my judgment, it has improved the surface of the roads treated, and will cause them to wear as macadamized roads fully one-sixth longer than they otherwise would have done.

The drawbacks to this system of treatment of roads are chiefly: As the tar is laid on in a hot liquid state, and does not set for a few days after being laid, pedestrians and vehicles "lick" up the tar, which becomes a nuisance to householders through the damage it does to their passages and carpets. The tar has also to be well sanded immediately after being laid, and the sand has to be carefully swept off as soon as the tar has sufficiently set, and weekly washings of the roads are necessary in order that the full advantage of the tarring may be obtained.

A further and more serious drawback is, I fear, that in the winter time the roads will become so slippery owing to their smoothness from the tar having set hard that it will be necessary to place a considerable quantity of gravel or sand upon the surface to make them safe for vehicular traffic, and this gravelling or sanding of itself will cause a certain amount of dust.

The following roads which are of a steeper gradient, varying from 1 in 10 to 1 in 23—namely, Dodworth Road, Pontefract Road, Cemetery Road, Park Road, Eldon Street North, part of Old Mill Lane, Eldon Street, part of Queen's Road, Kendray Street, Midland Street, Regent Street, part of Grace Street, part of Buckley Street, Racecommon Road, and part of Summer Lane—were treated with calcium chloride mixed with water. The calcium chloride is received from a well-known firm of chemical manufacturers, and is delivered to us in iron drums of 5 cwt. each. The drums are opened and the crystallized calcium chloride is broken into small pieces and placed in the street-watering carts mixed with town's water and distributed on to the roads in the same way as the ordinary process of street watering with water alone.

The total length of these roads so treated is 4½ miles. The toal cost, including calcium chloride, water, labour and steam labour, was $326.82, but I estimate that the sum of $322.32 was saved by the reduced quantity of street watering that was necessary, leaving the net cost of $1 per mile over and above street watering.

I consider that the effect upon the roads was well worth the cost; after the application of calcium chloride and water to the roads the dust was practically laid from periods varying from seven days to ten days before a further application of the chemical was again used on the roads. The dust was so far laid that a very noticeable improvement in that respect took place.

The effect upon the surface of the road as either improving it or deteriorating it was practically nil; it is a much easier and pleasanter way of applying than the laying of tarspra, but its drawbacks are, that it has to be frequently applied to the roads, namely, at periods varying from seven to ten days apart—and a tendency to make the surfaces treated slippery (especially tarred macadamized roads).

I consider that in Barnsley we are in a very much better position for dealing with the dust nuisance than are many other towns. Already the majority of our main and ordinary highways of ordinary gradients are macadamized with tarred macadam, and many of them have been so repaired and maintained for more than thirty years.

No ill-effects have been observed to the growing trees on our many tree-planted roads.

I would recommend that next year (if the season be favourable) an earlier application of the dust-laying material be applied, and in the meantime I intend to take careful observations of any improvements that may be brought out having for their object the prevention of the nuisance arising from the excessive dust from the roads, and the prolongation of the wearing lives of macadamized roads.

It is well known, of course, that the real cause of the increased expenditure necessary for keeping down the dust on the main roads is the greater use of traction engines, motor-cars and motor wagons, but I incline to the opinion that the placing of a tax or rate upon the owners and users of motor-cars and motor wagons by itself is an insufficient way of making a permanent improvement to the roads. I consider that the proper plan would be either to have constructed throughout the county separate motor tracks for rapid travelling at speeds exceeding 10 to 15 miles an hour, or that all the roads used by motors should be reconstructed with both new foundations and surfaces, where necessary, such surfaces being specially prepared with ingredients consisting chiefly of tar, bitumen, or other similar substance, and that the cost of providing these special tracks or of specially constructing the roads should (as a matter of national importance) be borne by the Government, who are the best able to control or regulate this description of traffic, and who ought to encourage this comparatively new industry which is becoming great and extensive.

I also consider that the time has arrived when heavy traction engines such as are now so largely in use should be prohibited from travelling along our highways, as they are the chief cause of the damage not only to the surface, but in many cases to the foundations of our roads, rendering the roads less suitable for both motor and ordinary traffic, and more liable to become dusty and muddy than by any other means of traction. I would not include in this prohibition the traction engines used for drawing threshing machines and other light agricultural implements along the king's highways. They do comparatively little damage to the roads.

* Copy of a report by J. Henry Taylor, M.Inst.C.E., Town Engineer for Barnsley to the Highways Committee of the Town Council.

CANADIAN NORTHERN RAILWAY.

The Canadian Northern Railway's gross earnings for the week ending November 21st, were $257,600, and for the corresponding period last year, $207,800, an increase of $49,800. From July 1st to date the earnings have been $4,329,300, as compared with $4,231,600 during the similar period of last year, an increase of $97,700.

The statement of earnings and operating expenses for the month of October made by the Canadian Northern is as follows:—

	1908.	1907.	Inc.
Gross earnings	$1,172,700	$931,200	$241,500
Expenses	752,600	621,300	131,300
Net earnings	420,100	309,900	110,200
Miles in operation	3,094	2,874	220

From July 1st to October 31st.:—

	1908.	1907.	Inc.
Gross earnings	$3,550,300	$3,549,400	$ 900
Expenses	2,490,100	2,452,000	38,100
Net earnings	1,060,200	1,097,400	x37,200
Miles in operation	3,094	2,874	220

x—Decrease.

THE FIFTH REPORT OF THE ROYAL COMMISSION ON SEWAGE DISPOSAL, 1908.

*A Review by T. Aird Murray.

The fifth report of the Royal Commission on Sewage Disposal, recently published in the form of a Blue Book, contains the result of an exhaustive enquiry. The work of the Commission was to determine:

I. What method or methods of treating and disposing of sewage (including any liquids from any factory or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of public health, and for the economical and efficient discharge of the duties of local authorities, and

II. If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, the particular method of treatment and disposal to be adopted be determined; and

III. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage.

The investigations leading up to the report include 144 meetings, at which no less than 197 witnesses were examined, including well-known medical officers, engineers, and other scientists having special knowledge on the subject. Also by means of circular letters, a large amount of assistance was received from scientific men from all over the world. Local authorities in association with the Commission carried out experimental investigations at Birmingham, Burnley, Heywood, Huddersfield, Leeds, Manchester, Oldham, Rotherham, Salford, and Sheffield. While the Commissioners carried out special investigations by their own officers at Accrington, Dorking, Exeter, Guilford, Hendon, and Ilford. The Commissioners personally visited a large number of sewage works.

This report has been anxiously looked forward to by those interested in the question. Local authorities have in many cases refrained from installing sewage disposal plant for some time back, waiting the result of these extended investigations.

The report presents the most complete and authoritative treatise on the subject of sewage disposal before the public, and will no doubt be accepted as a standard work of reference. In considering the report, however, it must be kept in mind that the theory and practice of sewage disposal have not by any means reached a final stage. Throughout its pages we find reiterated the statement, "fuller knowledge is yet required." in this, or that subject. Also, it must be noted, the experiments and investigations have been carried on over several years, during all of which time the subject itself has undergone evolutionary changes; and that even during the period elapsing between the time the Commissioners finished obtaining evidence and the time of issue of report, matter of importance has been added to the subject. Therefore, in considering the conclusions of the report it is well to bear in mind that such are only based on the evidence at hand at the date of the investigations.

On the strength of such an authoritative statement, there will be, as is always the case, a tendency to rely too exclusively upon such findings. Engineers may in the future have to face the assertion, "but, your plans are not in accordance with the conclusions of the Royal Commission." A careful consideration of the report, however, will tend to justify the opinion, that there can be no stereotyped scheme to suit all conditions and all localities. There are many points in connection with sewage disposal which remain still open questions. There are, however, since the issue of the report, fewer such questions. Points which were before considered debatable are now no longer so. A great weight of evidence has focussed many conflicting opinions into what may now be accepted as proven facts.

*This review was read by Mr. T. Aird Murray, Consulting Sanitary Engineer, Toronto, Ont., before the Engineers' Club, Toronto.

The report is divided into eight parts, viz.:—

Part I.—Preliminary Treatment of Sewage.

Part II.—Purification of Sewage by Artificial Filters.

Part III.—Purification of Sewage by Treatment on Land.

Part IV.—Sludge.

Part V.—General.

Part VI.—Standards and Tests.

Part VII.—Pollution of Estuaries and Tidal Waters.

Part VIII.—Summary of conclusions and recommendations.

PART I.—PRELIMINARY TREATMENT OF SEWAGE.

Introductory Remarks.

Paragraph 14.—Contains the general conclusions of a series of a number of experiments as regards the fermentative changes which occur in the purification of sewage from which the Commissioners state, "The purification of sewage is to a large extent a process of direct oxidation through the agency of bacteria, and one of the chief things required to be known about any particular sewage is how much oxygen is required for its complete oxidation. The rate at which the sewage will take up oxygen is also a factor of importance, in that it furnishes information as to the character of the organic matters."

"The dissolved oxygen test is a biological process, and it differs from the ordinary tests—such as oxygen absorbed from permanganate—in that it takes account of practically the whole of the organic matter, and not merely that of a particular kind."

Screens and Grit Chamber.

Paragraph 23.—"The evidence which we have received and our own experience show that it is generally more economical to remove from the sewage, by a preliminary process, a considerable proportion of the grit and suspended matter, before attempting to oxidize the organic matters on land or filters." The report then points out that at several places crude sewage has been satisfactorily purified in filters with almost complete absence of nuisance, but that at most places the plan has been abandoned because of the rapid choking of filters. The interesting point to be noted here is that, given a filter of a character not liable to choking, filtration in itself is sufficient to purify sewage.

Screens and grit and sedimentation tanks are recommended. The use of fine screens is not advised. Leeds is quoted where fine screen experiments were carried out with 30 to the inch mesh, and rather less than 10 per cent. of the suspended matter was removed, but their use was attended with great difficulty, as they choked readily. A more thorough preliminary settlement of grit, is thought desirable for septic tanks, than for precipitation tanks.

Sludge Retention.

A great amount of attention is given to this subject, and its supreme importance is fully recognized in the amount of experimental work devoted to sedimentation, chemical precipitation and digestion of sewage solids by putrefaction.

The Commission divide the various processes as follows, while they preface their remarks by saying that all tanks are sedimentation tanks:—

(a) Quiescent settlement without chemicals.
(b) Quiescent settlement with chemicals.
(c) Continuous flow settlement without chemicals.
(d) Continuous flow settlement with chemicals.
(e) Septic tanks.

With reference to the first of these processes no fixed rules can and are given. The sewage being allowed to remain in the tanks till such time as the greater part of the solids have settled and the liquor drawn off with a floating arm. The number and sizes of the tanks depending entirely on the quantity of sewage treated and the amount of time required for settlement with the particular sewage. Experiments at Leeds and Sheffield showed that from two to three hours was sufficient to remove a large portion of the suspended solids and produce a fairly good tank liquor. With these tanks it is usual to remove the deposit after

every first or second filling in order to obtain a highly efficient condition.

Continuous Flow Sedimentation.

The tanks in this case are practically the same as in the case of septic tanks, the only difference being a difference in operation with regard to the sludge. In the former case the sludge is removed before putrefaction commences, in the latter the sludge is allowed to remain, and undergo putrefaction whereby a proportion of it is digested and broken up into gases.

Par. 28.—Experiments in continuous sedimentation were carried out at Clifton, Halton, Oswestry, and Dorking. The results are of sufficient interest to bring to your notice.

Place	Shape of Tank	Dimensions of Tank	Time Allowed	Rate of flow per minute in inches	Solids (in parts per 100 000 reduced from
CLIFTON ..	Rectangular	39′×5′×4′	5.3 hours	1.7″	49 to 24
HALTON ...	"	25′×12′×6″	15.5 "	.66″	17.7 to 10 7
OSWESTRY	"	70′×15′×4′ 6″	4.1 "	3.40″	32.0 to 15.8
DORKING	"	18′ 6″×4′ 6″× 4′ 9″	11.9 "	.31″	20.8 to 10.1

The amount of settlement does not depend alone on the period of flow, but also on the nature of the suspended matter in the sewage, and the length of time during which the tank is used without being cleaned.

If the tank is not cleaned out, septic action in the deposit commences, the gas produced, carries suspended matter with it, as it rises to the surface of the liquid. Consequently the tank liquor contains more fine suspended and floculent matter, and is more liable to choke a fine filter. The Commission recommend that if filters of a fine material be constructed that the period of flow be from 10 to 15 hours, and that the tanks should be cleaned out at least once a week.

The Commission do not recommend the practice of passing the sewage from one tank to another. The first tank should do the work, as the suspended solids remaining in the supernatant liquor are of low specific gravity and will not deposit without quiescent settlement or chemical precipitation. "Settlement of sewage by sedimentation does not give rise to smell during the time the tanks are at work."

Septic Tanks.

A great amount of attention is given to the process of sludge digestion, known as the septic tank process. Many and varied opinions have been ventilated on this process, most, however, of a very exaggerated and unscientific character, arising no doubt from the fact, that the process has been run and boomed by a company whose chief object has been to sell their wares at a profit.

The Commission says: "The knowledge that the solid matter of sewage would be digested by passing the sewage through a sealed tank is by no means novel, but it does not appear to have had any extensive practical application until Mr. Cameron, city surveyor of Exeter, proposed the adoption of the "Septic tank treatment" for that city.

"It was claimed that the septic tank possessed the following, among other, advantages."

"That it solved the sludge difficulty, inasmuch as practically all the organic solid matter was digested in the tank."

"That it destroyed any pathogenic organisms which there might be in the sewage."

"That sewage which had passed through a septic tank was more easily oxidized than sewage from which the solids had been allowed to settle, either with or without the aid of chemicals, in tanks which were frequently cleaned out."

The Commissioners now are able to state, paragraph 340 "that all the organic solids present in sewage are not digested by septic tanks, the actual amount of digestion varying with the character of the sewage, the use of the tanks relative to the volume treated, and the frequency of cleansing. With a domestic sewage, and tanks worked at a 24-hours' rate, the digestion is about 25 per cent."

"The liquor issuing from septic tanks is bacteriogically almost as impure as the sewage entering the tanks."

"Domestic sewage which has been passed through a septic tank is not more easily oxidized in its passage through filters than domestic sewage which has been subjected to chemical precipitation or simple sedimentation."

In connection with the amount of solid matter digested the experiments were carried on for over two years at the Exeter and Ilford works.

As regards the third claim, the experiments were carried out by Mr. Eric H. Richards, the Commissioners' chemist at Dorking. The experiments are very complete and conclusive.

Paragraph 37 states.—The settlement of the suspended solids in septic tanks is not usually very thorough, and the evidence shows that at many places the liquor issuing from the tanks contains on the average from 15 to 20 parts of suspended solids per 100,000. Here follows a table showing the amount of solids in the tank liquor for 12 different plants. The amounts range from 22.2 to 5.3 parts in 100,000. Comparing these figures with those for the continuous flow tanks, we find that there is not much to choose between the resultant liquors as far as solids in suspension are concerned.

Paragraph 36 states.—"The more important claims which were advanced in favor of septic tanks have not stood the test of experience. At the same time, we think that in certain circumstances the adoption of this method of treatment, as a preliminary process, is efficient and economical."

Paragraph 75 gives a useful table showing the amount of sludge left in tanks by the various preliminary process.

After treating a sewage containing 40 parts per 100,000.

Preliminary process.	Sludge left in tanks in parts per 100,000.
Quiescent settlement with chemicals	37.5
Continuous flow settlement with chemicals...	35.5
Quiescent settlement without chemicals	28.0
Continuous flow settlement without chemicals.	25.0
Septic tanks	14.5

We therefore see that by allowing putrefaction of the settled solids to take place there is a less amount of sludge to be dealt with than by the other processes.

Paragraph 39 says.—From the point of view of sludge disposal alone, it would be generally advisable to allow septic tanks to run for considerable periods of time before cleaning out. There are, however, two important considerations to be taken into account, viz.:—

(a) The amount of suspended matter increasing in the tank liquor, which greatly increases as time goes on, and,

(b) The fact that at large sewer works, it would usually be less easy to deal with very large quantities of sludge at long intervals of time than with smaller quantities at short intervals.

The first point is of great importance, as in providing a certain grade of filter, a constant sewage must be aimed at. At Burnley it was found that the suspended matter varied from 15 parts per 100,000 after a few weeks' working to 35 parts at the end of six months. At Huddersfield the amounts were 6.6 parts per 100,000 at the commencement, and 23.3 parts at the end of eleven months. At Leeds, from January to June, 1903, starting with a perfectly clean tank, the suspended solids averaged 12.2 parts per 100,000, and from July to December, 1904, the average was 24.1. We thus see that when putrefaction of sludge takes place as in a septic tank, although about 25 per cent. of this sludge is digested, the action by means of gases constantly rising to the surface tends to in time increase the amount of suspended matter in the effluent, creating a difficulty to be encountered in the after treatment.

Paragraph 40.—The Commissioners therefore recommend that "in cases of population from 10,000 upwards, septic tanks should be cleaned out at short intervals of time." The time depending, of course, upon the character of the sewage treated.

Paragraph 42.—The main objects in passing sewage through septic tanks must be looked upon as,

"The settlement of the suspended matter in the sewage, the digestion of as much sludge as possible, and the equalization of the sewage as regards strength."

With reference to closing a tank over, the report states,

"As regards digestion of sludge and quality of tank liquor, the closed tank possesses no advantage over the open one. The Commissioners, however, recommend that the tanks be closed, so as to diminish the nuisance from smell."

The above conclusions appear to point to the advisability of some improvement to the septic tank as now used. The only point in its favor in comparison with other methods, appears to be in the fact, that a percentage of the sludge is dissolved by putrefaction and hydrolysis. The main point against it is that the liquor is not constant, and that the suspended matter increases as time goes on. This suggests that if it is desired to get rid of part of the sludge by putrefaction, then this purefactive process should take place apart from the liquid sewage. This could be done by withdrawing the precipitated sludge immediately from the sedimentary tanks into other tanks built specially for its reception in which septic action could be carried on for any length of time desired without affecting the liquor.

Chemical Precipitation.

Paragraph 57.—"There has been a tendency on the part of certain authorities to regard the chemical precipitation of sewage as an obsolete form of preliminary treatment. Our experience in no way justifies this view.

"In the case of some sewages, which contain trade waste, chemical treatment is almost essential, and in the case of domestic sewages, chemical treatment aids the decomposition of the suspended solids, and facilitates subsequent filtration."

From experiments carried out at Dorking, the Commissioners find that by passing septic liquor through tanks to hold one quarter of the 24 hours flow, with the addition of from 2 to 3 grains of lime per gallon, the suspended solids were reduced from 8 to 5 parts per 100,000, and a larger quantity of the liquor can then be purified per cubic yard of filter, and the offensive character of septic tank liquor largely destroyed.

The Commissioners give a large amount of valuable data regarding certain chemical reagents, and their effects upon various sewage characteristics, and the various methods of adding the chemicals.

Cost of Preliminary Processes.

In order to compare the cost of the preliminary processes named, the Commissioners assume a sewage discharge of domestic character of 1,000,000 gallons per day dry weather flow, when ample fall is available and simple rectangular tanks are built.

Comparative Capacity for Above.

Preliminary Process Arranged in Order of Tank Capacity.	Stay in Tanks.	Total No of Tanks.	Spare Tanks.	Total Capacity of Tanks Required (Gallons).
Continuous flow settlement with chemicals.	8 hours	8	2	444,440
Continuous flow settlement without chemicals.	15 hours	8	2	833,333
Quiescent settlement with chemicals.	2 hours	10	2	1,041,660
Quiescent settlement without chemicals.	2 hours	10	2	1,041,660
Septic tanks.	24 hours	6	1	1,200,000

Initial Cost of Above.

Preliminary process arranged in order of cost.	Constructional Cost.
Continuous flow settlement with chemicals.....	$18,985
Continuous flow settlement without chemicals...	25,560
Quiescent settlement with chemicals.....	29,935
Quiescent settlement without chemicals.....	29,935
Septic tank.	34,455

The tanks would be sufficient to deal with 3 times the dry weather flow.

Total annual cost including labor, chemicals, dealing with sludge, and repayment of loans assuming land to have cost $500 per acre:

Continuous flow settlement without chemicals.....	$2,820
Septic tanks (open).	3,145
Quiescent settlement without chemicals	3,620
Continuous flow settlement with chemicals.....	5,670
Quiescent settlement with chemicals	6,290

As the liquors from the above tanks vary in strength, and the sewage which has undergone chemical precipitation contains less supsended and colloidal matter than the sewage which has passed through a septic tank, it can be treated on a finer filter, and a less number of cubic yards of filtering material is required. The Commissioners, therefore, proceed to give the cost of the completed treatment of the sewage if filtered through percolating filters in each case.

Per Annum.

Preliminary process.	Total cost of preliminary treatment.	Total cost of filtration.	Total cost of complete treatment.
Quiescent settlement with chemicals...	$6,290	$2,860	$9,150
Continuous flow settlement with chemicals.	5,670	3,305	8,980
Quiescent settlement without chemicals.	3,620	3,830	7,450
Continuous flow settlement without chemicals....	2,820	4,800	7,125
Septic tanks.	3,145	4,800	7,945

Par. 83 states: "The form of preliminary treatment which should be adopted should depend upon the means at hand for the disposal of sludge and upon the class of filter to be used. If fine filters are to be used the treatment should be such as will eliminate a large proportion of the suspended matter."

Sewage is divided into three classes, viz.:

(1) Domestic sewages which are very strong.

(2) Domestic sewages of average strength.

(3) Weak domestic sewages.

Here it is also pointed out that where sewage is stored for pumping or where it may remain for a considerable time in the sewers, it is already in a septic condition when it reaches the sewage works. This is an important point as it is possible to "over septicise" a sewage, and owing to the amount of sulphuretted hydrogen produced make it difficult to oxidize it.

Para. 88. Speaking generally, the Commissioners recommend 'that chemical precipitation is more suitable for strong sewages or sewages likely to give rise to a nuisance, while sedimentation would usually hold the advantage with weak sewage. For sewage of average strength there is little difference between the processes.

Purification of Sewage by Artificial Filters.

Par. 90: Sewage filters may be divided into two broad classes:—Contact beds and percolating filters.

"Contact beds are tanks filled with some filtering medium. In this type of filter, the sewage is held up before it is discharged. The bed, after it is emptied, is allowed to remain empty for some time before receiving the next filling. The length of time during which the sewage is allowed to stand in this bed, is spoken of as the period of contact."

"In percolating filters the sewage is not held up, but is allowed to percolate through the filter."

Par. 91 contains an important statement, calculated on the figures given in subsequent paragraphs, viz., "that it is sufficient to provide half as much more material for three times the dry weather flow as is required for once the dry weather flow." This will have a marked effect on the design of future schemes.

Contact Beds.

Pars. 92, 93 and 94 lay down certain rules as to the amount of cubic yards of filtering media required of a certain

grade to purify a given volume of sewage of a certain strength. These may be tabulated as follows:—

Suspended Matter in Parts Per 100,000	Grade of Material.	Contact.	Fillings per Diem.	Gallons Treated per Cubic Yard.
20—30	3 in. dia. and upwards	double	1—1-2	30—40
30—50	"	"	1	30
10—15	1-2 in. to 1 in.	"	2	50
10—15	"	single	2	100
4— 7	"	double	3	80
4— 7	"	single	3	160
1— 4	"	double	4-6	100—160
1— 4	1-4 inch.	"	4-6	100—160
1— 4	"	single	4-6	200—320

The above deductions have caused a large amount of criticism, and an opinion has been expressed that the rates of 4 to 6 per day cannot be maintained. It is certainly concluded that they do not agree with good practice. The estimates are based on the assumption that the working capacity of a filter is 33 per cent. of the total bed capacity. However, the tables are useful as a guide to the sizes of material advisable with various strengths of sewage.

Par. 99 states.—There are grounds for thinking that the resting period is the more important phase of the cycle." This is not generally recognized so fully as it should be. Those who have had to do with overworked contact filters are too well aware of this fact. There is no doubt that as regards nitrogenous matter, the ammonia is extracted from the liquid during the period of contact, and oxidized during the period of rest, and that the resultant nitrate and nitrite are diffused through the liquid of a subsequent filling.

In the same paragraph we have the statement "The withdrawal of suspended and colloidal matter from the sewage during its passage through the bed appears not to be a simple mechanical effect of the material, for a matured contact bed, not clogged, will withdraw more suspended matter from the sewage than another bed similar in other respects, but not matured." In view of various statements publicly made of late this statement is of great importance.

Great stress in par. 100 is laid on the necessity of constructing contact beds of building materials and forming them water tight and not as in some cases simply digging the space out of clay, a system which has proved very defective in good working.

Par. 101 deals with the draining of the bed. There does not appear to be sufficient stress laid on the necessity for complete floor drainage. The Commissioners say "it is desirable to provide several drains." In good practice, however, the whole floor is generally laid with half channel tile drains, and at times a false draining bottom is provided. Insufficient drainage is one of the chief causes of failure.

Par. 103.—"The evidence shows that, within ordinary limits, the depth of a contact bed makes practically no difference to its efficiency per cube yard." The report goes on to give the results of reduction of oxygen absorbed at various depths, and then recommends a minimum of 2 feet 6 inches and a maximum of 6 feet.

Par. 106.—"The evidence shows that two hours contact and four hours rest have generally been found to give the best results in practical working, where the beds are filled three times a day, but no rule can be laid down which is of universal application." In the above connection the Commissioners have not pointed out the importance of a dosing tank, by means of which each bed is filled at the same rate. Dosing tanks are absolutely essential especially where the minimum rate of flow will not fill each bed in one hour.

Par. 110.—The Commissioners on the whole do not advise the use of automatic gear on large works where labor must in any case be employed. This advice appears good as in spite of the improvements made in automatic gear, such gear always requires less or more attention.

Par. 111.—The loss of capacity in contact beds is put down to the following factors:—

(1) Disintegration of the filtering material.
(2) Consolidation of the filtering material.
(3) Deposition of colloidal matter.
(4) Growth of organisms.
(5) The volume of liquid passed on to the bed.
(6) Insufficient rest.
(7) Inefficient drainage.
(8) The amount of suspended liquid passed on to the bed.

Then follows a great amount of information regarding special plants where such of the above factors have been noted all of a more or less interesting nature, but it will be apparent, that apart from Nos. 3 and 4, the causes of loss of capacity can all be easily guarded against, and really result from improper material, improper construction or defective management. In connection with Nos. 3 and 4 these causes can be neutralized by simply giving the beds from 1 to 2 weeks rest. The Commissioners, however, point out that some loss of capacity must of necessity occur owing to the growth of a slimy jelly substance over the surface of the filtering media. Decrease of capacity from this cause is, however, accompanied by increase of efficiency, showing that the organisms which act on the sewage are maintained in this jelly.

Par. 126.—The Commissioners conclude that good hard well burnt furnace clinker is the best material for filter beds. With this engineers are in general agreement.

Par. 128.—"The smaller the size of material used in a contact bed the greater is the internal surface area exposed, and consequently the more intimate is the contact of the liquid with the material, the greater the purification, and the more efficient the arrest of the suspended and colloidal matter."

If the liquid to be treated contained no or practically no suspended matter, medium sand would form the best filtrate, but if ordinary sewage liquor were put on this, the surface would become clogged in two or three fillings. The Commissioners conclude that with sewage liquor containing 40 parts per 100,000 of suspended matter, the material will probably have to be 3 inches upwards in diameter. With liquor containing 8 to 10 parts 3-8 to 5-8 of an inch may be used effectively, while with a good precipitation liquor containing from 1 to 3 parts, the best results will be obtained with material as fine as 1-4 inch diameter.

(Continued Next Week.)

CANADIAN CEMENT COMPANIES AND THEIR BRANDS.

The following table identifies particular Canadian companies with the brand of cement produced by them respectively:—

Company.	Brand.
Alberta Portland Cement Co., Ltd., Toronto.	Buffalo.
Belleville Portland Cement Co., Ltd., Belleville	Belleville A. A.
Canadian Portland Cement Co., Ltd., Toronto	Star.
Hanover Portland Cement Co., Ltd., Hanover, Ont.	Saugeen.
International Portland Cement Co., Ltd., Ottawa	International.
Lakefield Portland Cement Co., Ltd., Owen Sound	Monarch.
National Portland Cement Co., Ltd., Dur ham	National.
Owen Sound Portland Cement Co., Ltd.	Samson.
Sun Portland Cement Co., Ltd., Owen Sound	Sun.
Sydney Cement Co., Ltd.	Rampart.
Vancouver Portland Cement Co., Ltd.	Vancouver.
Vulcan Portland Cement Co., Ltd. (Que.)	Vulcan.
Western Canada Cement and Coal Co., Ltd., Ottawa, Ont.	Exshaw.
Western Ontario Portland Cement Co., Ltd., Attwood, Ont.	Maple Leaf.

RAILROAD CROSSINGS.*

By W. C. Sparks Superintendent of Roadway, Indiana Union Traction Company.

The maintenance of railroad crossings is a subject in which general managers and engineers of interurban lines are very much interested. Owing to the recent building of interurban lines it has generally fallen by contract to the various traction companies to construct, install and maintain their crossings with the steam lines. With some of the larger interurban properties which also operate city systems the question of maintenance of railroad crossings has become an important item and is an expense which must be considered by the management. On some of the larger systems it is almost equally as important as the question of tie renewals.

The growth of interurban lines has been rapid and there are now being operated 50-ton electric cars instead of 12-ton cars at speeds increased almost in proportion. This increased weight of interurban cars together with the greatly increased tonnage of locomotives increased weight and carryng capacities of steam cars, increased length of trains in proportion to the increase of tonnage of locomotives, have caused much trouble in maintaining track crossings under the constant hammering of such service.

Construction.

Generally speaking, there have been developed and are now in use two types of railroad crossings, namely, the built-up crossings and the manganese steel or hand centre crossing. The built-up type of crossing is in general use by interurban lines at crossings with steam roads. A few points which should be considered in building a crossing of this type are:

First.—Great care should be exercised in the measurement of the crossing, special attention being given to the reading of the angle, gauge and compromise joints and their drilling.

Second.—Easer and guard rails should be of the same section as the running rails and should be full section of rail.

Third.—Where the rail section permits bolts should not be less than 1 in. in diameter and preferably 1 1-8 in., applied with proper lock nuts.

Fourth.—If the crossing is to be run over at high speed both by steam and interurban cars, easer rails should be installed in both tracks. Short easers on the interurban rail will suffice, but on the steam rails the easer rails should extend at least 15 in. beyond the first joint and such joints should be supplied with rolled steel fillers.

Fifth.—Rolled steel fillers should be used at intersections and at points where easer rails extend beyond joints.

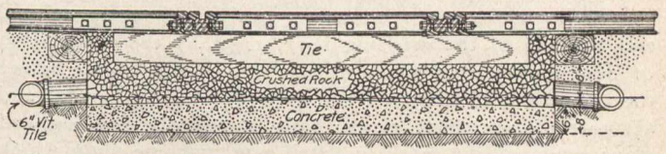
Hard Centre Type.

This type of crossing was designed to prevent the hammering and battering down of the crossing at flange-way intersections. It generally consists of rectangular manganese plates at the intersection of flangways. Some manufacturers, however, have made designs which carry the manganese plate on the steam rails from intersection to intersection. The excessive cost of this type of crossing has prevented many interurban roads from using it. The cost of the hard centre type, as a rule, is about two to three times the cost of the standard built-up crossing, the cost depending upon the angle of the crossing. The first cost of the manganese type seems so great that, as a rule, most companies decide to purchase the standard built-up type. For experimental purposes, in May, 1907, the Indiana Union Traction Company installed two crossings of this type at a location which was in almost constant use by the steam road at a cost about double that of built-up crossings. They have now been installed nearly two years and there is no perceptible wear at the flange-ways. At the present time they look to be good for at last 10 years longer or about four or five times the life of the standard crossing.

*Paper read at the Central Electric Railway Association, Lima, Ohio.

Nothing affects the life of a crossing of any type more than the method of installation.

There are different opinions as to the kind of ballast which should be used as a foundation for crossings. Some companies use gravel; others use crushed stone; while others are in favor of concrete. On the lines of the Indiana Union Traction Company crushed stone is used almost entirely for crossing foundations. The stone beneath the ties should be at least 18 in. in depth and thoroughly bar tamped. About two years ago, for experimental purposes, the writer put in foundations for two crossings of concrete made of gravel, the mixture being one part cement to five of gravel. The concrete foundation extended 12 in. below the bottom of the crossing timbers and was carried



Section Through Proposed Foundation for Standard Crossing.

up to the top of the ties. Within one year after the placing of the new crossing on a foundation of this character it was necessary to install new easer and running rails on the steam track. The concrete foundation had proved to be too rigid and the constant hammering of the steam cars soon battered the running and easer rails on the steam track to pieces, thus proving that in all railroad crossings there should be a certain amount of elasticity. Many steam roads also object to concrete because of the damage to their rolling stock.

The plan which the writer would suggest at this time for consideration and discussion consists of both concrete and crushed stone and is as follows:

The excavations for the foundation material should be 24 in. deep. At the bottom of this excavation there should be installed 8 in. of concrete so shaped that proper drainage can be procured. Upon this concrete base place 8 in. or 9 in. of crushed stone to receive the crossing timbers. The stone should not be less than 3-4 in. nor more than 2 in. in diameter and thoroughly tamped when the crossing is brought to proper surface. Fine stone should not be used, as it cements together and prevents proper drainage. By this method the concrete not only serves as the foundation, but acts as a partition, so to speak, between the earth and stone, and thus prevents the mixing of the earth and stone. The crushed stone acts as a cushion for the crossing and gives the elasticity desired. The writer has never used the above method for installing crossings, but expects to experiment along this line during the coming year.

Another important feature to be considered in the installation of a crossing is the question of drainage. All crossings should be drained with at least a 6-in. pipe with sufficient fall to keep it clean at all times. Large pieces of crushed stone should be placed over the end of the drain so that it will not become clogged. A well-drained and a dry foundation is necessary for the successful and satisfactory maintenance of any crossing.

Crossing timbers should be of white or burr oak and should be 7 in. thick, 9 in. wide and of the length required. In case of right angle crossings 10-in. x 12-in. timbers should be placed beneath the running rails of the traction company's track. This allows the steam track to be laid on the cross-ties and also affords a means for spiking the running rails of traction line. A tie plan should be furnished to the foreman in charge of the installation of the crossing. Wherever possible the use of crossing plank should be discontinued and crushed stone should be used. This affords an opportunity not only to keep the crossing tightened at all times, but prevents vehicles from using the tracks as a driveway. This refers to crossings on streets and highways. In many instances it has been possible to get the municipal authorities to agree to the use of crushed stone instead of planking, and in almost every instance they are pleased. An effort along this line is time well spent.

Maintenance.

All railroad crossings should be examined by the section foreman whenever he passes over them and once a week a thorough examination should be made. Special instructions should be given track men to see that the bolts in the crossings are kept tight at all times, as the life of a crossing is materially lengthened by keeping it tight.

At points where crossings are protected by interlockers the tower man should be supplied with a stock of bolts for the crossings and should see that bolts are tightened daily.

Drains should be inspected and kept open. Crossings should be kept in good line and surface at all times, as the damage done to a low crossing is much greater than if it were in good line and surface.

Maintenance cost of crossings can be materially reduced and the life of the crossing lengthened by the installation of new running and easer rails in the steam tracks before the crossing gets into too bad a condition. By careful and accurate measurement of the rails of the old crossing and plans made of the work in detail any machine shop which has a planer can make the running and easer rails at a cost of $40 to $50 per set. This price can be materially reduced if work can be done in the company's shops.

On the Indiana Union Traction Company's lines at many locations where the crossing is run over at high speed for both lines duplicate crossings have been supplied. While one is in service the other is taken to the shops and overhauled and repaired. It is then taken to the crossing location and stored for emergency use. The crossings are not allowed to become too badly worn before they are exchanged. This permits having the crossing in the shop at the time new easers and runners are made, which is quite an advantage, as it allows all new parts to be machined and fitted together before taking the whole crossing to its location. This has proved an economical method of maintaining standard built-up crossings, but the writer does not believe it to be as economical as hard centre crossings.

In conclusion the following points should be emphasized for the economical maintenance of railroad crossings:

First.—For interurban crossings with steam lines hard centre crossings should be used, especially at high-speed points.

Second.—Keep the foundation dry.

Third.—Keep the bolts tight.

Fourth.—Frequent inspection by roadmasters.

SOCIETY NOTES.

Canadian Society of C.E., Montreal.

A meeting of the electrical section of the Canadian Society of Civil Engineers was held at the Society's rooms, 413 Dorchester Street West, on the evening of October 26th. The paper for the evening was entitled, "Some Considerations in the Application of Low-pressure Steam Turbines to Power Generation," by Mr. J. R. Bibbins, of the Westinghouse Machine Company, Pittsburg, Pa., and was profusely illustrated with lantern slides. The subject is one of unusual interest to electrical and mechanical engineers, and Mr. Gibbins was listened to with keen appreciation, which was further proven by the numerous questions asked and comments made by members after the address was delivered. Mr. H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Railway Company, presided at the meeting, and in addition to his remarks on the subject of the lecture, there was considerable discussion by Messrs. L. R. Johnson, H. M. Jaquays, W. N. Dietrich, J. A. Burnett, and J. A. Shaw. The meeting lasted until nearly 11 o'clock.

The Technical Publicity Association.

Some four years ago this Association was formed in New York, and now consists of men filling the position of advertising managers in companies engaged in manufacturing machinery or concerns allied with the machinery industry.

At a recent meeting of the Association Mr. Charles S. Redfield, the president, introduced the question of foreign advertising. Mr. Redfield analyzed the position and condition of the trade and scientific press of Europe from an advertiser's standpoint, and his statements are worthy of careful consideration not only by the advertiser, but to the reader of advertisements.

It seems that the trade papers of Europe can be most justly dealt with by giving them a good "knocking"; but, on the other hand, there is an unwritten law somewhere that "you should not 'nock' or 'kick' anyone who is down"—and the trade papers of Europe may certainly be considered "down," and more or less "out."

It is, of course, an old saying that where there is a demand there will be a supply, and the average business man in Europe will probably tell you that the poor quality of the supply is because there is little demand for good trade papers in the various industries.

To my mind, however, a properly conducted trade paper produces its own demand, and then proceeds to fill it. Its mission is a definite one in America, and its place in the business world is a definite place.

The Germans have been called the "Yankees" of Europe, and I cannot express myself too strongly in commending their energy and wide-awakeness.

Imitation of competitors' goods and competitors' methods is keen everywhere (certainly we are used to it in this country), but for slavish imitation of everything which promises to earn a dollar for the imitator Germany has the rest of the world "skinned to death."

There is still another class of export publication which perhaps I should touch upon, namely, the papers printed in America by export houses and others. Like people, these are good, bad and indifferent. I have found some of the bad ones; one or two of the indifferent ones; and am on the hunt for a few good ones.

He also touched on the marked prejudice in England against printed matter prepared in America for English use. He further stated that a great advantage is obtained in not only having the printed matter turned out in England, but having the copy prepared there also, though to the American style of effort. Mr. Kimball feels that there is an enormous field in Europe for circular letters and "reason why" copy.

Mr. C. N. Manfred spoke briefly on foreign catalogues, and recommended that when foreign catalogues are translated from the English to the foreign language, that it is advisable to have the translation re-translated back into the English, to see how near it corresponds to the original English copy.

ENGINEERING SOCIETIES.

ARCHITECTURAL INSTITUTE OF CANADA.—President, A. F. Dunlop, R.C.A., Montreal, Que.; Secretary, Alcide Chaussé, P.O. Box 259, Montreal, Que.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, J. E. Hutcheson, Ottawa; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; Secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908. Annual meeting at Toronto Jan. 28, 29 and 30, 1909.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, P.O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

ENGINEER'S LIBRARY

THE COST OF STREET ILLUMINATION.*

Street-illumination is more often called street-lighting, probably because it generally refers to a number of lights erected in streets, which do little more than indicate the position of the road and pavements. The making of a street or road is in most cases in the hands of the local surveyor, who more often than not treats the whole thing as his father did before him, with the exception that he uses gas or electric lamps for the lighting of his streets in place of oil; but his method of obtaining what he considers suitable lamps for this purpose is to specify not the light these lamps should give, but the quantity of gas or electrical energy they should take. The result is that thousands of streets in this country are still lighted in the same way as they were twenty years ago; whereas if a little attention were paid to the correct arrangement and candle-power of the lamps, and the number of posts necessary to each street, far better illumination would be produced at a much lower cost.

The writer was asked to advise as to the best way of improving the illumination in the streets of a small town where both gas and electricity were available for the purpose; the latter being supplied through overhead mains attached to posts erected at the side of the road at about forty yards apart. The gas company had been asked to erect the lamp which they would recommend; and, though the reader possessing some knowledge of the elementary laws of illumination, may find it difficult to believe, they erected a post and lantern containing two inverted gas mantles. This appealed to a few members of the council on account of its brilliancy, but the majority at once noticed that, with the exception of the road and pavement close to the post, the illumination resulting was very poor. If the manager of the local gas company had had the slightest knowledge of the laws governing illumination he would have known that inverted mantles were quite unsuitable for street lighting in places where the posts are low and at long distances apart, and that ordinary mantles were well adapted for the purpose, owing to the relatively high candle-power of the rays approaching the horizontal.

The electrical engineer who consulted the writer followed his advice, and hung up, between the adjacent poles supporting his mains, eight 16 candle-power 25-volt osram lamps, connected in series. These came at distances of 15 yards apart, and the cost of erection and all materials was less than that of the one gas-post and fittings; the relative cost of lighting was the same. The interesting part, therefore, was the respective results as regards illumination. It requires very little calculation to see that the minimum illumination with the electric lamps—owing to their close proximity—was as high as it is even in Oxford Street, and, with the gas, lower than it would have been if a single ordinary gas mantle had been used.

It is quite time that the method of simply putting up so many gas lamps or electric lamps in a street at conventional distances apart was abandoned in favor of some more scientific allotment of the various forms of light available for the purpose. The actual cost per thousand burning hours of the various types of lamps, and the candle-power to be obtained from each type, can now readily be ascertained by all surveyors or lighting committees. Therefore, the type to use and the disposition of same for each individual case should not be difficult to decide, provided the matter is dealt with in a scientific or commonsense manner.

*Abstract of Haydn T. Harrison in "The Illuminating Engineer."

To take an example, let us suppose that various forms of lamps are obtainable at the following costs, including interest on capital charges:—

Table I.

Type of Lamp.	C.P. at 10° below horizontal.	Costs per annum of 4,000 hours (average).
(a) Electric flame arc lamp	1,200	£20 0
(b) Electric flame arc lamp	800	18 0
(c) Electric open type arc lamp.....	600	18 0
(d) Gas, high intensified lamp.....	600	17 0
(e) Electric enclosed arc lamp	400	14 0
(f) Gas, two mantle-burners	100	16 0
(g) Electric metal filament lamp	100	5 0
(h) Two electric metal filament lamps.	100	6 0
(i) Gas, single mantle-burner	50	3 5
(j) Electric metal filament lamp	50	3 0
(k) Electric metal filament lamp	*16	1 0

*Low voltage series.

This is a large choice, and is, of course, not always available; but it has been made as comprehensive as possible for the sake of an example, and any type not at his disposal can be struck out by the reader.

As it is now generally admitted that the minimum illumination at any part of the street is the correct factor on which to base street-lighting, it is necessary to see how many lamps of any type would be necessary to illuminate a mile of street up to a given standard, the average standards at present being as follows:—

Table II.

Class of Street.	Minimum illumination.	Relative.
(a) country roads	.005 c.f.	(1)
(b) Side streets	.01 c.f.	(2)
(c) Main streets	.05 c.f.	(10)
(d) Important thoroughfares	.1 c.f.	(20)

Minimum illumination is at a point halfway between the posts, and is equal to the candle-power of the lamp divided by the slant distance squared, the slant distance being equal to the height of the lamp squared plus the distance to the centre of the post squared. This is given by the following formula:—

$$(1) \qquad i = \frac{CP}{\left(\frac{D}{2}\right) + H^2}$$

Where

i Minimum illumination.

CP = Candle-power of rays approaching horizontal.

H = Height of lamp.

D = Distance between posts in feet.

But knowing the illumination and requiring to know the distance apart of the posts, the formula can be used as follows:—

$$(2) \qquad \left(\frac{D}{2}\right)^2 = \frac{CP}{i} - H^2$$

$$(3) \qquad D = 2\sqrt{\frac{CP}{i} - H^2}.$$

If the posts are erected alternately on either side of the road the number of posts for any given distance would not be represented by that distance divided by D, as D is the distance between two posts on opposite sides of the road, and is equal to a length of road represented by:—

$$(4) \qquad D = \sqrt{d^2 + a^2}.$$

Where:—

a = Width of road between the kerbs on which the posts are erected.

d = Length of kerb between each post.

Thus in order to find the number of posts to a given length of road if the posts are staggered, we have to find d as follows:—

$$(5) \qquad d = \sqrt{D^2 - a^2}.$$

Or in conjunction with the formula (2):—

$$(6) \qquad d = \sqrt{\left(2\sqrt{\frac{CP}{i}} - H_a\right)^2 - a^2}.$$

Applying this formula, for example, to a mile of street, 40 feet from kerb to kerb, to be lighted up to the standard of a main street, namely, with a minimum illumination of .05 candle-feet, by lamps erected 20 feet high, and giving 1,200 candle-power, erected on the kerb on alternate sides, by using formula (6) we find that the distance d betkeen each post measured along the kerb equals:—

$$d = \sqrt{(2\sqrt{\frac{1,200}{.05} - 20^2})^2 - 40^2}.$$

$$= \sqrt{(2 \times \sqrt{24,000 - 400})^2 - 1,600}.$$

$$= 303 \text{ ft. or } 101 \text{ yards.}$$

Thus, with the posts at distances of 101 yards the number of posts per mile will be 17.6.

From the same formula we can calculate the number of posts for each of the other units of light, and the result will be found to be as follows. The cost per mile is also given by multiplying the number of posts by the cost per annum given in Table I.:—

Table III.

Type of Lamp.	Number of posts per mile.	Cost per annum per mile.
a (20 feet high)	17.6	£352
b " "	21.5	387
c " "	25	450
d " "	25	425
e " "	31	434
f (12 feet high)	70	350
g " "	70	350
h " "	70	420

As any smaller unit would work out at less than 40 feet apart, it is obvious it could not be used for a road such as the example before us, which is 40 feet wide; but in the case of country roads, where the minimum illumination permissible is .005 candle-feet, a very different financial result occurs, as will be seen by examination of the next table, worked out from the same formula, for a road 30 feet wide between the kerbs:—

Table IV.

Minimum Illumination, .005 C.F.

Type of Lamp.	Number of posts per mile.	Cost per annum (40,000 hrs.) per mile.
a (20 feet high)	5.5	£110
b " "	6.6	119
c " "	7.6	137
d " "	7.6	130
e " "	9.4	132
f (12 feet high)	19	95
g " "	19	95
h " "	19	114
i " "	27	88
j " "	27	81
k " "	52	52

On comparing the two foregoing tables it is obvious that for wide thoroughfares where high illumination is required large units of light can be used without increasing the cost, but for roads where a low degree of illumination is permissible small units will give the required result at a much lower cost.

As regards the cost of maintenance of various sources of light, this is generally undertaken by the department supplying the gas or electricity, and it will be found that where there is competition the sums estimated by the competitors are as low as they can possibly be; but this cost will obviously be much affected by local conditions and the length of the contract. For instance, if a contract is entered into of such duration that it would pay the electricity undertaking to lay a special street lighting network of mains, thus saving the cost of lamp-lighters' wages, a considerable saving would be effected, and a low tender could be submitted. On the other hand, councils do not like entering into lengthy contracts, as improvements may come about by which they could obtain better illumination at a lower rate. Therefore, the type of contract in which the consumption of gas or electricity per lantern is specified is found most satisfactory, provided a clause is inserted by which the supply undertaking agrees to periodically replace such lamps, if called upon, for any improved types which may be brought out, the cost of such replacements to be borne by the local authority.

BOOK REVIEWS.

Books reviewed in these columns may be secured through the book department of this journal.

THE DRAINAGE ACTS.

By Frank B. Proctor, LL.B.

Ontario, Manitoba and British Columbia, 1908. Pages XIV. 373, size 6 x 9. Arthur Poole and Co., Publishers, Toronto. Price, $5.00.

This work is quite timely, as it is a subject very necessary for rural municipalities to deal with, yet the vagueness of many points made it difficult for the ordinary municipal officer to deal with the method of procedure and definitions of various terms, are here legally defined. "Grounds for Quashing," is one of the best sections for engineers to study so as to avoid the rocks, the legal decisions classified so that with promptness these matters may be settled.

The duties of municipalities is given with that clearness that there need be no hesitancy to come to a decision on drainage matters that will come before municipal councils. The responsibility for repairs has been fought out in the courts very often; here the decisions are given. Misunderstandings with railway companies have been the cause of much trouble; in the work a good deal has been made clear for those interested. Trespass and compensation have been the subjects of litigation in many of the courts. By referring to this work many would be saved time and law costs by following the rulings of the courts as here rendered available.

The Statutes of British Columbia and Manitoba, upon the matter of drainage, are given in full, making it of value to those not only residents of these Provinces, but those who are financially interested in these Provinces. The various Acts of the Ontario Provincial Legislature bearing upon this subject make it a ready Hand Book upon matters pertaining to this subject.

The Index, as given, is very full and complete, and one of the finest features of the book, so that any subject, decision, explanation or text can be referred to in the least possible time.

The publishers are to be commended for enterprise in bringing out such a work.

Every municipal council who may be interested in drainage should have access to a copy of this work, while every township engineer who studies and uses this work, will make a minimum of legal mistakes.

D. J.

Engineering Formulae. By Molesworth. Published by E. and F. N. Spon, 57 Haymarket, London, England. Pages 900, size 3 x 5. Price, $1.50.

A pocket book of useful formulae and memoranda for civil, mechanical and electrical engineers, prepared by Sir Guilford L. Molesworth and Henry B. Molesworth, and an electrical supplement written by Walter H. Molesworth. This is the twenty-sixth edition of this complete and reliable engineers hand book.

No pains have been spared to secure the utmost perfection. In correcting the proofs, not only have typographical errors been guarded against as far as practicable by comparison with the original manuscript, but in very many cases the accuracy has been tested by fresh and independent calculations.

By the substitution of new matter in the place of that which had become obsolete the book is made up-to-date.

Synopsis of Contents is as follows:—Levelling, Surveying, Latitude and Longitude; Strength and Weight of Materials; Earthwork, Brickwork, Masonry, Arches and Tunnels; Struts, Columns, Beams, Floors and Roofs; Girders and Bridges; Railways and Roads; Hydraulics, Canals, Sewers, Waterworks, Docks, Irrigation, Breakwaters, Diving and Dredging; Heat, Light, Color and Sound, Ventilation, Warming, Refrigeration and Gas; Laws of Motion, Gravity, Centres, Forces and Powers; Mill-work—Toothed Wheels, Shafting, Belting, Friction; Workshop Recipes, Alloys, etc.; Miscellaneous Machinery, Steel and Iron Manufacture; Steam—Steam, Oil and Gas Engines; Animal Power, Water Power and Water Motors; Wind, Windmills and Pneumatic Machines; Ships and Steam Navigation; Gunnery, Projectiles, etc; Buoys and Moorings; Weights, Measures, Money and Useful Numbers; Algebraical Signs and Formulae, Arithmetical and Geometrical Progression, Interest, etc.; Trigonometry; Differential and Integral Calculus; Conic Sections, Curves, etc.; and Lenses; Mensuration:—Arears, Circumferences, Contents; Logarithms and Slide Rule; Squares, Cubes, Powers, Roots and Reciprocals; Electrical Supplement.

Hydro-Electro Practice. By H. Von Schon, M.A., Soc. C.E. 382 pages, 223 illustrations and diagrams, octavo size. Published by J. B. Lippincott Company, Philadelphia. Price, $6.00 net.

A comprehensive and practical work in which special attention is given to the hydraulic features of water power development for the production of electrical energy. It places within reach of those interested, a valuable amount of data and information on this subject, giving an analytical treatment of the development of hydro-electric projects from inception to completion. The book is divided into two parts. The first is entitled "Analysis of a Hydro-Electric Project," dealing under five chapters with the economical value of a project with estimates and reports. This part of the work is very fully treated. In chapter I the available market, its analysis and probable revenue are discussed. The possibilities of power development are covered under chapter II. with determination of stream flow and the application of flow deductions, from precipitation, drainage areas and evaporation for the topography, and statistics available. A large table of the drainage areas and low monthly flow of rivers, appearing in the Federal and State Survey records and others computed by the author are added. Chapter III. treats with the question of Government control of streams grants, and riparian rights with a sample lease executed by the War Department. Chapter IV. is devoted to preliminary estimates of cost with a number of diagrams of quantities on foundations, dams, power houses, etc., and chapter V. contains a summoning up of the value of the project with a full detailed sample report containing complete data, with estimated costs to construct, annual charges, maintenance and revenues, suitably illustrated with plans and diagrams.

The second part takes up the final design and construction of the development with full details. Chapter VI. treats with the survey, examination of maps, reconnaissance, flow measurements from precipitation, evaporation and available statistics. The development programme is studied under chapter VII., covering the many possibilities presented by various conditions. Under chapter VIII. the author devotes a large amount of space to the practical design of the hydraulic works with original determinations of practical constants from his large practice, forming a most valuable section of the book, embracing terms, materials and methods of coffering, piling, with various types of cut off structures. The treatment of dams, and spillways is very thorough, special attention being given to a variety of designs and their details. The influence of overflow, back swell and control of flood discharge on the design is fully analyzed. Diversion works are fully treated with theories of flow, slope and velocities. The chapter closes by discussing practical variations of the design of power houses, and turbine settings. A description is given of the submerged power house which represents one of the most recent designs. Under chapter IX the hydraulic motive equipment is especially treated discussing the theory of turbine design, with diagrams of their efficiencies, dimensions and output constants. The various governors are illustrated and discussed. The chapter ends with a brief treatment of electric circuits, and the transmission of electrical energy, the design, efficiencies and regulation of generators. Chapter X. contains a brief discussion in plans, estimates and specifications. The book is original, well written and logically arranged with numerous and good illustrations, diagrams and cost data which are not of the catalogue type. It forms an excellent treatise on the preliminary survey and design of the hydraulic features of a water power development, and promoters, investors and engineers will find it a source of useful information. F. A. G.

CATALOGUES.

Drills.—The Pratt and Whitney Company, Hartford, Conn., are distributing a very handsome booklet describing their multiple drills adapted for various classes of work. Illustrations and specifications are given. Page 30, size 9 x 12.

Compressors.—In a hundred page catalogue the Canadian Rand Co., Montreal, Can., point out the high efficiency of the steam and power-driven air compressors of Rand design. Besides giving illustrations of their many machines they give main dimensions together with pages of practical suggestions that will be of great assistance to men in charge of machines.

Fire Bricks.—The Harbison-Walker Refractories Co., Pittsburg, Penn., in a booklet on "What are Your Lime Kiln Costs?" tell of the merits, tests, costs, etc., of their brick for lining lime kiln. They also give sections of many styles of brick for different work.

Electric Equipment.—Johnson and Phillips, Charlton, S.O,. Kent, electrical engineers, contractors and cable makers, send a portfolio containing catalogues of their motors, dynamos, switches, transformers, insulators, as well as information about cable, both steel and aluminium. Also a price list.

Manilla Rope.—C. W. Hunt Company in their pamphlet No. 082, give particulars of the use of manila rope for the transmission of power, for pile driving, hoisting. Besides giving information as to the best sizes of rope to use for each kind of work they also give prices.

Machinery.—H. W. Petrie, of Toronto, Montreal and Vancouver, is distributing his monthly stock list in which he gives particulars of his stock which includes almost every kind of engine, boiler, machine, motor, etc., made and used. His new catalogue to be had for the asking.

Milling Machines.—Pratt and Whitney Company, Hartford, Conn., have issued a handsome booklet describing their complete line of milling machines and precision tools. They also manufacture a great variety of other kinds of machine tools, machinists' small tools, gauges, etc., catalogues of which will be sent on request.

Steam Separators.—The ideal Steam Separator and Supply Co., 73 Adelaide Street East, Toronto, make a specialty of steam boiler attachments. The Ideal Internal Separator, the Potter Separator, and the Whaley Automatic Smoke Preventer are three lines of which they are pleased to give information.

RAILWAY ORDERS.

(Continued from Page 850).

5581—Nov. 7—Granting leave to the Bell Telephone Company to cross the Central Vermont Railway Company's tracks at P.C. Richelieu St., St. Johns, P.Q.

5582—Nov. 10—Authorizing the G.T.P. Railway to construct its railways across highways in the Province of Saskatchewan, from mileage 60 to mileage 109.52.

5583—Nov. 10—Ordering that the crossing at Aylmer Street, Peterboro, Ont., have watchman at same daily from 6 o'clock a.m., until 7 p.m., and the cost of same to be divided between the Railway Company (C.P.R.), and the Corporation of the City of Peterboro.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS.

Manitoba.

WINNIPEG.—Tenders, addressed to the chairman of the Board of Control, Winnipeg, for supply and erection of turbine pump, with electric motor, for the city waterworks, will be received at the office of the undersigned up to 11 a.m. on Monday, February 22nd, 1909. M. Peterson, Secretary. (Advertised in The Canadian Engineer.)

WINNIPEG.—Tenders will be received until December 28th, 1908, for the construction of the general works and for the supply and erection of various portions of a transmission line between Point du Bois and Winnipeg. Plans may be seen at power engineer's office, Winnipeg, or the offices of Smith, Kerry & Chace, Toronto. M. Peterson, Secretary Board of Control. (Advertised in The Canadian Engineer.)

WINNIPEG.—The Building Committee have decided to delay the erection of the building until the spring of 1909. Sealed tenders addressed to the chairman of the Building Committee of All Saints' Church will be received by the undersigned up to 12 o'clock noon on Tuesday, December 1st, for all trades—bulk and separate—required in the erection of a parish house. Plans and specifications may be seen at 201 (new) Nanton Building. Robert Wilson, Building Superintendent.

British Columbia.

PRINCE RUPERT.—The Chief Commissioner of Lands and Works has been busy settling the details of the specifications for the street improvements to Prince Rupert, contracts for the construction of which are now being called for. In the neighborhood of a quarter of a million is to be spent in Prince Rupert in laying sewers and planking streets.

VICTORIA.—Tenders have been invited for a 19-knot fishery protection cruiser for British Columbia, to be in by January 15th. The cruiser will be two hundred and fifty feet long, thirty-two foot beam, and seventeen feet deep. The British Columbia Marine Railway Company of Esquimault will submit a tender.

VICTORIA.—Tenders for new cruiser for British Columbia will be received up to noon of the 15th of January, 1909, for the construction of a twin-screw steel cruiser for fisheries protection service in British Columbia waters, of the following leading dimensions, namely: Length over all, 250 feet; breadth of beam (moulded), 32 feet, and depth from top of keel to top of beam at side, 17 feet; to be delivered at Victoria, B.C. G. J. Desbarats, Acting Deputy Minister of Marine and Fisheries, Ottawa.

CONTRACTS AWARDED.

Ontario

BARRIE.—On November 24th, contracts were opened for the County of Simcoe bridge across the Nottawasaga River near Vanvlack. The tenders were as follows for substructure:—

Name.	Address.	Price.
Jenks Dresser Co.	Sarnia	$8,784
Looby, L. L.	Dublin, Ont.	7,000
McAllister, A. L.	213 Huron St., Toronto.	7,000
Pratt and McDougall	Midland	*7,000
Queenston Quarry Co.	St. Davids, Ont.	9,500
Rowan and Elliott	St. Catharines	8,794
Stewart and Bennett	Edenvale	13,465
Trace, W. A.	Elmvale	7,300

*Awarded contract.

Consisting of two abutments and two priers of concrete. Piling foundations under one abutment, other abutment and two piers having footings about 10 feet below water level. Price also includes earth embankment approaches. To be completed June 15th, 1909.

And for superstructure:—

Name.	Address.	Price. With wood floor.	Price. With concrete floor.
Dickson Bridge Co.	Campbellford	$9,484	$9,911
Hill, A. and Co.	Mitchell, Ont.	6,867	*7,642
Jenks Presser Co.	Sarnia	7,905	8,710
Petrolea	Petrolea		9,350
Sage, F. W., for	34 Victoria St...		
Ontario Bridge Co.	Toronto	8,600	9,150
Stewart and Bennett	Edenvale	8,350	9,050
Vance, Jas. A.	New Hamburg	8,139	8,739

*Awarded contract.

Consisting of three 105-foot spans steel bridge, stiffened Warren truss (low type) with concrete floor, lattice railing erected on foundations. Live load 80 lbs. per sq. ft. on floor, and a 12-ton road roller. Generally according to standard specifications of Department of Railways and Canals. To be completed July 15th, 1909. J. T. Simpson, Chairman of Board; C. H. Mitchell, Engineer.

OTTAWA.—The contracts for new fire escapes on the Duhamel and the Breboeuf separate schools were awarded by the building committee, the contract in each case going to the lowest tenderers. The fire escape for the Breboeuf school for boys will be quipped with poles and will be put in by Trudel and McAdam for $575. The Duhamel school, for girls, will have fire escapes with stairs, to be put in by J. J. Enright for $425.

PETERBORO.—The Peterboro Lumber Company have been awarded the contract for cutting the 2,000,000 feet of timber for the Government wharf at Cobourg. 500,000 feet have been shipped.

Quebec.

QUEBEC.—The council has awarded the contract for 500 feet of red rubber hose for scouring purposes to the Gutta Percha Rubber Company at $1.05 per foot.

Manitoba.

WINNIPEG.—The Board of Control has recommended that the contract for air compressor and motor be awarded to Allis-Chalmers-Bullock at $2,315.

British Columbia.

NELSON.—The Canadian Fairbanks Company secured the contract for supplying the travelling crane for the power-house. Price, $3,620, f.o.b., Bonnington.

NELSON.—The Manitoba Iron Works received the contract for the steel work on the switch-board at the power-house. Price, $637.38. Work to be completed in ten days.

LIGHT, HEAT, AND POWER.

Quebec.

MONTREAL.—The electrification of the Grand Trunk workshops at Point St. Charles is the latest development of the company's progressive economic policy.

MONTREAL.—A delegation, to be headed by Mayor Payette, has been selected to deal with the Power Company, respecting the lighting of the city. A contract to expire at May 1st, 1910, is proposed by many as an alternative to the ten-year franchise at the increased price demanded by the company.

Ontario.

BERLIN.—Berlin is the first of the towns in the Niagara power zone to take action to receive Niagara power when it arrives. The council will be asked to submit a by-law to the ratepayers at New Year's to vote $35,000 to provide for the arrangement of the plant and the installation of the necessary appliances. Berlin is to have a central distributor for Waterloo and New Hamburg as well.

BROCKVILLE.—Brockville's light and power department has just closed its fiscal year. The statement shows that the gross profits for the past eight years were $13,404.53, and net profits for the same period $9,977.35. During that period reductions to the consumer in the way of illuminating gas had been made from a rate of $2 per thousand net in 1900 to $1.12 1-2 in 1908, and fuel gas was reduced from $1.15 per thousand to $1.12 1-2. The price of electric current per kw. hour net was lowered from .20 to .10. The profit for the past year was $8,539.58.

BRANTFORD.—A resolution was unanimously passed at a meeting of the general citizens and Aldermanic Power Committee expressing the opinion that it is in the best interests of the city of Brantford to close a contract for light and power with the Hydro-Electric commission, and that the council will act wisely by arranging such contract, and if considered advisable, submit the same to the ratepayers with the least possible delay. The committee received a new offer in writing from the Cataract Company, but certain provisions were named to which objection was taken.

MERRITTON.—Walsh and Son, contractors, have begun work on the erection of the new municipal transformer house at this place, in connection with the electric street lighting system now being installed.

NIAGARA FALLS.—A writ has been issued in a formal suit brought by the Attorney-General of Ontario and the Commissioners of the Queen Victoria Niagara Falls Park against the Electrical Development Company to recover $17,247.58 for excess of horse-power over 10,000. A similar action was brought recently by the same plaintiffs against the Canadian Niagara Power Company for $15,217.97. The object of the action is to obtain a construction of the agreement between the Province and Park Commissioners with the company as to the supply of power generated at the Falls by the company, especially as to the interpretation of the clause dealing with the rental payable, and as to the meaning of "horse power." Up to 10,000 horse power a flat rate is payable, and beyond that a rate per horse power. The company contends that "horse power" means horse power hour, and is to be averaged. The Government and Commissioners contend that it refers to the capacity developed.

WINDSOR.—Hon. Adam Beck will meet representatives of Windsor, Walkerville, and Sandwich to outline the proposition of the Government for extension of the hydro-electric transmission line from London to the border. City Engineer Hanes, of Windsor, believes that 5,000 horse-power will be needed to supply Windsor alone.

RAILWAYS—STEAM AND ELECTRIC.

Quebec.

MONTREAL.—Mr. Vanier, town engineer of St. Louis, Montreal, has been instructed to prepare plans and specifications of a subway for St. Lawrence Street at a cost of $70,000, payment of which would be divided between the C.P.R., the Montreal Street Railway and the town.

MONTREAL.—It is rumored here that the C.P.R. is making arrangements for the erection of the largest coal-handling plant in the world at Fort William. The capacity would be one million tons.

QUEBEC.—The Canadian Pacific Railway Company purpose erecting a 60,000 gallon water tank here, and ask for a rate of 25 cents per 1,000 gallons for water supplied by city.

Ontario.

OTTAWA.—The Railway Commission has established several divisions, and has apportioned the work among its inspection staff, so that rolling stock and equipment may be carefully watched. Ottawa will be headquarters for Ontario, Quebec and the Maritime Provinces. Another division is located for Manitoba and Saskatchewan, and another for Alberta and British Columbia.

OTTAWA.—The Department of Railways and Canals have been advised that the Lake Superior branch of the G.T.R., connecting Port Arthur and Fort William with the main line of the National Transcontinental Railway, has been opened for traffic. The line is 208 miles in length.

TORONTO.—Leave to amend its statement of defence has been granted the St. Mary's and Western Ontario Railway in the action brought against it by John E. Webb, a contractor. Webb alleges that he was squeezed out on the contract on building the road, and claims $30,000. He assigned his claim to the Bank of Nova Scotia in November, 1906. The railway moved before the Master in Chambers to have the Bank of Nova Scotia added as a plaintiff, or for leave to amend the statement of defence. Leave to amend was given.

Manitoba.

WINNIPEG.—Four thousand men will be sent in to the line of the National Transcontinental from Fort William over the Lake Superior branch, which opens Nov. 27. Hundreds of cars of railway material are now being shipped from Fort William over this branch, the stuff being unloaded at Waco Station. Northeast of Waco there is a lake of considerable size, and both men and materials are conveyed to the scene of operations over this lake.

Alberta.

STRATHCONA.—The Canadian Northern, who have a charter to construct a railroad through Strathcona from Fort Saskatchewan to the Brazeau coal fields, of the cost of which line the Government has guaranteed seventy-five per cent., will commence the construction of this road immediately upon the opening of spring.

British Columbia.

VANCOUVER.—It is understood that the management of the E. and N. Railway have asked for the appropriation of a considerable sum for works of improvement and extension to take place next year. Whether the money will be available, however, cannot be definitely asserted. The contemplated expenditure will have first to be sanctioned by the C.P.R. directors, and it is believed that their verdict will be made known somewhere about Christmas. If it is favorable—and it is thought that the adoption of such a policy is more than likely—marked advances in the railway facilities at present enjoyed by Vancouver Island are anticipated.

Foreign.

SPOKANE, WASH.—Regarded by engineers as a marvel of construction is the Spokane, Portland and Seattle Railway, 423 miles, the most direct line between this city and Portland, which will be completed January 1st, 1909. The road, built jointly by the Great Northern and Northern Pacific systems, is the most expensive in America, the cost of much of it ranging from $250,000 to $500,000 a mile. Twentyfive miles of track remains to be laid between Spokane and Pasco, and this work will be completed in two weeks. Besides this there are two bridges a mile apart near Devil's Canyon. One is 1,100 feet in length and 220 feet high, while the other is 1,000 feet long and 160 feet above the ground in the centre.

SEWERAGE AND WATERWORKS.

Quebec.

MONTREAL.—Regarding the latest interference in the work of constructing the new water conduit, for the city of Montreal, Mr. Janin, superintendent of the city water works, reports that the breach in the dam is a serious one. It consists of a seam in the rock, some 28 feet long, and the point at which the water leaks through the intervening earth bank can only be located by divers. Unless repairs are effected immediately, the conduit cannot be brought to the point at

which it may be of use to the city, till next spring. In this case, the supply will be very uncertain.

Ontario.

ST. CATHARINES, ONT.—The City Water Works Commission is considering the advisability of laying a new pipe line from the reservoir at De Cew Falls, three miles away, to the city. A survey will be made before the matter is finally disposed of by the Commission.

TORONTO.—As the result of a letter from City Solicitor Chisholm, the Board of Control decided to have City Engineer Rust try to make some arrangements with the Cameron septic tank patents, as the city may use the patented apparatus in its sewage plant.

British Columbia.

VANCOUVER.—The pumping machinery of the North Dairy farm pumping station is arriving in the city, two carloads having already reached here via the E. and N. railway, and the balance is now on the way. The pump, capable of pumping 3,600,000 gallons of water every twenty-four hours, was manufactured by the John Inglis company, of Toronto, to which concern the contract was awarded for the price of $17,800. It is a cross compound engine and as soon as the foundations now in course of construction are finished at the station the engine will be installed.

CURRENT NEWS.

Nova Scotia.

SYDNEY.—The rail mill of the Dominion Iron and Steel Company has been put on a 24-hour shift, every available steel worker here being employed. Work is being rushed on the Punjab, India, and New South Wales orders.

Ontario.

OTTAWA.—One of the most important features of the award which has been given under the Lemieux Act in the dispute between the Canadian Northern Railway and its locomotive engineers is the stipulation it makes that a railway company must provide adequate stopping places for train crews along its road, where they are forced to remain over night, and sometimes after a long trip in most inclement weather.

THOROLD.—The first sod was turned November 25th in the construction of the new Pulp Mill, and work will now be rushed along quickly, in order to have the buildings completed before the cold weather.

Quebec.

MONTREAL.—At a meeting of the directors of the Montreal Polytechnic School, held last evening, the question of opening in the school a special railway department, was discussed and approved, and it was decided to ask Government aid for the new departure. The directors also expect help and support from the Grand Trunk and Canadian Pacific railway companies, as well as from the federal Government.

Manitoba.

WINNIPEG.—The city council have authorized the Board of Control to call for tenders for the general work on the power plant. This work is estimated to cost the city $1,500,000 and the tenders will be received up to December 28. The work will extend over a period of two yars, and the installation of the machinery for operation will cost an additional $1,000,000, making, with the $500,000 already expended, a total of $3,000,000 for the power plant, when it will be ready to distribute electrical power from the subs tation at Winnipeg.

Alberta.

EDMONTON.—The building permits for the month of November totalled over $100,000.

LETHBRIDGE.—Operations have come to a permanent stop at the gas well and the borers are giving up the hole although they have given the Electric Company no official notice of such action. The hole is not being abandoned because of any impossible or impenetrable formation of rock but because there is a broken bit at the bottom of the hole which is now 2,170 feet deep, and it has been found impossible to get it out or to get past it in any way.

Foreign.

DETROIT, MICH.—Mr. H. von Schon, Consulting Engineer, has been engaged to prepare plans for an important hydro-electric development of the power of Cuyahoga Falls, Ohio.

PITTSBURGH, PA.—Figures compiled by the American Bridge Company show that in the 12 months ended October 31 there was structural work bid on and actually carried forward amounting to 1,226,127 tons, against similar work in the previous 12 months of 902,790 tons, a gain of 37 per cent. The compilation covers only such work as the company bid on, excluding export business, but it covers the work whether the contract was awarded to it or to others. The statement is made that in the previous 12 months the leading interest secured more than half of the work which went forward, while in the past 12 months it secured less than a fifth, the work going chiefly to outsiders on account of the low prices bid.

SAN FRANCISCO.—Across 4,700 miles of ocean aerograms have been received from Japan by the operators in the United States wireless telegraph station in this city. This marks a record for receiving wireless messages.

MISCELLANEOUS.

Nova Scotia.

SYDNEY.—The rail mill of the Dominion Iron and Steel Co. has been on twenty-four hour shift, every available steel worker in the city being employed. The residue of the Punjaub order of nine thousand tons is finished, and work will be immediately started on the New South Wales order.

FINANCING OF PUBLIC WORKS.

Ontario.

FORT FRANCES. — The financial arrangements necessary to complete the immense power dam and attendant industries here have been satisfactorily made. A mortgage has been filed on the whole works for five million dollars. The First Trust and Savings Bank of Chicago is advancing the money.

Manitoba.

WINNIPEG.—Tenders, addressed to the Secretary-Treasurer, Winnipeg School Board, will be received up to twelve o'clock noon, December 18th, 1908, for the purchase of $200,000 of debentures of the School District of Winnipeg, No. 1. R. H. Smith, Secretary-Treasurer.

Saskatchewan.

MOOSE JAW.—Tenders will be received by the undersigned up to Tuesday, 1st December, 1908, for the purchase of six thousand dollars debentures of the Moose Jaw Public School District, No. 1. H. Jagger, Secretary-Treasurer.

YORKTON.—The ratepayers on November 23, voted on a by-law providing for the raising of the sum of $20,000 by debentures for the following purposes: $8,000 for additional waterworks connections; $1,300 to cover a shortage on the sale of municipal telephone bonds last year, and $700 to reimburse the town for money spent on the preliminary work in connection with the town's waterworks system.

Foreign.

ALBANY, N.Y.—Up State Public Service Commission to-day received application of the Erie Railway for authority to issue 5 per cent. collateral gold bonds to the amount of $44,000,000, the bonds to run no more than 20 years. The purposes for which the money is being realized is for the acquisition of property, construction, completion and extension, or improvement of its facilities, and for improvement and maintenance of its service, and for the discharge of lawful refunding of its obligations.

LONDON, ENG.—Applications are invited for Canada Atlantic $598,400 consolidated first mortgage 4 per cent. gold bonds, price 93.

LONDON, ENG.—The bonds of the Huron and Ontario Railway Company to the amount of $302,400 have been sold to R. G. Shaw and Company, East India merchants, at 84. A. McD. Allan, of Goderich, Ont., has been here for some months in regard to the matter, and has latterly had the assistance of T. M. Sanders, a well-known engineer, who is to manage the entire construction and equipment of the roadroad. J. Gerry, London, Ont., is the contractor, and H. Middemist, Toronto, the construction engineer. The Shaw Company is to give the railway the use of their offices here and throughout Europe, Asia and America, where the bonds and their interest coupons are likely to be payable. Mr. Shaw, speaking to the Canadian Associated Press over the telephone, stated that the bonds had not been sold them, but that they were negotiating, and have sent a representative to Canada regarding the matter.

RECENT FIRES.

HALIFAX, N.S.—A most disastrous fire, causing over $100,000 damage, destroyed the car shops of Rhodes, Curry and Company, at Amherst, N.S., destroying many finished railway cars, as well as thousands of dollars' worth of raw material and partly finished rolling stock. In the erecting room were four new vestibule colonist cars all complete for the Intercolonial Railway and twelve baggage cars for the Grand Trunk Pacific, and many others in earlier stages of completion.

TELEPHONY.

SIMCOE, ONT.—Mr. Martin, an official of the Bell Telephone Co., is in town, preparing for the work of putting a portion of the local system into conduits. The work will be started after New Year's.

PERSONAL.

MR. LESLIE CRAUFURD, C.E., has been appointed city engineer of Nelson, B.C.

MR. E. V. NEELANDS, B.A.Sc., has been appointed manager of the Hargrave Mine at Cobalt, Ont.

MR. J. T. HALLISEY has been appointed superintendent of the Halifax and St. John Division of the Intercolonial.

MR. WM. N. COURTNEY, of the Standard Engineering Co., Toronto, is now in Montreal that company having opened an office at Room 234, Coristine Building.

MISS B. MARION WADE, a graduate of Trinity University, Toronto, has been appointed by the Boston Board of Health as bacteriologist and chemist in the laboratory of the department.

MR. J. F. H. WYSE, of Messrs. Wyse and Middlemist, engineers, has been appointed by the Ontario Railway Board to report on the disputes between North Toronto and the Metropolitan Railway.

S. B. BIRDS, A.R.I.B.A., formerly of Toronto, has identified himself with the Concrete Engineering and Construction Co., Ltd., Vancouver, and he reports that that concern is now figuring on several large contracts, and the prospects very good indeed.

MR. FRANK BARBER, S.P.S. '06, who for several years was assistant to the late James McDougall, County Engineer for York, has been appointed County Engineer. In addition to county work, Mr. Barber will carry on a consulting practice from his offices in the York Chambers, Adelaide Street East, Toronto, Ont.

MR. E. B. MERRILL, B.A., B.A.Sc., formerly Chief Assistant Engineer of the Power Construction Department of Winnipeg, has opened offices as a consulting engineer in the Lawlor Building, corner King and Yonge Streets, Toronto, Ont. Mr. Merrill, besides being a University man, is also a member of the Can. Soc. of C. E. and American I. E. E. He purposes taking up general engineering work with particular attention to power and allied works as his main field.

DR. EUGENE HAANEL, director of the mines branch of the geological survey, is now on his way to Sweden on the invitation of the Government of that country, to be present at the opening of the new electric smelting plant at Dumnarfot on December 1. He will continue for the mines department investigations he made some two years ago on the electric smelting process, now coming into vogue in Europe, and on his return further important developments in the plant already started at Sault Ste. Marie in connection with the new system may be expected.

MR. GEORGE A. POWELL who has been associated with the Packard Electric Co., Limited, of St. Catharines, Ont., for the last 15 years, has severed his connection with that company. Mr. Powell has started business for himself in the electrical line as commission broker with offices in the Union Bank Building, Winnipeg. He will continue to represent, amongst other agencies, the Eugene F. Phillips Electrical Works, Ltd., of Montreal, well-known makers of bare and insulated copper wires and cables.

OBITUARY.

C. A. DERTSLER, C.E., engineer for the British Columbia electric railway, was drowned at Chilliwack while attempting to cross the Vedder River on a raft. In midstream the raft, on which were Dertsler and a companion, was smashed to pieces on the rocks.

MR. HENRY PETER COBURN, vice-president and general manager of the Sawyer-Massey Company, Hamilton, Ont., died at Hamilton, Ont., November 25th, 1908. The late Mr. Coburn was born on August 21st, 1835, at Dracut, Mass., which has since become a part of Lowell, Mass. He was a son of the late Augustus Coburn, who conducted a large general store at that place, and descended from old English stock. His ancestors came to America in 1650 and settled in Massachusetts, and soon became known as among the best of that sturdy old stock for which the New England States are noted. He attended Phillip's Academy at Andover, Mass., where he began and completed his school education. After quitting school he entered his father's store and there enjoyed the benefit of the father's knowledge of business, and this, with strict religious discipline that was maintained in his father's family, fitted him to accept a larger position when the opportunity offered. In early manhood he came to Hamilton to take a temporary position with the late L. D. Sawyer, head of the firm of L. D. Sawyer and Company, who was his uncle. He took charge of that firm's collecting and sales department and soon showed his ability to take a more important place. In two years' time he was made a partner in the business and was appointed its manager. Here he again showed his business ability, and under his management the firm of L. D. Sawyer took a front rank as manufacturers of farm machinery. So large did its volume of business become that it was considered advisable to form a limited stock company, and the Sawyer-Massey Company was brought into being, with Mr. Coburn as its general manager and vice-president, which position he held up till the time of his death.

MARKET CONDITIONS.

Toronto, Dec. 3rd, 1908.

A sudden cold snap, coming after a fortnight of September-like weather, has not helped the activity of building bu rather the contrary. There is nothing remarkable to be written about building materials, the activity of building having received a check and demand being thereby lessened.

The metals market exhibits some features such as the buoyancy of pig iron and the stronger tone of several metals. Copper accumulated in November, owing to heavy output, and there was a decline. But after Thanksgiving a sharp rally came in the States and electrolytic became active. The result of the fluctuations has been (Dec. 1ts.) a net advance. Since activity in buying pig iron began in September a million tons was placed on contract in the United States. This sounds large but is not, for the capacity of the country is 2,400,000 tons a month. The Eastern foundries are not buying heavily. Steel structural material has been inactive, and prices at tidewater have been shaded as also prices of plates and sheets.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

Antimony.—Price unchanged at 8¾c., with more enquiry.

Axes.—Standard makes, double bitted, $8 to $10; single bitted, per dozen, $7 to $9.

Bar Iron.—$1.95 base, from stock to the wholesale dealer.

Boiler Plates.—1-4 inch and heavier, $2.40. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Orders are small. Lap-wielded, steel, 1 1-4 inch, 10c.; 1 1-2-inch, 9c. per foot; 2-inch, $8.50; 2 1-4 inch, $10; 2 1-2 inch, $10.60; 3-inch, $12.10; 3 1-2 inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c per roll; tarred, 40c. per roll. Business no longer brisk, but much fallen off.

Bricks.—Common structural, $9 per thousand, wholesale, and the demand moderately active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.—Market still weak; cement can be had in 1,000 barrel lots at $1.70 per bbl, including the bags, which is equal to $1.30 without bags. At this time of year building operations are closing down, demand is therefore naturally limited. The smaller dealers, however, are busy selling small quantities.

Coal Tar.—Season about over, price still $3.50 per barrel.

Copper Ingot.—There is more activity in the States, and better demand here. Prices are higher, at 15 to 15½c. with a prospect of their maintenance for a while.

Detonator Caps,—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Roofing Felt.—Only moderate request. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. A steady but not large demand.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50, 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29, $4.50; 10¾, $4.50 per 100 pounds. Fleur de Lis—28-gauge, $4.30; 26-gauge,$4.05; 22-24-gauge,$3.50. Queen's Head—28-gauge, $4.50; 26-gauge, $4.25.

Iron Chain.—¼-inch, $5.75; 5-16-inch, $5.15; ⅜-inch, $4.15; 7-16-inch, $3.95; ½-inch, $3.75; 9-16-inch, $3.70; ⅝-inch, $3.55; ¾-inch, $3.45; ⅞-inch, $3.40; 1-inch, $3.40.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $9.22; 1½-inch, $11.07; 2-inch, $14.76. Steady request of late.

Lead.—Active and unchanged at $3.90 to $4.00 Old Country market quiet but steady.

Lead Wool.—$20.00 per ton, f.o.b. factory.

Lime.—In adequate supply and moderate movement. Price for large lots at kilns outside city 22c. per 100 lbs. f.o.b., cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—Dressing pine we quote $32 to $35 per thousand for usual lengths (12, 14, and 16 ft.), and stock sizes of boards, and $38 to $40 for special lengths, common stock boards, as to grade, $24 to $28; Cull stocks, $20; sidings, $17.50. Norway pine is neglected in favor of Southern, which is much stronger in fibre and the price well maintained. Hemlock continues to sell pretty freely, though not in large lots. Spruce flooring is quoted at $25 and plenty moving. The season being practically over for shingles, there is but little movement in them, and prices are weak though unchanged at $3.20 for British Columbia. White pine lath are scarcer, No. 1 especially, we quote $4 for No. 1 and $3.50 for No. 2 firm. A good deal of varied stuff is moving, not so much good pine as cheaper goods, such as hemlock and spruce. But all kinds of Canadian lumber are likely to continue firm, because smaller quantities of logs have been taken out this season.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3. There is a fair supply and no especial activity.

Pitch.—An active trade at unaltered prices, at 70c. per 100 pounds.

Pig Iron.—Business is only moderate; pries are decidedly maintained. Clarence quotes at $20.50 for No. 3; Cleveland, $20.50 to $21.00; in Canadian pig. Hamilton quotes $20.00 to $20.50. We note elsewhere the old country market.

Plaster of Paris.—Calcined, wholesale, $2; retail, $2.15. Active business.

Putty.—In bladders, strictly pure, per 100 lbs., $2.25; in barrel lots, $2.05.

Rope.—Sisal, 9½c. per lb.; pure Manila, 12½c., Base

Sewer Pipe.—

	4-in.	6-in.	9-in.	10-in.	12-in.	24-in.
Straight pipe per foot	$0.20	$0.30	$0.60	$0.75	$1.00	$3.25
Single junction, 1 or 2 feet long.	.90	1.35	2.70	3.40	4.50	14.63
Double junctions	1.50	2.50	5.00	....	8.50	.....
Increasers and reducers	....	1.50	2.50	....	4.00	.....
P. traps	2.00	3.50	7.50	....	15.00	.....
H. H. traps	2.50	4.00	8.00	....	15.00	.....

In good demand; price 70 per cent. off list at factory for car-load lots; 60 per cent. off list retail.

Steel Beams and Channels.—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.50; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes of angles and tees.

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton, for 500 tons or over: Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

Sheet Steel.—Market steady, with fairly good demand; 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2 65; 28-gauge, $2.85.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 18c.

Tank Plate.—3-16-inch, $2.50.

Tin.—Market very irregular, but active and prices strong at 32 to 33c. Price in Singapore is higher, but the visible supply has increased and London is weak.

Wheelbarrows.—Navvy, steel wheel, Jewel pattern, knocked down, $21.35 per dozen; set up, $22.35. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

Zinc Spelter.—Business fairly active at better prices,, $5.25 to $5.50. The London Market stronger.

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Montreal, Dec. 2nd, 1908.

The markets for pig iron in the United States are less active and strong than the indications of a few weeks ago gave promise of. Added to other somewhat complex factors, is that of the tariff, introduced lately by Mr. Hill and more especially by Mr. Carnegie. The latter having come out strongly for free trade in iron and steel, manufacturers are more or less uncertain in their attitude, and whether Mr. Carnegie's contention that the industry would benefit greatly from free trade is justifiable or not, the unsettling of conditions cannot but have the effect of delaying business in the meantime. The Westinghouse Company is reported to have been able to place its order for 3,000 tons for delivery second quarter, at around $14.50, Valley, per ton, this being from $1.00 to $1.50 less than many makers were demanding. In fact, some were apparently not anxious to quote at all. It would seem that the situation in scrap in the west is exceedingly firm and that a shortage in this material is being experienced. The United States Corporation is now in the market for it. A few railways have placed their orders for steel rails and the report that one road has purchased foreign rails is denied. Some very good orders for structural steel have also been placed, so that the outlook continues promising.

In England, notwithstanding the more favorable conditions, particularly in the United States, the market for iron lacks strength and the situation is not very encouraging. Cleveland warrants have declined about a shilling and the hematite trade continues rather slow, so far as new business is concerned. The East coast sends in better reports than the West coast. It would seem that makers are not very badly situated as regards orders and a favorable feature is that the price for future delivery is much higher than that for prompt.

The local market is very little changed, though pig iron has had to be marked up somewhat, owing to the altered basis upon which it is quoted. Cement is available at lower figures, in some cases, for immediate delivery, though manufacturers are looking forward hopefully to the coming season. The rest of the market shows very little alteration. The copper market is firm at present, and in fact, the tone throughout the list is hopeful.

Antimony.—The market is steady at 9 to 9 1-4c.

Bar Iron and Steel.—Prices are steady all round, and trade is quiet. Bar iron, $1.85 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $2.00; sleigh shoe steel, $1.90 for 1 x ¾-base; tire steel, $1.95 for 1 x ¾-base; toe calk steel, $2.40; machine steel, iron finish, $2.10; smooth finish, $2.75.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 19c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 55c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 45c. per roll of 400 square feet, No. 2, 28c. (See Roofing; also Tar and Pitch).

Cement.—Quotations are for car lots, f.o.b., Montreal. Canadian cement is $1.55 to $1.65 per 350-lb. bbl., in 4 cotton bags, adding 10c. for each bag. Good bags re-purchased at 10c. each. Paper bags cost 2½c. extra, or 10c. per bbl. weight. English cement is $1.65 to $1.85 per 350-lb. bbl. in 4 jute sacks (for which add 8c. each) and $2.20 to $2.40 in wood. Begian cement is $1.60 to $1.65 in bags—bags extra—and $2.10 in wood.

Chain.—The market is steady as follows:—¼-inch, $5.30; 5-16-inch, $4.05; ⅜-inch, $3.65; 7-16-inch, $3.45; ½-inch, $3.20; 9-16-inch, $3.15; ⅝-inch, $3.05; ¾-inch, $3; ⅞-inch, $2.95; 1 inch, $2.95.

Copper.—The market is steady at 15½c. per lb. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb. cases, 40 per cent. proof, 18c. in single case lots, Montreal. Blasting powder, 25-lb. kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder. Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, 1$ extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Galvanized Iron.—The market is steady. Prices, basis, 28-gauge, are:—Queen's Head, $4.40; Comet, $4.25; Gorbal's Best, $4.25; Apollo, 10¾ oz., $4.35. Add 25c. to above figures for less than case lots; 26-gauge is 25c. less than 28-gauge. American 28-gauge and English 26 are equivalents, as are American 10¾ oz., and English 28-gauge.

Galvanized Pipe.—(See Pipe, Wrought and Galvanized).

Iron.—Prices are higher, owing to the iron having been put in store. Values, however remain about the same, the tendency being firm. The following prices are ex-store: Canadian pig, $18 to $19 per ton; No. 1 Summerlee, $21 to $21.50; No. 2 selected Summerlee, $20.50 to $20.75; Carron soft $20.25 to $20.75; No. 3 Clarence, $18.75 to $19 per ton.

Laths.—See Lumber, etc.

Lead.—Trail lead is unchanged and steady, at $3.70 to $3.80 per 100 pounds, ex-store.

Lead Wool—$12 per ton. f.o.b. factory.

Lumber, Etc.—Prices on lumber are for car lots, to contractors, at mill points, carrying a freight rate of $1.50. At the moment, the market is exceptionally irregular and prices are uncertain. Red pine, mill culls out,