PAGES

MISSING

# The Canadian Engineer

WEEKLY

ESTABLISHED 1893

Vol. 15. TORONTO, CANADA, OCTOBER 2nd, 1908. No. 40

## 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** |

ADVERTISEMENT RATES ON APPLICATION.

**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.

**Winnipeg Office:** Room 315, Nanton Building. Phone 8142. G. W. Goodal Business and Editorial Representative.

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, OCTOBER 2nd, 1908.

### CONTENTS OF THIS ISSUE.



**We have a request for a number of copies of the "Canadian Engineer" of December 20th, 1907. Our supply is exhausted, and to each subscriber sending in a copy of this issue we will grant one month's extension of subscription.**

## THE PLAN—ITS USEFULNESS.

It is not a new story, that of the roadmaster, who, when asked if he had seen the plan of the new bridge, said: "No; I have not seen the paper—but I have built the bridge." We all admire the practical man—his resourcefulness, his ingenious methods, his power of planning and remembering details. But with all his good qualities, the purely practical man is often wasteful when he refuses to recognize the value of a good sketch plan, a well-devised general scheme worked out on paper, or the economy that may be secured by the use of proper drawings.

It is true many important construction works have been completed without the use of the scale and drawing-board, but the wisdom of such methods is doubtful. The haphazard placing of machinery foundations and interior walls and passages does not meet the demand for economy of space, such as is, or should be, required in all buildings.

When the work is done by contract, complete plans are necessary to prevent misunderstanding, avoid disputes, and to make possible a fair estimate of cost. It is when the work is being carried on by day labor, or cost plus a fixed sum, that the careful preparation of plans is neglected. In fact, too often extensive field work is undertaken without even first preparing a general plan. This is never economy, and the pressure for early completion is misdirected when it compels such procedure.

It is not by any means necessary that construction be delayed until every detail is worked out. Usually, as soon as the general plan is decided upon, work may commence and the detail sheets prepared as work progresses; but every consulting engineer of standing will insist that no work be done until the drawings indicate the nature of the work. A plan may be of very little value because of too much detail, just as it may be worthless for want of detail. The draftsman is a better office man if he has had field experience. He will understand that certain annoying and costly details may be well omitted and understand the dimensions and design that are necessary.

Plans should also be a record of work done. A new engineer taking charge of work should have at his disposal a correct and clear set of plans. He will thus become quickly familiar with the layout and be able to judge of the work as a whole. Personal inspection will also be necessary, but a set of plans will make this easier.

## ELECTRIC THEORY OF MATTER.

The London "Times" has lately been flooded with criticisms by chemists and others adverse to the "Electronic Theory of Matter." This is to be expected, for, without failing to recognize the value of the research work of Sir Oliver Lodge, Professor Rutherford, Dr. Thompson and others, it must be remembered that their work simply consists of original methods in the chemical analysis of rare metals.

Mr. J. Stanley Richmond, who as far back as August, 1904, remorselessly criticized the "Electric Theory of Matter" in the "Electrical Review," of New York, informs us that he placed before the American

Institute of Electrical Engineers about a year ago a short paper on the "Universality of Mechanics," tersely showing how this theory is opposed to fundamental physical laws. Professor Sheldon, however, as a former president of the institute, had written a lengthy paper supporting, in a somewhat non-committal way, this theory. Mr. Richmond's finding on this question is as follows:—

"He who delves deeply in the field of scientific truths must, and does recognize in the highest sense that the Creator is an actuality. Accepting, therefore, the Creator as our Arbitrary Zero or starting point in the consideration of the Universe, only two main factors remain. These, respectively, are matter and changing position of matter, the latter being technically termed motion. As far as mortals are concerned, therefore, 'Everything is matter and motion.'

"We all understand that nothing in the universe remains still, and several of us understand that motion has many phases. But it is only a few who have any physical conception of molecular motion, which is one of the two main divisions of motion, the two being:—

"1st. The motion of a mass of matter from point to point. Instances of this class of motion are a moving train, a moving cannon ball and a planet moving in its orbit.

"2nd. The motion of change of position from the normal of the minute particles of which matter is composed. Instances of this class of motion are light, sound, heat, electricity and thought. This class of motion is generally termed molecular motion.

"Tyndal, the famous scientist, wrote elaborately on light and heat being modes of motion, and I, after considerable difficulty, managed to have the view that electricity is also a mode of motion published in the 'Electrical World,' of New York, about four years ago.

"So-called direct current is but a steady abnormal position, in the form of a steady strain of the molecules in a conductor; and so-called alternating current is but the alternating abnormal position, in the form of an alternating strain, of the molecules in a conductor, the alternations being from side to side of the normal position of the molecules and taking place rythmically."

In regard to the theory of the electrical composition of matter, Mr. Richmond sums up by saying: "Electricity being a phase of motion, and motion being the changing position of matter, how can matter be composed of electricity, or, in other words, how can matter be composed of changing position of matter if matter is non-existent?"

## FOREST FIRES.

September, 1908, will be remembered in Eastern Canada for its forest fires. For weeks the smoke hung in the sky, a banner telling of the destruction of vast forest areas and valuable natural resources. Many lives were endangered and millions of dollars worth of timber dstroyed. It is impossible to estimate the damage done, for not only were merchantable trees burnt, but the large areas of young shoots and trees—the timber wealth of the future—were wiped off the face of the great timber areas.

The demand is increasing, the supply diminishing. Almost every trade and industry, and certainly every large construction work will feel the effect of this great waste.

Every autumn this tragedy of the forest is enacted. We seem to gaze at it with awe and wonder, never thinking that it should be stopped—never planning to prevent it.

In Canada our forest wealth is a great source of Government revenue, and one wonders that our Governments give so little thought to forest preservation and spend such small amounts in developing forest areas.

'Tis true fire rangers are scattered here and there to prevent, if possible, the starting of forest fires. These men may do conscientious work, but fires do start, and when once started they sweep across the country, there being no organized forces to fight them.

A chief is just as necessary in fighting forest fires as fighting fires in cities. A man in the field with knowledge of the country and with authority and men—men who know what may be expected of them and who know the bush.

Our forests should be protected by small armies of trained bush rangers, men under a chief who could be moved quickly from one section to another.

It might cost thousands, but it would save millions.

## THE HUDSON BAY ROUTE.

The announcement of the Hudson Bay Railway survey was made at such a time as would suggest "politics," and, if much of the criticism one reads of this undertaking is politically prompted, it will be hard to judge of the merits of the enterprise as a transportation route.

The West is looking for cheap transportation to tide water. Fort Churchill as a seaport is a possibility. The following table gives the distance in miles to Churchill, via The Pas, the present terminus of the C.N.R. Hudson Bay line:—

| | Miles to Churchill. | Miles to Montreal. | Advantage of north route. |
|---|---|---|---|
| Winnipeg | 945 | 1,422 | 477 |
| Brandon | 940 | 1,555 | 615 |
| Regina | 1,200 | 1,750 | 550 |
| Medicine Hat | 1,500 | 2,082 | 582 |
| Calgary | 1,682 | 2,262 | 580 |
| Edmonton | 1,129 | 2,247 | 1,118 |
| Prince Albert | 717 | 1,958 | 1,241 |

The line will be built by the Dominion Government, but will not be Government operated.

The success of the venture will depend on the possibilities of the sea route. Reports are being circulated that Hudson Straits can only be navigated for some three weeks in the year.

Government exploration parties and Mounted Police parties claim a much longer season.

The Government should be just as certain of the practicability of navigating Hudson Strait as to building to Fort Churchill. They will never enlarge the spout by running it into an ice-field.

## EDITORIAL NOTES.

The design of the new Quebec Bridge is now under consideration. It appears the question of location is settled. The question of height of the bridge is again up for discussion. Every effort should be made to secure a design that will be sufficiently high to permit of the largest steamers passing under it.

* * * *

The assurance now obtained of a good crop in the Canadian West is having its effect in various directions. Lumber dealers, heavy metal merchants, cement makers, hardware men, dealers in building materials, such as sand, lime, roofing and building paper, tell the same tale of hurried orders for their goods, which indicate confidence in the future. This is reassuring, since it concurs with intelligence from the United States of a like kind with a like basis. The revival of activity here indicated means much to factory proprietors and workers everywhere in Canada. For the wheels which have been silent for many months will again "go round," and extensions projected a year or more ago, but suspended because of the financial depression, may be expected to be gone on with. The greater liberality of bank credits, of which we learn, here and there, is also a welcome factor in a somewhat expanding trade.

# THE SINKING OF THE PIERS FOR THE GRAND TRUNK PACIFIC BRIDGE AT FORT WILLIAM, ONT., CAN.*

**By H. L. Wiley, Jun. Am. Soc. C.E.**

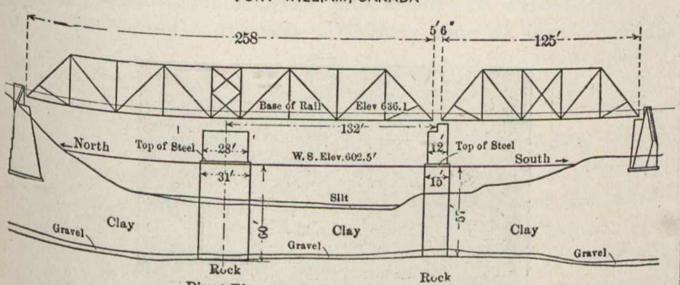
This paper outlines the construction methods used in sinking the piers for the Grand Trunk Pacific Railway bridge crossing the Kaministiquia River at Fort William, Ontario, Canada.

The proposed terminals of the Grand Trunk Pacific at the head of Lake Superior are separted from the main line by the Kaministiquia River. At the bridge site the river has a maximum depth of about 20 feet at low water being at that stage 325 feet in width. The north bank of the river, to which the draw span of the bridge swings, is steep, and rises to a height of about 35 feet above water. The south bank is low, sloping from the river at a grade of 1 in 10.

Test borings, taken at the bridge site during the winter of 1906-7 by the railway engineers, showed a stratum of firm, blue clay, about 35 feet thick, covering a layer of water-bearing gravel, varying in thickness from 3 to 7 feet. The water contained in this gravel was under sufficient pressure to maintain a steady flow through several of the abandoned test holes, and, when confined, it rose to an elevation of 4 or 5 feet above the river level. This gravel is underlaid with bed-rock, from 57 to 60 feet below the water surface. The rock surface is comparatively level, dipping to the north about two degrees.

The plans prepared by the railway showed only the general design of the two piers, the details and construction methods being left for field decision. The pivot pier consists of a steel shell, 31 feet in diameter, sunk to bed-rock and filled with concrete. The south pier is composed of two smaller shells, set side by side. These are 15 feet in diameter, and 18 feet apart from centre to centre.

SKETCH SHOWING FOUNDATIONS
G. T. P. BRIDGE.
FORT WILLIAM, CANADA




The plans called for ½-inch plate, single-riveted on the horizontal seams and double-riveted on the vertical seams, and ¾-inch rivets with round heads. The contract for the work having been let in the latter part of August, 1907, an interval of about three months remained before severe cold weather would set in, closing navigation and rendering all outside work more costly. Therefore, operations were begun immediately.

For the falsework at the pivot pier, two rings of piling were driven about the centre of the pier, the diameter of the inner ring being 37 feet and of the outer one 54 feet. These piles were cut off and capped 8 feet above the water. The caps were of 12 by 12-inch fir timber, radial from the centre of the pier, and overhanging the perimeter of the steel shell two feet. There were twenty piles in each ring. These were cross-braced and tied securely, making the structure as rigid as possible, to lessen any movement that might be caused by the current, which varied from three to six miles per hour. The piles were driven to gravel, to prevent settlement in the finished falsework. The structure was then decked and a circular track built upon it. This track was for a small derrick car, the purpose of which was to pick up the plates forming the shell, carry them to place, and hold them in position while being bolted up ready for riveting.

A slot, 2 by 8 inches, was cut through the caps where their centre lines intersected the perimeter of the steel shell, and a casting, through which "hanger rods" worked, was set on each cap. The hanger rods were for holding a course of plates during riveting, supporting the finished shell until the river bottom was reached, and for controlling the movements of the shell until it rested on bed-rock. The rods were 8 feet long, of 1½-inch steel, threaded, and an eye of Swede iron was welded to the lower end of each. Hook-plates, hung in these eyes, connected the hanger rods and the plates forming the shell. There were two hanger rods at each cap, four inches from centre to centre, one outside of the shell and one within it. The hook-plates covered four rivet holes, and were bolted to the steel plates while the derrick car held them suspended, the weight of the plates being transferred to the hanger rods by slacking the chain blocks with which the derrick car was rigged.

The plates were of ½-inch steel, 10 feet long and 5 feet wide; they were curved to a radius of 15½ feet, and weighed about 1,100 pounds each. There were 130 plates in the shell, thirteen vertical courses of ten plates each. The time required to swing the plates for one course from the storage yard to the derrick car, and to bolt them up ready for riveting, averaged about 2½ hours, or 15 minutes for each plate. Five courses were riveted up when the shell touched bottom. The weight of the shell caused it to penetrate the bottom to an average depth of one foot. A 2-inch water-jet was then rigged from a single-cylinder, 6-inch steam force pump, and by this means the material at the cutting edge was disturbed sufficiently to permit a further settlement amounting to about one foot.

Each outside hanger rod was then carried back to the pile carrying the cap from which the rod was suspended, and bolted to the pile, thus tying the inner end of the cap in place. Jacks were placed under each cap, resting on the edge of the shell, and the combined action of the water-jet and twenty jacks forced the shell about five feet farther into the bottom, the total penetration being at this time seven feet.

The shell was then pumped out. As the water was removed, a course of bracing was placed at each horizontal seam of the shell. This bracing was 12 by 12-inch hemlock, four timbers being set in the form of a square. Two squares were placed together, one being turned 45° about the centre of the pier, thus forming a star-shaped set of bracing, giving eight points of support to the sides of the shell, and leaving an octagonal central opening about 18 feet across.

Five days after the shell was cleared of water, the material under the cutting edge gave way, and the shell filled, the blow being confined to about 4 feet of the perimeter. This hole was carefully filled, and the shell pumped out again, only to blow out, about five hours later, at a different point.

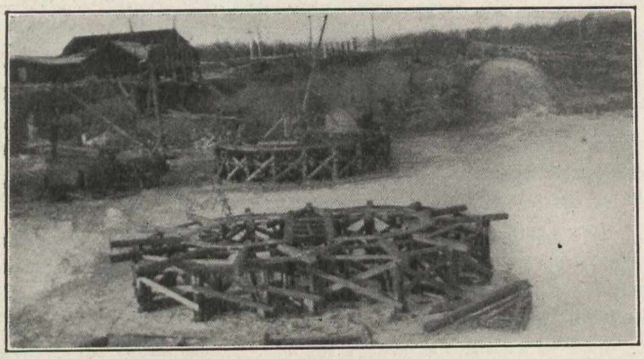
At this time a flow of water within the shell was noticed, coming apparently from one of the holes left by the test borings, and being approximately equivalent to the flow from a 4-inch pipe. It was evident that there would be great difficulty in keeping the shell cleared of water, and an attempt was made to sink it still farther into the river bed. It was loaded with 175 tons of steel rails, the jacks were placed in position as before, and it was forced downward another 5 feet, the total penetration then being 12 feet. Another attempt to clear the shell of water, resulting in failure, indicated that the flow from the gravel had destroyed the integrity of the material within the shell. This method was abandoned and the work proceeded as follows:—

The overhanging caps were cut off, and two more courses of steel were riveted up. Timbers were placed across the top of the shell, and a tight floor, about one foot from water level, was hung from these timbers within the shell. A form was built, following the octagonal outline of the inner opening left by the timber bracing, and concrete was deposited between this form and the steel shell. Meanwhile, a derrick was erected on a fender crib which had been sunk immediately up stream from the pivot pier, and excavation was commenced within the shell, using an orange-peel bucket. The settlement of the shell was constant from this point, and, as it sank, the ring of concrete was carried

*Read before the American Society of Civil Engineers.

upward, thus forming a steel-protected pipe or drum, having an outside diameter of 31 feet, the inner opening being octagonal.

When the shell finally reached rock, the surface of the rock was cleaned, and a layer of concrete about seven feet in thickness was deposited under water, which sealed the flow from the water-bearing gravel and allowed the removal of the bracing. When the timber was removed, the interior



**Falsework and Derrick Car, Pivot Pier.**

opening was filled with concrete, forms were built at the water level, and the pier was carried up to its final elevation.

The concrete used was a 1:3:5 mixture, the gravel and sand being brought in by train from a point thirty miles distant on the line of the Grand Trunk Pacific. This material was clean, and in its natural state closely approximated the required proportions. Tests were made from time to time to determine its condition, and enough sand was added to make it comply with the specifications. Screening was considered unnecessary. To prevent the concrete from freezing, the sand and gravel were heated. Three heaters, made from sections of 36-inch cost-iron pipe, were placed near the stock piles. Wood for heating purposes was plentiful, and the cost of heating all material averaged about $1 per cubic yard of concrete. The materials were conveyed to the mixer by cars, and the concrete was swung to the derrick on the fender crib by using a second derrick located on the river bank. After the ice formed, the derricks exchanged boxes on the ice, and the mixer, running constantly, kept one batch of concrete moving at all times. The batches averaged 22 cubic feet, the average output being 11 cubic yards per hour.

In the concrete, pieces of stone, containing from 2 to 15 cubic feet, were placed by the derrick on the fender crib. These stones were heated by immersing them in a tank of hot water for a few minutes, the volume being indicated by a displacement scale marked off inside the tank. In this way a check on the total volume of material was obtained, the combined volumes of stone and concrete equaling the quantity indicated from measurements made inside the shell. The total quantity of stone and concrete in this pier is 2,200 cubic yards.

Conditions at the smaller pier on the south side of the river were somewhat different, the water being only 17 feet deep, and bed-rock 57 feet from the water surface.

This pier consists of two concrete-filled steel shells, 15 feet in diameter, set side by side at right angles to the centre line of the bridge, with a space of three feet between them. Falsework, similar to that at the pivot pier, was erected. To handle the steel plates, a derrick was placed on the centre line of the bridge, resting on three small cribs sunk for the purpose.

The shells were lined with concrete as they sank, and, owing to the fact that they could be pumped out, about two-thirds of the total excavation was completed in the dry, the derrick disposing of the material as it was excavated. The shells were in no way connected, but were carried down with as nearly the same amount of progress as possible. The general progress was in jumps of from 2 to 5 feet. The steel was carried high enough at all times to prevent any chance of the shell disappearing beneath the surface. The progress could be closely controlled by the amount of excavation. The shells were brought to place finally with a difference in elevation of less than ½ inch. Along the centre line of the bridge they were about four inches out of position. This was corrected when the forms were built at the water line, where a slight offset had been provided for such a contingency.

There were 1,055 cubic yards of concrete in this pier, the same mixture, 1:3:5, being used as in the pivot pier. The two shells were joined at the top by a reinforced concrete beam. The sand and gravel for this pier had been placed on the south bank of the river before the close of navigation. This material was dredged from the bed of Lake Superior during the summer, and was used without screening. The mixing plant for this pier was located on the south bank, and the concrete was conveyed to the derrick by cars running on a track laid on the ice.

It was thought that difficulty might arise from the shrinkage of the concrete inside the shell, with a consequent destruction of the bond between it and the steel, and, to prevent this, the first course of concrete was allowed to set under water, where some expansion would occur. The concrete in the piers was kept warm, where exposed to the air, by covering the piers and turning live steam into the enclosed space. The concrete below the ice line, and under water, was, of course, in no danger from freezing.

The steel shells were rendered watertight by caulking them at the laps, and by driving a small triangular wedge at the scarfs. The resistance of the material through which the shells were sunk was found to vary from 275 to 320 pounds per square foot. This is the net skin friction, after deducting the resistance caused by the cutting edge, the laps in the plates and the rivet heads.

The cutting edges were reinforced by riveting to the lower course of steel an additional ½-inch plate, three feet wide. This was considered sufficient, as the test borings had shown the material to be clear, and free from sunken trees or boulders.

The riveting and caulking were done with air, the compressor being of the locomotive type. Owing to the atmospheric moisture, the air line and hammers at times gave some trouble, due to the intense cold.

The plates for the shells were punched and bent at Chicago, and shipped ready for erection. They were fitted

**Interior of Shell on Pivot Pier, Showing Bracing.**

up easily and rapidly, as the work of bending and punching had been done well and carefully.

Work was carried on as rapidly as possible, three shifts being employed on the concrete at times. The total time consumed in this work, disregarding lapses and minor delays, was about five months. The cost of the two piers was about $60,000.

The work came under the supervision of Mr. George A. Knowlton, Division Engineer in charge of the Lake Superior branch of the Grand Trunk Pacific Railway. The writer designed the lay-out of the plant and the method of construction, and was in charge of the work.

# CONCRETE STRUCTURES FROM THE VIEW-POINT OF THE CONTRACTING SPECIALIST.*

**By DeWitt V. Moore.**

### Work by Contract.

There have been much discussion and differences of opinion as to the manner of executing any construction work, but at this time we believe the majority of the architects and engineers and prospective builders will agree that the best results are secured by bona fide propositions from reliable contractors and the awarding of the contract to the lowest responsible bidder. Certainly it would seem that the best results should be obtained in this way, as the man who gives his life and his constant thought to the building trade, watching for every improvement in methods and materials and continuing constantly in touch with the labor and material market, is far better qualified to build economically and efficiently than is the owner who takes upon himself the doing of same. The owner can have but one object in mind in handling the work himself, and that is, to save the contractor's profits, and this purpose is nearly always defeated by the increased cost and errors in the work so done.

Granting then, that when work is to be done it is to be by contract, the next question is to determine the lowest responsible bidder. It would seem there is no line of work in the business world so easy to enter into as contracting. It appears to the observer that when some individual is looking for a new or change of occupation, who perhaps has gained some slight knowledge of construction work, sees contracts constantly being awarded to contractors who apparently are making money (it is always the successful contractors who are noticed and the unsuccessful ones who soon drop out of sight), he decides that here is a field for his efforts and one in which he can soon secure a competency. By his own effort, or possibly by hiring some young engineer, he calculates the quantities of work to be done and figures his bid, which, nine times out of ten, will either be an excessively high figure or an excessively low figure. Having no real experience of his own, he must depend for his unit prices upon the published prices paid for work previously let. Since the prospective contractor has little personal knowledge and since his hired estimator has no individual financial responsibility, errors in quantities and unit prices are liable to result. The writer has personal knowledge of a case where an error of this kind was made. A contract was awarded for a large amount of concrete work for $4.85 per cubic yard. The next day after a contractor of the above description bid exactly the same price for the construction of several reinforced concrete culverts, where the amount of concrete was practically nothing and the form work was the large item. He was bidding on the latter work on the basis of the work let the previous day and asking the same price for work that was worth twice as much on a cubic yard basis. Numerous cases of the same kind can be mentioned.

As this paper is intended to deal particularly with the modern use of concrete for construction, some of the statements as above may not be equally applicable to other lines, for the reason that the concrete industry is to a very large extent not yet thoroughly understood or organized. Along the lines of structural steel construction, cut stone, brick, timber, etc., we are dealing with industries of long standing, which are well organized and which can not be entered by the irresponsible individual, due to the fact that a considerable amount of money must be invested in the plant and working capital in order to qualify for the work. On the contrary, along the line of concrete, much stress has been laid upon the fact that anyone can mix concrete and that no capital or previous experience is required; therefore, we find men rushing into this work with the idea of mixing the concrete by hand, with no investment except for wheelbarrows and shovels. To illustrate a little further along this line, the manufacturers of concrete mixers and concrete block machinery have flooded the country with circulars demonstrating beyond the shadow of a doubt that with no capital and no experience the investor in their machinery can secure work at enormous profits. An understanding of this kind may be satisfactory and true so far as the placing of concrete foundations, pavements and perhaps for sidewalks, steps, cellar floors, etc., but when we broaden along this line and include structural concrete, properly reinforced, the experiment is a dangerous one.

For structural work of this kind the contractor should have a complete organization and plant and he also should have a knowledge of design in the material he is using. The contractors should be more timid about entering the field of concrete work unless thoroughly prepared than he would be to attempt the competing constructions in steel and timber.

### Engineering Design.

The designing of work in concrete, so far as the details are concerned, will not be touched upon in this paper. Design in structural concrete has advanced to a point where there are numerous individuals and firms properly qualified to prepare an efficient and economical design. These parties have made a study of the subject and have informed themselves by reference to all existing data, and, in addition, are keeping pace with the advance in the construction with concrete by close observation and reading, and while all may not have exactly the same idea and may use slightly different forms of reinforcing material and may differ in their methods of work, still so far as the results are concerned the prospective builder should have no hesitancy or doubt in his mind in placing entire confidence in the plans prepared by such experts. The only thing occurring to the writer along the line of design as belonging particularly to this paper is to lay as much stress as possible on the economical design. Many engineers and architects prepare plans for structures which are absolutely safe beyond the shadow of a doubt, but which are extravagant in their excess use of concrete or steel, or both, and also are many times extravagant in the preparation of a design which is more expensive than necessary in the preparation of the forms and centers, which, even when economically designed, comprise very important items in the cost.

### Effect of Plans and Specifications.

It is always presumed that the plans and specifications of the work go together and are explanatory, one of the other, and what is not clearly set forth in one is to be found in the other, etc., but in the practical work of construction, as the writer has experienced same, this is not always the case. The plans may be very carefully prepared and be efficient in strength according to the latest and best information, but the specifications may place such restrictions and be so exacting as to make the interpretation of the plans not only a serious question, but also to result in high prices and unnecessary expense. Many specifications are written by men, who, though perfectly familiar with the design, have no practical idea whatever of the actual construction, and the result is—a specification as to quality of material, amount of materials, manner in which they are to be handled, etc., which are very unreasonable. As an illustration, specifications may mention what kind of forms and centers are to be constructed and the length of time they are to remain upon the work, and same may be entirely out of reason. Each and every structure must be considered by itself on this question. Again, the manner of finishing or kind of finished surface of the concrete specified may be entirely unnecessary when the purpose for which the work is to be used is considered. Many times it is far better to have the concrete left rough than smooth. Too often specifications for one job are copied verbatim for a new job under different conditions. Another illustration is the specifying of the live load to be carried without the proper consideration to the fact that concrete construction when properly designed is far more rigid than either timber or steel. In other words, exactly the same loads are specified for concrete as for timber and steel in alternate design. This is not a fair comparison, as a floor

---

* Abstract of paper read before the Indiana Engineering Society.

designed for 300 pounds live load per square foot on a safety factor of four would, in the case of timber and steel, if tested to four times the specified loading, be deflecting to a very large extent; whereas the concrete work designed under exactly the same conditions will be able to carry its load without any deflection whatever. No doubt the reason for this is that no advantage is taken by the designer of the arching and trussing effect of concrete construction, and as we have no reliable data or tests on the load carrying capacity of these factors, it is proper to ignore this additional safety factor. But on the other hand the writer feels that it is not justice to concrete construction in its competition with wood and steel to first have a safety factor due to over-specifying of the live load, which is often done, then to design with the ordinary safety factor of four and then to have in addition the safety factors due to the arching action, truss action and neglect of the tensile strength of the concrete. The writer personally knows of case after case of concrete floors designed in the ordinary manner, which have been tested to eight times the load for which they were designed without damage. Again, specifications a great many times are written in a sort of a half-hearted description of the style of reinforcement which is to be used. By this I mean that the exact idea of the architect and engineer is not expressed clearly. Either a certain definite type of reinforcement should be specified, or the specifications should be left open to any kind of reinforcement with the stipulation that plans and specifications must be submitted. The specifications for reinforced concrete should recognize the fact that work in structural concrete is too large a part of the whole building to be subordinated to all the other building trades, as is so often done. If a structure is to be built of concrete, then the other trades should be grouped around and specified to depend upon the concrete and the contractors along the lines of these other trades should be called upon to consult with the structural concrete contractor with the idea of adapting their work to his. There is a very good reason for requiring this specification, in that as concrete is but comparatively a new line the other trades are not familiar with the proper methods of handling their work under the new conditions; whereas, with the old idea of building they were entirely familiar, due to years of experience. Much damage, extra cost and delay can be caused by failure to recognize this fact. The specifications for structural concrete should also specify that where construction in concrete is to be carried on through cold weather, resulting in slower progress, that if it is necessary to begin the construction during the cold period, of which we have only three months, then that all other lines of work such as excavation, preparation of foundations, preparation of cut stone, mill work, interior fittings, etc., be completed as far as possible during such time and possibly anticipating its need in the building; since, if this is done, when the cold weather has passed by the reinforced concrete and the balance of work can proceed simultaneously, resulting in a rapid completion of the structure, as concrete is particularly desirable where it is desired to complete each part of the structure as construction proceeds.

### Responsibility for Success or Failure.

The writer considers that the foregoing is only a preface to what is the real subject of this paper. It seems to the writer that too little attention is paid to the subject of responsibility for work done in structural concrete.

In the aforegoing we have considered the doing of work by contract and stress has been laid upon the importance and necessity of an experienced organization. The question of responsibility is a very important one and it is with reference to this particular idea that the writer desires your closest attention.

Who is responsible for the construction of a good structure and who is responsible for a failure? The writer has given much thought along this line and while ordinarily the credit or blame is placed upon the architect, engineer and the contractor who secured the contract, he is of the opinion that this is wrong. Most propositions are awarded to the low bidder, regardless of his responsibility and experience, provided he is able to furnish a bond, on the theory that if he should make a failure of the job the bonding company with its millions of assets must step in and complete the work to the satisfaction of the architect and engineer, and the owner upon the signing of the contract and securing of the bond tosses same into a pigeon hole of his desk and says: "There, now, that is settled."

In the first place, granting that we have an efficient design, I believe the financial worth of all of the contractors bidding on the work should be considered and the contract awarded to the lowest responsible bidder and not necessarily to the lowest bidder. I say financial worth of the contractor because I believe that his financial worth does not necessarily mean all dollars, but rather includes the value of his character, ability, education, experience and broad-mindedness. Few specifications demand these attributes and it is not practical to so specify them.

In the first place I take it all will agree that any person or firm choosing any profession, occupation or vocation in our business and social life and publicly announcing such purpose assumes more of a personal responsibility than simply the earning or accumulation of a personal selfish income or competency. It is necessary that some one shall be in a position to fulfil the needs of the community along the lines of each and every want, need, or desire of mankind, and having selected a certain line, he is under a moral obligation to his neighbors to so fit himself and so prepare the business he has selected as to be always in a position to furnish the particular want when called upon. While it is granted that the selfish end of personal advancement or gain is perfectly legitimate and laudable, still the further moral obligation to his fellows to give his best knowledge, advice and protection on any question pertaining to his own line is demanded, for, otherwise, he is acting short of honest purpose.

Competition generally controls and fixes prices, but it is presumed that all those competing know their business. The ignorant, inexperienced man may advertise a certain line, but he must employ the skilled and experienced assistant to execute, or otherwise he is a danger to the community. When in need, the one needing has a right to expect his neighbor who is a doctor, lawyer, grocer, coal man, or contractor to not only be properly prepared to fill his need, but to tell him the truth regarding same and all the truth.

Now with especial reference to our subject, the owner of the prospective building is not supposed to possess anything more than a general idea of the art of building.

He calls upon his architects or engineer to plan for him and specify for him how his structure is to be built, in order to carry out his ideas. He expects, and rightly, that the architect or engineer is so informed that the resulting structure will be fully up to modern standards. He also expects him to so design as to comply with all municipal regulations provided to protect the public.

He expects his own public officers to so fulfil their pledges and duties of office that any and all proper regulations will be published and enforced.

He expects his legal adviser to examine his title to the building site, to satisfy him of the legal right to build a structure of the kind contemplated in the manner planned, and to draw up a contract which will secure for him a structure for the stipulated price and protecting him against improper construction and unreliability and dishonesty on the part of the builder.

He expects the architect's or engineer's inspector on the structure to be honest and to know what is the correct interpretation of the plans and specifications.

He expects the builder to be experienced in the class of construction he proposes and expects him to be interested and of the intention to give him a dollar of construction value for the dollar of money expended.

He expects the bonding company and liability insurance company to protect him against loss should the builder prove to be unreliable.

The owner having apparently taken care of all points, feels protected, but is he in the full sense of the word? His architect or engineer, if of any standing, will not disappoint his client. In all communities of any importance the building regulations are sufficient if properly enforced. His legal adviser's professional standing and reputation warrant the confidence placed in him. The inspector is in a position where his ability and trustworthiness can be ascertained and if unsatisfactory a change can be made. The builder's reputation for reliability, experience and honesty of purpose should determine his selection, but here is the weak link in the chain.

The owner is selfish in his desire to secure his structure for the least cost possible and almost invariably will award the contract to the lowest bidder, although usually a provision in the specifications allows the opportunity for discrimination. What is the owner's protection at this point and who should he expect to consult with him, advise him, and if necessary remonstrate should he persist in the awarding of the contract to the lowest bidder, if there is any doubt as to his desirability? The builder is selfish in his desire for the job and the anticipated profits he expects from his estimates. Suppose he is wrong in his estimate, who is to protect him? The owner needs protection against the results of too low a bid and the builder is in exactly the same position.

Too often the owner is advised by his legal adviser to go ahead, for even if the builder's bid is too low the bonding company is back of him. The architect or engineer desires that the job be let, as his fee is dependent on the construction. If the builder fails or makes breach of his contract the work must be completed by the bonding company, whereupon the architect or engineer will still secure his fee and the legal adviser, if such difficulties develop, will secure further fees from the adjustments, and possible, and I may say, probable litigation.

Are such advisers truly disinterested or in a position to advise? There is reason to question that such is the case and the interested party who by position and moral obligation to the owner and builder should be called upon to advise carefully and properly is the bonding company and liability insurance company. Why? The reason is logical and simple. Nearly every specification for important work requires a bond, not only covering construction, but also the maintenance and a guarantee. A liability insurance company's policy is generally demanded, and if not, it should be.

These companies are constantly thrown into contact with construction work of all kinds and their rates are the direct result of their experience. They presume that the builder making a bid and asking for a bond or policy knows his business and their inquiry of him is generally the question as to his financial strength with reference to the size of the proposed job, and with reference to the amount of other work he has under construction. The rate is determined by the standard rate for the same kind of work.

Suppose these companies go further in their investigation. Suppose they investigate the builder personally as to his previous experience, his organization, his equipment, his estimate and proposed methods, his prices for material and labor, etc., and compare his bid with the other bids submitted, with proper consideration for the same qualifications of such other bidders. The bonding company, the liability company and the financial backer of the builder are all taking a chance on the builder's reliability and honesty, and, granting his honesty has been established by previous association, still each new job affords the opportunity of errors and bad judgment. An exceptionally low bid is always to be regarded with suspicion and the bonding company, the liability insurance company and the financial backers have a right to demand from the owner the relative standing of the bid of the low or successful bidder with the balance of the bids. Such errors and bad judgment many times prompt and lead to the work being sacrificed and skimped and methods of work adopted to save money, which result in damage to the work and to the employees. No ideas of premiums should influence the higher thought of only backing the man who can demonstrate his fitness. In addition, by such investigations, the losses to these companies are reduced to a minimum and the rates charged can be correspondingly reduced and yet as much profit result. The owner is protected by the refusal to bond or furnish a policy, and the builder, even at the result of his own immediate injured feelings and humiliation, is protected against a sure ultimate loss.

But all this is looking at the question from the purely selfish, money-making or losing point of view of the owner, the builder, the bonding company, the liability company and the financial backer. Let us go back to the moral responsibility of the individual or firm to the public, and with special reference to this new, better construction in reinforced concrete, which can and will revolutionize the art of building if properly organized and controlled. Failures have occurred by the use of this splendid building material, and advantage has been taken of this fact by competing jealous constructions in wood, steel, iron, brick and stone to influence the public by criticisms through the public press. Is this fair? By years of actual use the education of the building trades has been largely completed in the use of these other materials and full and complete data published in standard tables. Even the ordinary uneducated laborer has by usage and association formulated an opinion as to safe construction with same. At the present and for some time to come, knowledge of construction in structural concrete must be confined to the few who will spend the necessary time to study and develop the industry. In time this opposition of competing materials and labor unions must disappear and concrete take its place as a standard, with standard rules, tables and methods.

The responsibility for these failures can not be placed upon the material, but instead may be analyzed as follows:

First—Failures caused by bad design. These would not have happened if the proper regulations of the building laws had been enforced, but granting this control is lacking, no builder of experience and ability would bid upon or construct such a design.

Second—Failures have happened because of improper materials or workmanship. A builder such as just mentioned will use no such material and his experienced organization will prevent the latter.

Third—Failures have occurred because of the lack of knowledge of the properties of concrete, plain and reinforced. Such could never be with the builder who is properly qualified.

Where, then, rests the responsibility? Is it upon the builder? The builder may, with motive and intentions of the best and seeing the rapid advance of building in concrete, decide to enter the new field. What others have done and apparently made money doing he can do. Loss of money, possible business failure, may result to him; litigation, loss of property and above all loss of life may result because of ignorance. The builder's ambition is sincere and to be commended, and no one told him where he was wrong until the damage was done. His estimate is confidential and can not be exposed to his competitors of more experience. His men are lacking as he is in experience, unless he has engaged experienced help before entering the field, which is improbable, as such an organization is generally formed after the work has been awarded. In facing the responsibility, therefore, why not look to the bonding company and the liability insurance company, who are constantly coming in contact with construction work, and who must be a party to the contract sooner or later, who are in a confidential capacity by the very nature of their business, and who are in a position to dictate whether the builder shall have the contract or not by either furnishing or refusing a bond and liability policy.

In order to benefit by this protection, it is incumbent upon the owner to require a bond and liability policy from a company of established standing and to select a builder, not necessarily the lowest bidder, who is qualified and who can furnish the bond and liability policy.

### Construction Organization.

There is no kind of construction which requires more detail labor and inspection under more adverse conditions than structural concrete. I do not say this to discourage the line, but rather to encourage. Structural concrete can be better compared to structural steel than to any other kind of competing construction. But note the difference.

In the case of structural steel, after the structural shapes have been secured, the various members are built and assembled in a shop by skilled labor with modern tools and conveniences, and in such a manner that very ordinary inspection will suffice. The work from the time it first enters the shop and until riveted in place in the structure is constantly exposed and can be inspected as often as necessary.

How is it with concrete? There is less trouble or difficulty in securing the reinforcing material of proper size, etc., but each and every member of the structure must be built in place. The forms may be inspected and the dimensions checked to see that everything is correct. The reinforcing material may be checked as to size, number of pieces and location before the concrete is poured. The actual operation of pouring the concrete covers out of sight all this reinforcement upon which depends the strength of the structure, and we must depend upon the reliability of the inspector and the experience and ability of the workmen and the efficiency of the superintendents to be sure that the reinforcing material is where it is shown on the design.

To a certain extent no fixed rules can govern concrete work. The composition of the concrete must vary from day to day as the materials fluctuate in quality. The specifications should demand that the architect or engineer have an experienced superintendent or engineer on the work. The specifications should also provide that the contractor should be experienced, that his organization should consist of an experienced superintendent and experienced foremen in the concrete, forms and centers and placing of steel. In addition, the specifications should require that either the contractor himself shall be an engineer and be on the work, or that he have in his employ an engineer of authority above the superintendent, such engineer to be experienced not only in actual construction, but also in the design, and who may be depended upon to correct defects and flaws in the plans or in the work as same proceeds.

Structural concrete when built by such an organization can be done cheaper than by unsystematic and unorganized effort.

The contract entered into should be fair and no attempt made by the owner to take all the advantage to himself. Such contracts will not stand if contested and the effect of same is to cause arguments and controversies and possibly a bad feeling to exist; whereas, to secure the best results to all concerned, good nature and co-operation should exist. The spirit of the specifications and the undertaking should govern and not the letter of the former. Since no two men do the same thing in just exactly the same manner, an inspection which presumes to govern rather than to supervise is a detriment to the work.

There should always be on the work a representative of the owner and the builder, who are qualified by experience, knowledge of the work and by authority, so that the majority of questions may be settled directly at the time when they arise. Any failure to provide for contingencies of this kind can not do otherwise than to cause the builder and perhaps the owner unnecessary dollars, which are worse than wasted. Reasonable limits in the quality of work and variations from dimensions, etc., should be allowed without question if the same do not seriously affect the structure. No builder will intentionally violate any provisions along these lines, nor will any builder who comes under the description of this paper intentionally place in the work any material or labor which is a detriment to same. Therefore, a reasonable interpretation of the specifications will be an advantage to the work.

**Results.**

Since results are what is desired, details can many times be overlooked if the work will eventually be properly and safely done.

If the structure is designed and constructed along the lines of this paper and the suggestions contained therein the results should be gratifying to all concerned.

In the first place, the cost should be satisfactory and truly economical and the owner should receive value dollar for dollar in the completed structure for every dollar invested. He will not receive something for nothing by taking advantage of the ignorance or error of the builder or by demanding through his inspector more than he really has a right to ask. The quality of the work will be assured, the permanency of the investment can not be questioned, the maintenance of the structure will be practically nothing, but instead there will be an increasing value.

The protection to the owner's investment, his business, and his peace of mind will be assured without the payment of annual premiums for insurance. There is no class of construction quite so satisfactory from all standpoints as the use of structural concrete. Its adaptability to any and all kinds of structures, its load-carrying ability, its permanency and lack of maintenance charges, the opportunity for alterations and extensions, its fireproofness and freedom from injury by the elements, warrant us in thinking that there will come a time when it practically will be the only construction used. However, to be as near perfect as just mentioned, far more attention must be paid to the responsibility of the various parties interested in the new structure. Far from being the class of construction which can be executed by the negro who can neither read nor write, or the contractor who is his own foreman and goes about in his shirt sleeves, the work in concrete demands all that any other line of building industry demand, and in addition requires a systematic organization far more than many of the other lines. It seems that when it is fully impressed upon the owners, architects, engineers, bonding companies, liability insurance companies and the financial institutions that work in structural concrete is a science and art, we will have reached a point where structural concrete can truthfully be said to have come into its heritage.

At present it is an outcast suffering criticism and knocks, if I may use the word, of all the other trades, looked upon with suspicion by prospective builders and only kept alive by the energy of the engineers and engineering contractors, who, looking forward, can see the possibilities and who are endeavoring by constant effort and application to place structural concrete in its proper recognized place at the head of the building industry.

## THE GAS ENGINE.

A suction gas engine is being tried aboard H.M.S. Rattler, an obsolete warship, on which an engine of this description has been installed. The advantages claimed for the suction gas engine are that no stokers are required and that cheap coal can be used, while with an equal amount of coal consumption 50 per cent. more power is obtained than by a steam engine. The gas is prepared by passing steam and air through a furnace in which coal or coke is burned, and the gas thus produced, after being cooled and cleaned by passage through the scrubber filled with damp coke, is sucked off by the engine just as it is required for driving it. In this way only so much gas as is wanted to feed the engine is produced. The suction gas engine needs neither boilers nor funnels. The stokehold of the Rattler is described as a huge, airy compartment with two or three great upright cylinders in it, not at all hot but clean and free from the usual objectionable concomitants of stokeholds. The Rattler's engine is only in the experimental stage, but the old vessel was driven by a 50 horse-power engine at a rate of nearly eleven knots an hour at a cost of 6 cents per ten miles.

## THE WATER LEVEL.

Lake Ontario shows the highest August stage in 38 years, or since 1870, when it was ¼ inch higher. In 1861 it was higher by 1½ inches, and in 1862 higher by 3¾ inches. It is 21 inches higher than the average August stage of the past ten years, 43¼ inches higher than in 1895, 4¾ inches higher than in 1886, and 3¾ inches higher than in 1904.

# STEEL RAILS FOR PRESENT SERIVCE; THEIR MANUFACTURE AND THEIR FAILURES.*

By Dr. P. H. Dudley, N.Y., Central R. R. Co.

It was a quarter of a century last April (1908) since I completed and submitted to the New York Central and Hudson River Railroad Company, the design for the first 5-in. 80 lb. steel rail for service in the United States. My track inspection mechanism had been in service four years and as complete as at present for two years. I had taken several thousand miles of diagrams of the surface undulations in the track, with a large number of sections of rails ranging from 52 to 67 lbs. per yard and from 3½ to 4½ inches in height. I had made repeated inspections over the tracks of the Philadelphia, Wilmington and Baltimore, the Boston and Albany, and the New York Central and Hudson River railroads. I had also run over the tracks of the Boston and Maine, Eastern, Lake Shore and Michigan Southern, Baltimore, and Potomac, and portions of the Pennsylvania railroads.

The autographic diagrams on a scale of one inch in length of paper to fifty feet of track with the surface—vertical—undulations full size, indicated the action and behaviour of the various sections under the wheel loads of the mechanism of all the important foreign and American brands of rails. The finish of each was different, and in a short time I could recognize the principal brands from the diagrams, as we passed over the track. The data collected for analysis and interpretation of facts, from the different sections and railroads included a great range of conditions of operation and maintenance and was of more value than could have been obtained from a single railroad. It soon became evident from the diagrams and the figures of the combined mechanism for summing the undulations into feet and inches per mile, what the trackmen could do with the sections in the track and quite as important what were their limitations. Railroad officials expected at first on those portions of the track which were found below the standard desired, that more labor, ballast or cross-ties would correct the deficiencies and render the entire track uniform per mile.

Repeated inspections after such improvements by labor and material, without change of rails, still gave evidence of characteristic conditions of the steel per mile and while the general track was improved by the higher standard of maintenance, those features pertaining to the steel and sections were not eliminated. This was a new fact for consideration and elicited extended discussion.

I recall reporting to a Railroad President, who was interested in the track inspections and investigations, that the instruments indicated a few miles of new rails laid the preceding year, had minute waves in the surface, but which he considered hardly probable. He said, however, "if you can prove that you have interpreted the indications correctly, I will have the rails replaced." A steel straight edge confirmed the character of the indications, and it was necessary only to make plaster casts of the surface of portions of a few rails, which he could have in his office for examination, to convince him that the interpretations were reliable.

The rails were replaced by those having a smoother finish with decided improvement in the surface and riding of the track. The early steel sections out-wore six to ten of the iron rails they replaced and enabled the railroad companies to reduce the excessive cost of operation and maintenance incident to the daily breakage and failures of the iron rails. The cost per ton of the steel rails contributed to the retention of the limber sections in the track which permitted the concentration of the major portion of each wheel load in passing to every successive cross-tie, the latter abrading and crushing under the rail seats.

The fishing depths of the sections were low and inadequate, the joint fastenings inefficient, and the rails in a short time acquired permanent sets in the tracks which I classified under three principal forms.

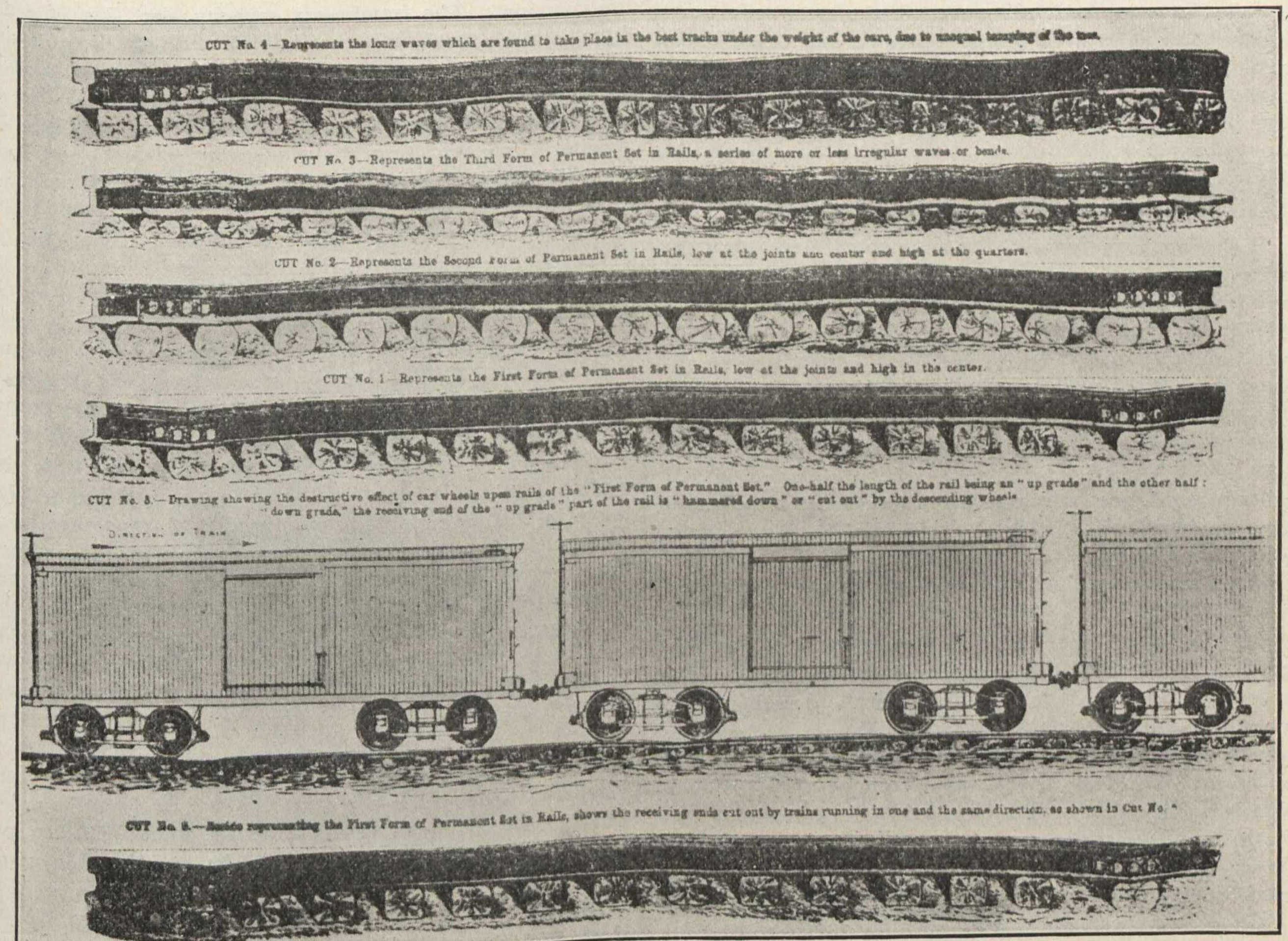



Fig. 1.

**Different Forms of Permanent Sets in Light Rails.**

---

* Read before the Western Society of Engineers.

The first form was where the joints were low and the centres high.

The second form, the joints and centres were low and the quarters high.

The third form, the surface was a series of short waves called "kinkey" by the trackmen.

There were often combinations of the first and third, and of the second and third. The static wheel loads were augmented by the wheel effects—dynamic shocks—once or twice what they should have been, incident to the low joints and irregular surface of the rails with a consequent high train resistance.

The driving wheel loads had increased but little upon the light steel rails, over the practice upon the iron sections. The expended tractive effort had been augmented a few per cent. in the American 8-wheel locomotives, but the steam generating capacity was inadequate for the essential requirements of through express trains. Moguls and consolidation locomotives were being used for freight service on lines with heavy gradients.

The light steel rails did not admit sufficient driving wheel loads, combined with the effect of the expended tractive effort to permit the progress in transportation that a country of vast extent of territory required for its development.

It was not alone weight, but augmented mechanical properties of a rail section in the track which would allow the development desired. The road beds were of ample strength to double or treble their tonnage provided the moving wheel loads were distributed in passing to a longer portion and greater area of the road bed. The stiffer rails would relieve each individual cross-tie of as great weight as it received under the lighter rails by distributing a greater percentage in the wheel spacing.

Railway officials riding in my Track Indicator Car, became convinced that the most economical way to increase the stability and capacity of their tracks was to replace their light and limber sections with rails possessing greater mechanical properties, of stiffness and strength.

Officials who did not ride over their track in my car were equally as positive that the increased cost of the proposed heavier section would be greater than the benefits to be derived. Good and sound criticism is the most valuable aid a worthy project can have. I was able to point out the fallacies of each criticism to the satisfaction of the New York Central officials who would be directly responsible for the installation of the stiffer section. A 5-in. 80 lb. rail reqiring only 23 per cent. more of metal to secure a gain of 66 per cent. in stiffness and 40 per cent. in strength over the former 65 lb. rail was a valuable and economical engineering structure, to increase the stability and capacity of the track. The most optimistic estimates of the benefits of the stiffer rails in the track were less than the realized results, in the progress of transportations.

The 5-in. 80 lb. section was rolled in April 1884, and laid in the tracks the following July. Mr. J. D. Hawks, Chief Engineer of the Michigan Central R. R., made a 5-in. 80 lb. section which was put in service in 1886. President Roberts of the Pennsylvania Railroad, riding over the 5-in. 80 lb. rail on the New York Central R. R., observed and inquired what it was, and ordered his engineers to design a 5-in. 85 lb. section for their service. The former round topped 4½ inch sections had given the trackmen so much trouble in rolling out and spreading the gauge, that it required the cross-ties to be adzed and the rails rolled in, each winter, and they were positive that the 5-in. rails could not be held in the track.

My explanation to the supervisors, that I had considered that feature and had made the head broad, with a 12-in. top radius, to make the passing wheel treads hold the rails in vertical position, was hardly credited until after thorough trial. When the supervisors found that their tracks with the broad topped, stiff rails kept the gauge even without braces on the curves, and also remained in surface for a longer time than the former 4½-in. rails, they saw they were being encouraged and aided in their efforts to secure high standards of track.

The stiff and stable track with the 5-in. 80 lb. rails, enabled Mr. William Buchanan in 1889 to design the first 100 ton passenger locomotive for service in the railway world. It commenced to run in April 1890 and November 30, 1891, the "Empire State Express" was installed, the educator for high speed trains for all railway countries. The activity and development of the use of stiff sections of rails, in the meantime, had been great, for American railway officials are quick to perceive and apply principles which achieve results. In 1892 the first 100-ton locomotive started its high speed runs on the first 100-lb. rails.

The stiff sections of rails, as girders, have permitted a development of locomtives until those of 125, 150 and even 160 tons weight, with an equivalent increase of tractive power are common. The freight car capacity also, has increased from 10 to 50 tons, while the freight train load, according to the topographical features of the lines, has been augmented four to six times in tonnage.

The work the metal must do on the bearing surface to receive, carry and then distribute the heavier wheel loads through the section to the cross-ties, ballast and road bed, is of necessity greater than occurred in the light and limber sections. The bending moments are greater but with less deflection of the rail cross-ties, ballast and road bed. The records of my work in the past show that I recognized the necessity of increasing the physical properties of the metal, as the mechanical properties of the sections were augmented, and from 1890 to 1900 I made over 600,000 tons of rails of 0.60 per cent. or over, in carbon, according to the section, the phosphorus being confined to 0.06 per cent. or under.

The work that I was able to do between the dates mentioned when cupola-metal was used for steel making and care taken in the composition, shows by actual experience in the track, that sound ingots have been made in which piping is the least of their defects. This can be repeated in larger ingots with the advance in metallurgical knowledge of to-day.

I made 95 pounds high carbon, low phosphorus rails from 14 in. ingots at the Bethlehem Steel Company's Works for the Boston & Albany R. R. in 1891 and 1892, and gave 5 to 6 minutes in the ladle for the oxidation products to escape from the chemical reactions of the recarburizer. The 75-pound rails for Dr. Webb's Mohawk and Malone railroad were also made at the same time. Those high-carbon, low-phosphorous rails were rolled while Mr. John Fritz was general superintendent of the plant, for he was the only manufacturer who admitted at the time that such rails could be made. These were premium rails, and the late Mr. William Bliss, president of the Boston & Albany R. R., paid $2 per ton additional for the high grade of steel, and Dr. Webb also paid the same premium for part of his rails. Mr. Bliss considered it economical to secure as good material in his rails as possible, and their services after seventeen years, most of them being still in the track, has proven the wisdom of the undertaking.

Prior to this Mr. Fritz had constructed his 48-in. blooming-train for 16-in. and larger ingots but it cracked the skin of the ingots so much more than the former 26-in. blooming-train, that as I had my choice of which size of ingots to use, I chose the 14-in. ingot, which made two lengths of 30 feet. rails, while the 16-in. ingots made three lengths of rails.

The Boston and Albany rails were of 0.60 per cent. in carbon and down to 0.06 per cent. in phosphorus, as were also a part of the Mohawk and Malone rails. The molten steel after being recarborized in the converter, was poured and remained in the ladle from five to six minutes, to allow the chemical reactions and oxidation-products to escape, before teeming the ingots; these were stripped, then thrown down in the pits and charged into horizontal furnaces for equalizing the heat before blooming. The 26-in. 3-high blooming-train of eleven passes was used, and the blooms were cropped until sound steel was obtained, then chipped under the steam hammer, and again charged into horizontal furnaces for reheating and then rolled in eleven passes into rails. They were finished between 950 deg. C. and 1,000 deg. C., as nearly as could be measured by the Siemens copper ball and water pyrometer. We had not then advanced to the scientific requirements of sawing the rail 0.01 inch shorter for each second of time after leaving the roll and rolling so cold as to frequently damage the rail as a girder. Rolling the rail cold, for wear, is one factor to be considered, but this in any case must not exceed the safety-factor as a girder. The new type of rail sections with 0.5 inch thickness of edge can be rolled too cold for safety, as had occurred in some experiments. The Bethlehem rails, on the Boston and Albany R. R. after sixteen and seventeen years' service on heavy grades and sharp curvatures, have lost only about ⅛-inch in height, from the large volume of traffic which has passed over them. These rails were not lettered to show from which part of the ingot they came, but walking over the track it can be readily seen which were the rails from the top of the ingots. The fractures of these rails, both on the Boston and Albany and the Mohawk and Malone railroads

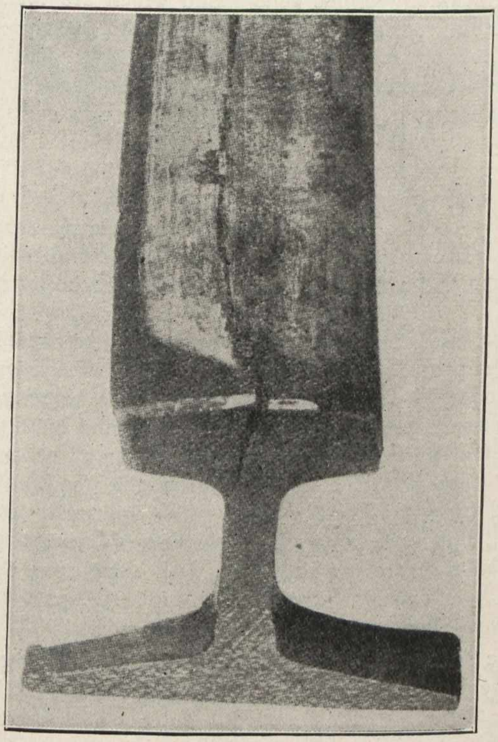


**Fig. 2.**

B. & A. R. R.R—95 lb. rail, Bethlehem, 1891.—Failed January 1908. Supported at joint by 20-inch angle bars of 0.10 per cent. Carbon, which were soft and wore rapidly. The rail head flattened and split from insufficient support, rather than from inferior metal.

have been exceedingly light after so many years of service. They have excellent wearing properties and are also tough as girders.

More than 600,000 tons of rails of my sections were rolled at Scranton, Pa., with carbon of 0.60 per cent. and phosphorus of 0.60 per cent. These were rolled from 14-in. ingots of sufficient length for three—30 feet rails. Special efforts were made to secure a composition which would set well in the ingots and be free from pipes. The number of "stickers" which were broken under the drop were sufficient to show the general soundness of the ingots.

**Defects of Ingot Structure.**

Pipes, as shrinkage cavities or from slag inclusions from the recarburizer, or from vessel slag which accidentally gets into the ingot moulds, are well known facts, though pipes due to shrinkage cavities are best known.

Minute blow holes often occur in the sides of the ingots and frequently are numerous in the central core. The latter are generally surrounded by segregated elements of carbon, phosphorus, sulphur and silicon.

The chemical composition should serve two important functions:

1st, to provide the basis for the physical properties desired in the steel.

2nd, to secure sound ingots. This requires the adjustable feature of the composition used in making the high carbon and low phosphorus rails.

The exhaustion of the low phosphorus ores requires the use of phosphorus at 0.10 per cent. and the carbon for 100 lb. rails for service where the temperature falls to 20 or 30 deg. below zero Fahr. should not exceed 0.45 or 0.50 per cent. The silicon can be from 0.10 to 0.15 per cent. with the manganese at about 1 per cent. for ingots of a length of about 2½ times the width of base. Sound ingots can be made by holding the steel after recarburizing in the converter, 2½ to 3 minutes or about the same time in an intermediate ladle before teeming. The latter has been the practice at the Illinois Steel Company, South Works, for some years and the benefits are well established. The nozzle in the ladle should not exceed 1½ inches or at most 2 inches in diameter, and the metal be poured in a solid stream, to avoid spattering the moulds, and carrying quantities of air in with the steel.

The columnar structure in the corner of the upper part of the ingot will entrain traces of slag and gas which will appear as defects in the heads of the rails after more or less service. The upper part of the ingot will have a well defined central core inside the columnar structure of the ingot.

To study the defects of ingot structures besides those due to pipes, I commenced lettering the rails A, B, and C, as rolled from the top, middle and bottom of the ingot for the New York Central and the Boston and Albany railroad companies in December 1892, at the Lackawanna Iron and Steel Company's plant, Scranton, Pa. The rails contained 0.06 per cent. in phosphorus and 0.55 to 0.60 per cent. in carbon for 80 lb. rails and 0.60 to 0.70 per cent. carbon for 95 and 100 lb. rails. These rails after twelve to sixteen years' service have developed but comparatively few base fractures, which were nearly equally divided between the letters. Out of over 500,000 tons, only twenty piped rails, in the webs and heads, have been found to date, though there is about one-fourth of one per cent. of split heads, which are common to all of the letters. There is a slightly greater percentage of defective rails in the letter A than in either the B or C rails. These rails were all made from ingots which were cast in the pits and as soon as they were stripped, thrown down into a horizontal position, then loaded upon the ingot trucks and charged into horizontal heating furnaces. The chemical composition was adjusted to make a sound ingot, the metal carrying from 0.6 to 0.8 per cent. of copper. Many of the ingots as "stickers" were broken under the drop to see the solidity of the metal, and it was rare to find a central cavity of ⅛-in. diameter in any of the ingots after they were cold. The rails are giving a slow rate of wear and only near the inside running edge of the upper corner of the head of the A rail, for about one-third of its length, do they show the slight inclusions of gas or slag in the structure of the upper part of the ingot.

The B and C rails rarely show any defects. The letters can be found on most of those now in the track. The "New York Central Lines" have been restencilling a number of rails with white paint, indicating by the letter so that persons can examine them and see the different rates of wear between the A, B and C rails. The A rail usually wears slightly faster than the B or C. Rails which have been in service sixteen to seventeen years and have carried from two hundred and two hundred and fifty millions of heavy tonnage, have lost only from 1-16 to ⅛ of an inch in height in the centre of the head, while those on the curves show but little flange wear. The effort in making those rails was to secure a slow rate of wear by a chemical composition and not by cold rolling, as is proposed at the present time. But few half-moon breaks in the base have occurred in these rails after their long service.

**Cold Rolling.**

It is not generally understood that steel for rails, can be be rolled too cold during their manufacture. It is found by experience that cold rolled rails, which have been manufactured extensively since 1900, break to a greater extent in the tracks when the temperature falls to zero or below, than the rails which were rolled at the ordinary working temperatures. The cold rolling is beneficial for the rate of wear in the head, but when the rails are rolled at near or below the "critical temperature" for the steel, it is detrimental to the rail as a girder. The base, web and head may be chilled and hardened so that the ductility is decreased, for the ordinary chemical composition of the section, and they are injured under the straightening press.

The half-moon breaks, which have occurred over the cross-ties in the rails of the past four or five years manufacture, are generally associated with cracks or seams in the base. These may be due to cracks in the skin of the ingot in blooming, inclusions of silicates of manganese, or laps from the passes, or ragging. Many consider that these are the primary causes of the fractures. The more recent physical examinations of broken rails show, that associated with these seams, the metal is usually brittle, having been chilled in rolling. The flange cracks easily under a light blow of the sledge. The fractures can in many cases be traced directly to the initial strains in the metal due to "gagging" in straightening the rail at the time of manufacture. The edge of the base of the rail on one side will check from the bottom upwards, and in an inch or two from that, the top of the flange may check from the top downward.

These are detailed progressive fractures even though completed under the locomotive or train, and usually when found some part of the fracture had previously oxidized or discolored, showing it had been days, weeks and sometimes months in developing.

The gagging in such cases was sufficiently severe to put reversed bends in the edge of the base and had left decided initial stresses in the metal at the junction of the base and web and in the flanges due to permanent sets of the metal in straightening the rails. The majority of the half-moon or crescent shaped fractures occur on the top of the cross-ties, and finally rising through the web and head, as a vertical sheer with slight curvature through the web. Comparing these fractures with those which occur over the supports of the drop testing machine, they are found to be identical except as to the length of the curve, as the rail shears over the support. Increasing the thickness of the base for colder rolling than has been before considered permissible, does not check the tendency of the metal to fracture in the edges of the base under the reversed strains of the gagging process. The cold rolling reduces the ductility, the same as though greater additions were made of carbon or phosphorus. The fractures in the base of the cold rolled rails are not confined to the letter A, representing the top of the ingot, as is generally understood, but are distributed through the entire rails of the ingot and in a few cases have been identified as confined to a single ingot of the heat. Out of 201 specimens of broken rails, 43 were A, 46 B, 33 C, and 18 D rails. The latter form the smallest percentage of any of the letters in the track, for the reason that in long ingots they generally make the most seconds and are rejected as second-class rails. There were 61 rails out of 201 specimens in which the letter had become so oxidized as to prevent identification. The A rails formed about 21 per cent. of the letters identified, the B 22 per cent., the C 18 per cent., and the D about 9 per cent.

The base failures I have described are those of my observation under high speed trains where the temperatures were 20 to 30 degrees below zero Fahr. for several consecutive days. The winter of 1906 and 1907 had the longest protracted periods of low temperatures, in many localities that the weather bureau has yet recorded, and I did not see more than one or two direct tension breaks, all of the fractures being developments of injuries, strains or defects in manufacture, coincident with the combined cold and heavy service. These are technical problems for the rolling mills and the railroads to investigate and solve.

The low temperature has two effects upon the ordinary Bessemer steel rails: First, to raise the elastic limit and increase its fragility under shocks. Second, to set up thermal stresses due to contraction before the ends of the rails slip in the splice bars.

Each fall in temperature of one degree Fahr. sets up a stress of 200 lbs. per square inch of the area of the section where the ends of the rails are held firm. The friction of the splice bars per lineal inch of the 80 lb. rail of my sections, is 4,300 to 4,400 lbs., and for the 100 lb. splice bars it is 4,800 to 5,000 lbs. One half of a 36-in. 80 lb. splice bar would hold a tension of 77,000 lbs., and the 100 lb. splice bar 86,000 lbs. before the ends might slip in the splice bars. The most frequent base breakages are in the periods of low temperatures, and consequently affect the rails laid in cold, more than in warm climates.

**Head Failures.**

The numerous split heads in rails of recent years, called by the trackmen "piped rails" and which are found in all brands, occur more in some than in others. When the steel is cast in long ingots, the upper part is not deoxidized as much as the average, and with a well defined exterior envelope not securely connected to the spongy central core. The passing wheel loads cause the metal in the bearing surface to spread laterally and it becomes loosened from the central core underneath. The widening layer of metal eventually checks and splits that of the central core underneath. The surfaces of the vertical split discolor in a short time and are often reported by the trackmen as a flaw or pipe.

There are often one or more minute layers of ladle slag—(silicates of manganese)—from the chemical reactions of the recarburizer, ⅛ to ¼ of an inch under the bearing surface, which permits the metal to spread easily and split the metal underneath, particularly when there are small seams formed by the closing and elongating of small gas bubbles surrounded by segregated metal. The split may develop at the end, but more often occurs in one or two places in the quarters or centres of the rails. It sometimes starts and breaks from one side of the head and develops towards the centre and then across to the opposite side.

The spattering of the mould in pouring or when a heat must be pricked, seems responsible for some split heads; but the teeming of the ingots too quickly after recarburizing the steel, containing minute globules of silicate of manganese associated with insufficient deoxidized metal, seems to be a greater factor.

The central core of the upper part of the ingot is often a motley collection of segregates in the insufficient deoxidized metal which were rejected by the setting steel of the lower portions of the ingot and entrained before rising to the top. Some of the segregates, as ovoid bodies in the ingots, are drawn out in rolling into long cylinders and form the dark streaks in longitudinal etchings of the rails, while the white streaks are generally carbonless iron. The silicates of manganese as globules, are drawn out into threads in the section of the rails, resulting in a reduction of the solid volume in the heads, particularly when associated with insufficient deoxidized metal. The rapid wear, flow of metal and crushing of the rail ends, are to be expected from such conditions.

Pipes in ingots from shrinkage cavities or inclusions of ladle slag or vessel slag, ganister and split heads, would be "pipes" to the trackmen, but each requires a different metallurgical treatment for correction.

The consumer is expected to tell the manufacturer when the rails fail, which is but a small part of his privilege and duty; he must investigate and tell the manufacturer the reasons why they fail to meet the conditions of service. Transportation has made such rapid strides during the past two decades on the stiff rails as engineering structures and the demand of the commercial interests for more facilities, so pressing and insistent, that some things have been done to meet emergencies by both the consumer and manufacturer, obliging both to work nearer the upper margin of capacity than would otherwise have been done. Some manufacturers have shortened by one or two minutes the essential time after recarburizing the heats before teeming the ingots, while the consumer has been obliged to increase the wheel loads, expended tractive effort of the locomotives and speed of his trains to a degree only recently considered possible.

Two years ago to suggest to the manufacturer that slag was disseminated through the steel in the rail head, was met by what he considered just indignation as to the correctness of this statement, but when shown to him, he no longer doubts but takes measures for its elimination. The steel

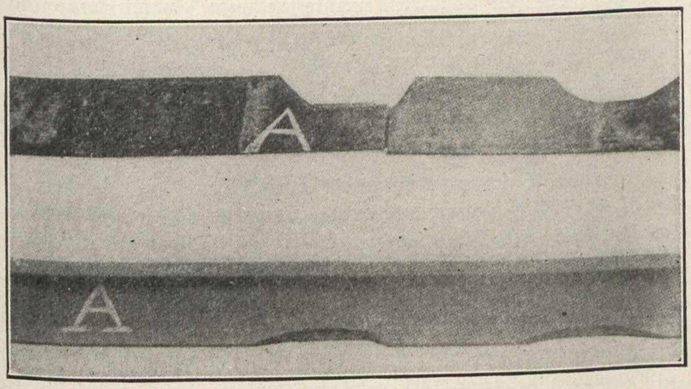


**Fig. 3.**

N. Y. C. & H. R. R. R.—100 lb. rail—L. S. Co.—1904. Two crescent shaped pieces broken from base of rail. The development of checks or strains under the straightening press in manufacture. One of these checks or strains contributed with seams of manufacture in the base, to its detailed fracture and shear of the remaining part of the section and is typical of rail breakages in cold climates. The check adjacent to the shear of the web started from the underside and also split near the median line of the base, while the opposite end is checked from the upper side of the base. The other crescent fracture checked from the underside of the base.

manufacturer has to contend with the storms quite as much as the rail user. The atmospheric moisture will not wash out or submerge the manufacturer's plant, but the amount of moisture which in humid weather, will go into the blast furnace will change the character of the product.

The Bessemer converter uses for the conversion of each ton of metal, five to six-tenths of a ton of air, and whether each cubic foot of air contains one, or six to eight grains of moisture is felt at once in the Bessemer department and the rail mill by increased difficulties of manufacture, not easily surmounted.*

It is gratifying for me to find that from independent investigation that the consumer and manufacturer are arriving at the same facts and conclusions from which mutual benefits will result.

* The "dry blast" was applied to the Bessemer Converter at the South Works—Illinois Steel Co.—a few days after this paper was read and with beneficial results. P.H.D.

---

The modern development of the electrical business in Japan has resulted in such a large demand for electric wire that the annual sale of the article now amounts to about $8,000,000. Of this, $5,000,000 worth is imported from abroad. It is admitted that the imported wire excels the home-made in quality, and is generally used in warships, steamers, and also for underground work. The art of electric wire manufacture has, however, made rapid strides in Japan of late years, and this, coupled with the ample supply of cheap copper, has reduced the cost of production, with the result that the wire is offered at a price considerably lower than is charged for the imported article. The Sumitomo firm has now under consideration the establishment of an electric wire factory. The Furukawa Copper Mining Office has also decided to erect a factory working in conjunction with the Yokohama Electric Wire Company, taking up one-half of the latter firm's capital ($1,200,000).

## RECENT TENDENCIES IN SEWAGE DISPOSAL PRACTICE.*

Advances in the art of sewage disposal by processes of rapid treatment have been made almost wholly in England. It is natural that such should have been the case, since the concentration of population in that country renders some method of treatment necessary, and since the lack of sandy soil makes the method of intermittent filtration impracticable. The first steps were taken by Dibdin in the London and Sutton experiments of 1892-96, which proved that the contact bed was capable of successfully treating sewage at high rates. Meanwhile, Cameron's septic tank, installed at Exeter in 1896, was demonstrating the anaerobic process of preliminary treatment. At both Sutton and Exeter septic tanks, followed by contact beds, have since been installed. At London the system of chemical precipitation remains essentially as it was in 1892. The experiments carried out by Clowes and Houston in 1898-1901 led, however, to the recommendation that instead of this process there be substituted (a) sedimentation of mineral matter; (b) septic treatment in tanks of six hours' capacity; and (c) treatment in single-contact beds of coke 6 ft. deep.

The next important series of investigations was that carried out at Manchester. This city, the third metropolis of England, has a population of half a million and a daily flow of 42 million gallons of strong industrial sewage. Chemical precipitaion was introduced in 1894, but the effluent created a nuisance in the ship canal into which it was discharged. No land was available for treatment, and in 1898 a commission consisting of Baldwin Latham, Percy Frankland and W. H. Perkins began a series of experiments on the newer rapid methods. The first report, made in 1899, concluded that in spite of the presence of industrial wastes, the "bacterial system is the system best adapted for the purification of the sewage of Manchester." The experts believed that double-contact beds would produce a satisfactory effluent. "It may be taken broadly that in the first contact 50 per cent. of the dissolved impurity is removed and that in the second contact 50 per cent. of the impurity still remaining in the effluent is disposed of." They held that "in order that a bacterial contact bed may exercise its full powers of purification it is necessary (a) that it should be allowed sufficiently frequent and prolonged periods of rest; (b) that the sewage applied to it should, as far as possible, be free from suspended matters; and (c) that the sewage applied to it should be of as uniform a character as possible." They therefore recommended the installation of open septic tanks and double-contact beds. The secondary beds have not yet been constructed, but 46 acres of primary beds were in operation in 1904 (Baker, 1904).

The next important investigations were carried out at another great manufacturing centre, Leeds. Here some experiments were made in 1870 which led to the adoption of chemical precipitation. In 1894 a special commission recommended broad irrigation, but sufficient land was not available. In 1897 investigations were begun by T. Hewson, W. H. Harrison and T. W. Harding, and reports have been made in 1898, 1900 and 1905. It was found that the double-contact process gave good results with crude sewage and excellent results with septic effluent, but that serious difficulty was experienced in maintaining the capacity of the primary beds. Trickling filters of fine material gave good results, but clogged badly. It was finally recommended by the Leeds experts that coarse, trickling filters be installed, either preceded by septic or chemical treatment or followed by subsequent sedimentation. Construction has been delayed on account of legal and political obstacles.

Birmingham, the fourth largest city in England, with a population of 800,000, has faced similar difficulties. The discharge of sewage into the River Tame was begun in 1852. In 1859 experiments were carried out which led, in 1872, to the installation of chemical precipitation tanks and a sewage farm. Recently a most elaborate series of large-scale experiments, unfortunately never reported in print have been carried

* C. E. A. Winslow and Earle B. Phelps in Public Works.

out by Watson, the city engineer, and have indicated the application of biological processes. In 1900 a beginning was made by converting the precipitation basins into septic tanks. The sewage is now first settled for about four hours in tanks which are cleaned once a week. Thence it passes through the open septic tanks, which have a capacity of eight hours' dry-weather flow. No sludge had been removed from these tanks after three-and-a-half years of operation. The septic effluent is then treated on the largest farm in England, 2,830 acres in extent, of which 1,784 acres are in actual use. It is planned in the future to settle the septic effluent in Dortmund tanks and to purify it by passage through trickling beds, of which four were in operation in 1904.

Experiments second in importance only to those mentioned have been carried out at other large cities in England. At Leicester in 1898-99 a series of investigations was made by E. G. Mawbey, involving sixteen combinations of detritus tanks, settling tanks, single, double, and triple contact beds, and land treatment. Most of these experiments were unfortunately of very short duration. At present the Beaumont-Leys sewage farm of 1,700 acres is still in operation, but the installation of settling tanks and single-contact beds is planned for the near future. Huddersfield has a serious problem in the presence of large amounts of industrial waste from the scouring and dyeing of wool; but it was shown in a series of experiments carried out between 1898 and 1900 by J. L. Campbell that chemical treatment, sedimentation, and contact treatment would solve the difficulty satisfactorily. At certain hours of the day a single treatment would be sufficient, while at other times secondary beds should be used. Triple-contact beds treating crude sewage gave good purification, but clogged badly. At Oldham studies carried out by J. B. Wilkinson from 1898 to 1900 led to the adoption of sedimentation and single-contact beds. At York chemical treatment has proved unsatisfactory, and since 1899 investigations have been carried on by A. Creer, which indicated that septic tanks and trickling filters would best solve the problem. Large scale experimental filters have been put in operation, but the final construction is not yet under way.

The review of existing conditions in 1904, published by M. N. Baker (1904), describes some of the most interesting plants in actual operation. At Manchester, Sutton, Exeter, Yeovil, Barrhead, Oldham and Burnley he found septic tanks and contact filters. At Birmingham, Salford, Accrington and York trickling filters were in operation. There is a strong general tendency to the conversion of old chemical precipitation systems into septic tanks, except at Glasgow, where the former process is to be maintained. Sewage farming is not extending, although it has its strong advocates, and many of the farms now in use operate satisfactorily. The popularity of double-contact beds, at a maximum five years ago, seems already on the wane. Trickling filters, either preceded or followed by septic treatment or sedimentation, are growing in favor.

The general progress of sewage disposal in England has been seriously checked by the Local Government Board, which enjoys extraordinary authority over any exercise of the borrowing power on the parts of municipal corporations. The Sewage of Towns Commission had reported in 1865 that "the right way to dispose of town sewage is to apply it continuously to land, and it is only by such application that the pollution of rivers can be avoided." The Rivers Pollution Commission in its five report from 1870 to 1874 recommended intermittent filtration as the best method for sewage treatment, with broad irrigation next, and chemical precipitation last. The Metropolitan Sewage Commission of 1882 reported in 1884 that chemical precipitation should be adopted by London, and that the effluent should finally be treated on land. The Local Government Board, on the strength of these precedents, has maintained a position of extreme conservatism, requiring, save in exceptional cases, that "any scheme of sewage disposal for which money is to be borrowed with their sanction should provide for the application of the sewage or effluent to an adequate area of suitable land before its discharge into a stream." The following detailed rules of the Board were set forth in a circular issued in 1900: "In any sewage works three times the dry-weather flow must be treated, and an equivalent amount in addition must be provided for by special storm-water filters. Septic tanks or sedimentation basins must have a capacity equal to the dry-weather flow if followed by double-contact beds, and 50 per cent. larger if followed by single-contact or trickling filters. Contact beds must not be over 4 ft. deep and may receive two fillings a day, or three if automatic devices are provided. Their capacity shall be figured on an open space of 33 per cent. with preliminary septic treatment or sedimentation, and of 25 per cent. with crude sewage. Trickling filters must be at least 6 ft. deep, and may operate at a rate of 1,000,000 gallons per acre per day with crude sewage, which may be doubled with sedimented sewage or septic effluent. The effluent from either the contact or the trickling process must be subsequently treated on land, 1 acre being allowed for every 1,000 persons contributing sewage. With crude sewage on land 150 persons per acre is the limit."

In view of the experiments at London and Sutton, and at Leeds and Manchester, such rules were an almost intolerable burden, and with these facts in view a new Royal Commission was appointed 1898, with the Earl of Iddesleigh as chairman, to determine "what method or methods of treating and disposing of sewage (including any liquid from any factory or manufacturing process) may properly be adopted." This Commission made a first interim report of three volumes in 1901, a second on special chemical and bacteriological problems in 1903, and a third in two volumes on the treatment of trade effluents in 1903. Of a fourth report four volumes were issued in 1903 and 1904, three on the pollution of tidal waters, with special reference to contamination of shell-fish, and a fourth (in five parts) on the land treatment of sewage. The first interim report of 1901 accomplished the chief work of the Commission, since it contained the conclusion that "It is practicable to produce by artificial processes alone, either from sewage or from certain mixtures of sewage and trade refuse—such, for example, as are met with at Leeds and Manchester—effluents which will not putrefy, which would be classed as good according to ordinary chemical standards, and which might be discharged into a stream without fear of creating a nuisance. We think, therefore, that there are cases in which the Local Government Board would be justified in modifying, under proper safeguards, the present rule as regards the application of sewage to land." The conclusions of the Commission throw open the way for progress, and the development of the next decade may be watched with interest.

On the continent of Europe progress in sewage disposal has been much less rapid than in England. Germany is ahead of other countries in this respect, but even here the problem has not pressed heavily. The population is less dense and the rivers larger than in England. The installation of purification systems was slow, and when they were found necessary land for irrigation was generally available. The knowledge of the process of sewage farming dated from a visit to England made in the early seventies by a Berlin commission headed by Rudolf Virchow, and inspiration along more modern lines has similarly come from England. In 1897, of forty-three English cities with over 70,000 population twenty-three treated their sewage by irrigation or chemical precipitation. In Germany at the same time there were only nine cities with over 70,000 population having disposal systems, of which three were precipitation works and six sewage farms.

The most important experimental work carried out in Germany has been that of the experiment station of the Hygienic Institute of Hamburg. This was founded in 1894 to test various sewage purification processes, and placed under the charge of Dr. Dunbar as director. Experiments on the contact process were begun in 1897, and the studies at this station have done more than any others to elucidate the theory of the contact bed. The general results indicated that good effluents could be obtained from single-contact beds of fine material, but that under such conditions clogging occurred, which must necessitate the removal of the material for cleaning several times a year. Meanwhile, Schweder had installed, in 1897, an experimental septic tank and contact bed at Grosslichterfelde to treat part of the sewage of Berlin. A commission appointed by the Prussian Ministry of the Interior studied this plant in 1897-98, and arrived at the same conclusion which Dunbar had reached in the case of Hamburg.

In 1901 the Royal Testing Station for Water Supply and Sewage Disposal was organized at Berlin, and its annual communications since 1902 have furnished a succession of papers of the greatest value. Unfavorable results were first reported from contact beds at Tempelhof and Charlottenburg. In 1901 Zahn (1901) on behalf of the station carried out a series of investigations at Charlottenburg (Westend) which showed that non-putrescrible effluents could be obtained with single contact. Experiments by Schury (1905) at Stuttgart led to similar results, septic treatment and single contact giving good results, little improved by secondary treatment. Trickling filters proved slightly better than contact beds.

The general trend of the German experimental work has, till recently, been in favor of single-contact treatment in beds of fine material, to be dug out and cleaned at intervals. Opinion is not favorable to the septic tank. Considerable interest has been recently manifested in the trickling filter, especially at Berlin. In spite of the great importance of the Hamburg work in relation to theoretical questions, the writers cannot feel that the German experiments have furnished a fair test of the modern biological processes. It is true that German sewage is strong and contains large amounts of industrial wastes, yet in addition to these facts it seems even to local observers that the experimental filters have not been operated with the judgment and skill necessary to secure the greatest practical efficiency.

Actual practice in Europe outside of England is still largely confined to chemical treatment and irrigation. In Germany in 1904, according to the official charts exhibited at the St. Louis Exposition, there were 254 cities with over 15,000 inhabitants. Twenty of these had no sewerage system. Of the remainder, 132 discharged their sewage into water, 84 treated it by various chemical processes, and 18 disposed of it on irrigation areas. Bredtschneider and Thumm were sent by the Berlin Royal Testing Station and the city of Charlottenburg to study English conditions in 1903, and their report, together with the results of the Hamburg and Berlin experiments, is likely to bear fruit in the near future. In France, too, active interest is manifested in the newer processes. A commission including MM. Calmette, Beckman, and Lannay visited England in 1900 to examine the works there in operation, and later experiments showed that the sewage of Lille could be satisfactorily treated in septic tanks and double-contact beds.

In the United States sewage disposal practice necessarily varies widely in different localities. New England, covered with a mantle of glacial drift, finds the Lawrence method of intermittent filtration through sand eminently satisfactory. Following the construction of the beds at Framingham in 1889 and at Gardner and Marlboro in 1891, plants of this type have been rapidly added in Massachusetts till in 1903 there were twenty-three intermittent filtration areas in the State. In Connecticut in 1902 there were nine plants in operation, all sand filter beds. West of the Appalachian Mountains soil conditions change, and available areas of sand become more and more difficult to obtain. The septic tank is frequently called in to remove solids and make possible the treatment of sewage at more rapid rates. The plants at Saratoga, N.Y., Lake Forest, Ill., and Wauwatosa, Wis., are good examples of this type. In the middle west the newer biological processes are rapidly gaining a foothold.

The first septic tanks at Urbana, Ill. (1894), and Champaign, Ill., have been mentioned. Septic tanks have since been installed at Kewanee, Ill. (1898), Fond du Lac, Wis. (1901), Madison, Wis. (1901), Mansfield, Ohio (1902), and a score of other places. The construction of contact beds began about 1900 and some dozen plants are now in operation, the most important being at Mansfield, Ohio. In 1905 there were in Ohio thirty-two purification plants, of which nineteen were sand filters and seven contact beds; thirteen made use of septic tanks at some stage in the process. The only trickling filter of large size is at Madison, Wis.

Most of the plants in the middle west are small, and in many cases their maintenance is grossly neglected. The city of Columbus is the first American municipality to approach the subject with a serious intention of finding the method of treatment best suited to local conditions. Here, under the direction of Hering and Fuller, a testing station was equipped in 1904, and a force of experts, including G. A. Johnson, W. E. Copeland and A. E. Kimberley, carried out for a year an elaborate series of experiments. The station included a laboratory, one set of open tanks for preliminary treatment, and three sets of filters, with a gallery under a frame covering for each set. The sewage, amounting to about 350,000 gallons per day, was raised by a centrifugal pump to a screen chamber with two movable screens of ⅜-inch diagonal wire mesh. Next it passed to one of the tanks for preliminary treatment. These were seven in number, each 40 ft. by 8 ft., 8 ft. deep at the upper end and 9 ft. deep at the lower end, built of wood lined with galvanized iron. The first two tanks were called grit chambers, the sewage flowing through in about one-and-a-half hours. The other five tanks were either "plain sedimentation" or septic tanks, in which the sewage remained eight hours or more, the difference being that the former were emptied and cleaned whenever septic action began. In the septic tanks periods of eight, sixteen and twenty-four hours were compared.

The sewage after treatment by one of these three preliminary processes (grit chamber, plain sedimentation basin, or septic tank) was purified by treatment in one or more of thirty-five experimental filters. These were cypress tanks 6 ft. deep; one was 11 ft. in diameter, four 12 ft. 10¾ in. in diameter, and the other thirty 7½ ft. in diameter. They were all open filters and arranged for the most part in two blocks of two rows each, with a covered dosing and sampling gallery between the rows, in which all the engineering details of operation were regulated with the greatest accuracy. Twenty-one were intermittent sand filters, two primary and four secondary contact beds of broken limestone, two coke strainers, and six trickling filters. With this plant the widest possible series of combinations was tried, including sand filters, trickling filters, and contact beds alone, either of these preceded by plain sedimentation of septic treatment, and sand filters preceded by contact or trickling filters. The results of the experiments have led to the recommendation of septic treatment, following by trickling beds.

In the extreme west a third set of conditions confronts the sewage expert. The arid climate here makes the sewage of special value for irrigation and the sparseness of population renders sewage farming the most profitable means of treatment. Following the early broad irrigation areas at Cheyenne, Wyo. (1883), Greeley, Colo. (1890), Hastings Nebraska (1892), Los Angeles, California (1892), Trinidad, Colorado (1892), a dozen or more plants have been laid out and are in operation. the largest in 1904 being at Los Angeles, Cal., Salt Lake City, Utah, and Hastings, Nebr. Chemical precipitation plants, built before the newer processes were developed, are maintained at Alliance and Canton, Ohio, and at other places to avoid the cost of change. At Providence, R.I., on account of special local conditions, this process seems well adapted for continued use.

In a comprehensive review of conditions in the United States, Fuller (1905) states that of 1,524 cities and towns with a population over 3,000, 1,100 have sewerage systems and ninety have purification plants. Among these ninety plants are fourteen irrigation areas, forty-one intermittent sand filters, thirteen chemical precipitation works, twenty-nine septic tanks, and ten rapid filters of coarse materials. The fact that of a population of 28,000,000 connected with sewerage systems the sewage of 20,400,000 is discharged into fresh water and of 6,500,000 into the sea furnishes some indication of the problem which must be met in the near future.

## WATER PROBLEMS OF THE MIDDLE WEST.*

**R. J. Manion, M.D., Fort William, Ont.**

Water is one of the first necessitities of life. Without it no vegetable or animal life could exist upon the earth. It is a vital element of our food, and a man could probably not live more than ten days without it. It preserves the fluidity of the blood, aids the excretions by flushing the bowels, kidneys and skin, and assists in maintaining a normal temperature. It is necessary for drinking, cooking and for personal and household cleanliness. The community at large requires it for public baths and drinking fountains, for flushing sewers and cleaning streets. It is therefore necessary that the supply should be plentiful as well as pure.

The fact is being brought home to the public that the first necessity of a municipality is a pure water supply. The Toronto Globe in its campaign in favor of the by-law for the city of Toronto to spend $750,000 on a filtration system to filter the waters of Lake Ontario wisely remarks, " We could say no more magnificent thing of the city than that its water supply is of absolute purity." This by-law was passed in June last.

Nothing is so costly in all ways as disease, and nothing is so remunerative as the outlay that augments health.

The ancient Romans knew well the value of a good water supply, and of many of the other laws of sanitation. Their Cloaca Maxima for the disposal of sewage, and their aqueducts for conveying water from the hills many miles to the city of Rome were works of such magnitude that they have seldom been surpassed even at the present day. One of these aqueducts, the Pont du Gard is described in the lectures of John L. Stoddard. By the words of Mr. Stoddard one realizes not only the great hygienic knowledge, but also the highly developed engineering and architectural ability of the ancient Roman civilization. He says, " I shall never forget the moment when, turning the corner of a sombre gorge, I suddenly beheld above a mass of oaks and olive trees, the form of this stupendous aqueduct. It is a granite chain uniting two mountains and crossing the flowing waters of the River Gard in a series of perfectly preserved arches, the highest of which rises one hundred and sixty feet above the gorge. Of all the Roman aqueducts which I have ever seen, including that of Segovia in Spain, none has impressed me as the Pont du Gard. So solidly is it constructed that even now, after the lapse of nineteen hundred years, it is still well nigh perfect, and joins the opposite hills with perfectly fitting blocks of stone so huge that one conjectures in amazement how they could have ever been placed in their position." And still others of these works are still standing as monuments to the sanitary knowledge possessed thousands of years ago by the Romans.

A scheme which is being worked out on this continent, and which in magnitude will outclass the Roman works, is that by which the city of New York will bring its water supply from the Catskill Mountains at a cost of $160,000,000.

Parkes says that in ancient Rome the supply of water was certainly not less than 300 gallons per head per day for a population of one million, or about ten times as much per head as we would consider a sufficient supply to-day. The ancients used a great deal of this supply for public baths and fountains. There is good reason to believe that the Chinese and Egyptians many centuries before the Christian era, obtained water from great depths below the surface of the earth by means of artesian wells, and yet the practice of making deep borings for water was not introduced among Western nations until compartively recent times. It has been said also that the Egyptians had an almost perfect system of ventilation in their tombs in the pyramids. So in the laws of public health, as in many of the lost arts, the ancients were before us.

Practically all drinking water has at some time or other fallen upon the earth from the atmosphere in the form of rain, hail, snow or dew.

Rain water is sometimes used as a source of water supply, but because of its uncertainty of amount and distribution, it is not a good source to depend upon. In some of the continental cities rain water is collected in underground reservoirs, and constitutes almost the sole source of fresh water supply to the inhabitants. Rain water, being the product of atmospheric distillation it should be, theoretically, pure, but unfortunately as it falls it carries down the impurities of the air such as gases, soot and bacteria. Thus rain is a great purifier of the air, so explaining why the air seems so pure and clear after a shower. Rain water is especially useful for cooking and washing because of its softness, that is its freedom from the salts of lime and magnesia. When hardness is due to carbonate of calcium or lime, it can be removed by boiling, for this reason being termed temporary. Otherwise it is said to be permanent. Hard water causes great waste of soap and fuel.

Surface waters, as streams, rivers and lakes, are frequently used as sources of supply. Streams and rivers being the natural drainage channels of the surrounding country, are not, generally speaking, good as water sources. But a water supply taken from rivers or smaller steams, not polluted by the refuse and sewage from towns, factories or cultivated lands higher up the stream may be fairly pure and safe for use. Such water may be tinged slightly with vegetable or mineral matter, but in general such coloration is not harmful. On the contrary, streams which have received any sewage or refuse should be considered at least suspicious, as sewage may at any time add to the water the germs of disease.

Water from large fresh water lakes will be of good quality providing it be taken sufficiently far from the shore to be sure that it is not contaminated with excreta. Many cities and towns obtaining their water supply from lakes and rivers have sedimentation and filtration plants, where the water can be treated before use.

Wells are of different kinds, as shallow, deep and artesian. Shallow wells are, generally speaking, not a good source of supply, although many villages and the outskirts of some towns get their sole supply from this source. Shallow well water may be pure, providing that sufficient of the surrounding land is protected from pollution, but frequently water from shallow wells is grossly polluted, and it is a peculiar fact that this impure water is often clear, sparkling and palatable. I have seen in one house a number of cases of fever caused by a shallow well behind the house and have had to have the well closed because of this.

Deep wells are supplied by water which has usually travelled a long distance since it fell as rain upon the surface of the earth, so that this water is usually pure even when the well is situated in the midst of a large city, but, because of the limited quantity available, deep wells are not advisable, as the sole supply of a large community: but, for a temporary pure source for drinking purposes in times when the regular supply is dangerous they are excellent. This has been well proved to me in my own city in the past three years where a well 150 feet deep has given us our only pure Adam's ale. I will speak more of this later. A well may sometimes be called deep when it is not of great depth, but when the boring goes through one or more impermeable strata.

Artesian wells, so-called from the province of Artois in France where they have long been used, are formed when a boring taps a subterranean reservoir which is basin-shaped because of being confined between two impermeable strata so that the water in trying to reach its level spouts out the mouth of the boring. Among the deepest artesian wells in the world are those at Grenelle in Paris, 1,800 feet deep, and at Kissingen in Bavaria 1,878 feet. The same remarks apply to artesian as to ordinary deep wells.

To sum up, the purest waters are from deep wells, deep spring sand upland surfaces, while the waters from the subsoil, from cultivated surfaces and from rivers are especially liable to be organically polluted. I think I might add to the pure waters those of large lakes such as the Great Lakes

* Read before the American Health Association.

between Canada and the Republic to the south, providing the water is taken far enough from the shore. An eminent physician of Toronto one time made the statement to me that he considered the waters of Lake Ontario much more pure than those of Lake Superior and Lake Erie, because of the thorough aeration which the water is subjected to as it plunges over Niagara Falls. However, I notice that the people of Toronto are not taking any chances for they are putting in a very expensive filtration plant to filter the waters of Lake Ontario.

Impure water is the cause of many diseases.

Diarrhœa is very commonly caused by a change in drinking water, and passengers are well advised in passing from the East to the West of Canada to drink only mineral waters or light wines at least till they become acclimatized. Typhoid fever in a great majority of cases may be traced to the water supply. One of the surest ways of judging the purity of the water supplied to a city is by its typhoid fever death rate. Most epidemics are caused by impure water, and I saw in my own city in one year 900 cases of the disease in a population of 9,000 due almost solely to a contaminated water supply. Asiatic cholera, diphtheria and scarlet fever may no doubt be communicated in this manner. Even goitre appears to be influenced. Entozoa may be introduced into the body such as round and tape-worms. Also Bilharzia haematobium, which causes endemic haematuria in Egypt and Abyssinia, and the filaria sanguinis hominis which produces endemic chyluria in the tropics.

Metallic poisoning, such as that of lead and arsenic, may be caused by water dissolving these metals.

By power of accommodation and through long habit a community may become so protected against impure water as to manifest no striking symptoms while strangers may be seriously affected by it. But even in such a case the condition of those habitually using the water will be more or less depressed, and it appears certain that the health of a community always improves when an abundant and pure supply is given.

Purification of water may be carried on either on a large or small scale. A city at the present time can not have any more important subject than the purification of the water supplied to its citizens.

Nature's methods of purifying waters are sedimentation in lakes and rivers and percolation through the earth. And in artificial purification we have utilized these methods. Subsidence takes the place of sedimentation and filtration that of percolation. A third method is sometimes used, namely chemical treatment.

Chemical treatment consists in the addition to the water of some chemical such as alum, iron, or lime, and this is frequently followed by filtration

But the most popular, because the most efficient, purifier of water to-day is the sand and gravel filter. This filtration is frequently preceded by sedimentation where the water to be filtered is turbid even if only at intervals. This is unnecessary where the water comes from lakes or rivers with very slow current for the obvious reason that sedimentation takes place naturally. In cold climates such as ours filter beds should be covered. An essential in the management of all large filters is the daily bacteriological and chemical examination of the water before and after filtration.

Of the different methods of domestic purification boiling is the most commonly used. It destroys living organism and disease germs, but as it drives off the gases it leaves the water prone to take up other gases, sometimes impure. Boiling is very useful during epidemics.

Distillation gives a pure water but also drives off gases. Distillation of sea water is now carried out on board ships of His Majesty's navy and in the large steamships of the mercantile marine. As long as there is fuel on board a most wholesome water can be obtained.

Sterilizers are sometimes used, especially by armies on the march. A good example is the Forbes.

House filters, usually consisting of a tube of unglazed porcelain, are largely used, but unless given very great attention they are more likely to give impurities to a water than to take them from it. The Posteur-Chamberland is the most useful of these house filters.

Ice, unless known to be pure, should not be added to drinking water, as typhoid bacilli can live in ice.

Of the above forms of domestic purification boiling is the most useful, and, if it is done on three or four successive days, the spores, which escape destruction by the first boiling, have time to develop into adult bacteria and are destroyed by the next boiling.

The difference between filtration and boiling is that filtration removes the bacteria while boiling kills them.

What should be aimed at in a public water supply is to get, at its source, a pure water; but failing this, it should be efficiently purified before distribution. The sewage and water systems should not be too close to each other.

Thirty gallons per head daily is a good average amount, some of the European cities having more, many having less than this amount. In my own city of Fort William I had the importance of a pure water supply brought home to me very forcibly in the last three years. The city is situated on alluvial soil, north of the Kaministiquia River, and being only a few feet above the level of the river and very flat, sewage is rendered somewhat difficult. It has not been exactly a boom town, but it has grown very rapidly, and I can remember only a few years ago when water was delivered for all purposes by wagons which were filled on the banks of the Kaministiquia River with pails, the handiest spot being chosen, little heed being given to sewage contamination. The water was then sold to the citizens at fifteen or twenty cents per barrel. Ten years ago, as the city became of greater size and importance, a waterworks system was installed. To take water from Lake Superior or Loch Lomond would have greatly increased the cost of the system, so it was decided to go on using the Kaministiquia water, more particularly since it had been used for years and no markedly ill effects caused by it, as Fort William up to the time of the great epidemic in 1906 was a very healthy town. A pumping station was built on the bank of the river, just above the most populous part, but not above the whole town, and the intake pipe was made to reach for some distance up stream. Although this could not be claimed to be an absolutely pure water it was at that time a good water, as the river ran through a very thinly populated part of the country. As years passed the city grew greatly in size, the part of the city above the intake pipe much more populous, the district more thickly settled, and gradually the water of the river became more and more polluted. Typhoid fever became little by little more prevalent, but as the increase was gradual it required an epidemic to awaken the citizens to their danger and an awful awakening came.

The sewers from the west end of the city were emptying into the river above the intake pipe, and the population for twenty miles up the river had increased. To make matters worse, in the autumn of 1905 a steamer passing up the river dragging her anchor had broken the intake pipe about twelve feet from the shore, so that all the filth and sewage about the broken end was being sucked in and distributed by the city mains. The break was not discovered at first, and then there was some delay in its repair, as it was not repaired until about the end of January 1906. Then it was only a matter of a little less pollution. By the end of 1905 typhoid was increasing so rapidly that notices were put up and a proclamation issued instructing every one to boil all drinking river water. Of one prominent gentleman who bored before the waterworks system had been established, was reopened. The well water is clear, hard and pure. It was delivered in wagons to the citizens free of charge, and the public were advised to use it alone for drinking purposes. Many disregarded these orders, some openly boasting of drinking river water. Of one prominent gentleman who had asserted that he had never drunk anything but river water, it was said, that he had never drunk water in his life unless it was well diluted by good whisky. The typhoid fever increased so rapidly that in seven days in February 161 cases were reported, and for the whole month 412 cases. Many practising physicians were attacked.

It was during the latter part of February that I first practised in Fort William, and believe I am within the bounds when I say that for two months every physician in the city was attending from thirty to sixty patients per day. Dr. Douglas, of Montreal, arrived in the city the same day as I did, and he took charge of the outbreak for the city. He had all the houses where the disease broke out placarded, and had the inmates given all instructions as to isolation, disinfection and so forth, to prevent other cases occurring. He insisted on all physicians reporting new cases at once. He was assisted by Dr. Birdsdall, medical health officer, and the members of the Board of Health. He had the outbreak checked about the middle of April, after one of the worst epidemics in the history of Ontario.

Dr. Starkey, Professor of Hygiene in McGill University, Montreal, who was engaged on the recommendation of Dr. Hodgetts, I understand, to investigate this outbreak, gave in his report the following causes of the epidemic:—

First.—A polluted water supply.
Second.—Personal contact or personal infection.
Third.—The unsanitary condition of the ground due to
(a) Defective sewerage.
(b) The privy system.
(c) Want of proper garbage disposal.

On August 1st following the outbreak the medical health officer resigned and I was appointed. I continually kept before the public the importance of not using for drinking purposes unboiled water from any source except the deep well above mentioned. But despite all precautions some 200 cases occurred between July 1, 1906 and January 1, 1907. The main cause of this was to my mind the carelessness of a great many people in neglecting to act on the advice, and in drinking the Kaministiquia water, which was still running through the taps. This carelessness was unnecessary as the city was distributing free the pure water from the deep well.

The Board of Health has kept on from that time to the present impressing upon the citizens the importance of drinking unboiled only the well water, and gradually the whole city has realized how important is this advice as the following figures will show:—

| Year | Number of cases | Deaths | Pop. |
|---|---|---|---|
| Nov. 1, 1905—Nov. 1, 1906 | 900 | 90 | 9,000 |
| Nov. 1, 1906—Nov. 1, 1907 | 77 | 9 | 12,000 |
| Nov. 1, 1907—Aug. 1, 1908 | 9 | 0 | 15,000 |
| i.e., nine months past | | | |

That is, during the year of the epidemic there was one case of typhoid in every ten, and one death in every hundred people, whereas in the past nine months, only nine cases occurred with no deaths.

And the only change of importance was the carefulness of the citizens in regard to the water which they drank.

True the sewerage system has been improved, the privy system lessened, a method of garbage disposal introduced, and dairymen and soft drink manufacturers instructed to use only the deep well water for cleaning their utensils and so forth, but these are of minor importance in comparison to purer water being used for drinking purposes. As soon as the citizens had time to think they decided on procuring water from a more satisfactory source. As a temporary source it was decided to utilize Crescent Lake, a small body of water about three miles from the city and work was at once begun. But unfortunately the Crescent Lake scheme proved a failure, and so it has been necessary to wait till the permanent system shall be completed. For a permanent source they had a choice of installing a filtration system and taking the water from Lake Superior, or, of getting a water pure at its source from Loch Lomond. As the latter scheme involved a much smaller outlay it was decided upon.

John Galt, the consulting engineer, of Toronto, whose advice was asked, spoke in favour of this scheme. He describes the lake in the following words: "Loch Lomond is situated about seven miles from the city at an elevation of 333 feet above the Kaministiquia River. It is a beautiful body of soft, clear, pure water, free from all contamination, and a delightful water for all general and domestic purposes." Mr. Galt then gave the city the estimated cost and an outline of the necessary work. The lake is about ten square miles in extent and at some places is 200 feet deep. It is fed by an area of about fifty square miles, and, it is situated on a plateau among a range of hills south-west of the city. It has no source of pollution so long as the watershed is protected. Not only is the water of this lake perfect from a sanitary standpoint, but by damming the outlet at Carp River the supply would be abundant for a population of a quarter of a million. The supply will be brought to the city by a natural gravitation system. But as the lake is on the other side of Mt. McKay a tunnel one mile long and six feet square is being driven, and is nearly completed, through solid rock. A large reservoir has been built about one mile from the end of the tunnel, from which reservoir the water will be conveyed by cast iron piping under the river and distributed through the city mains, making it an engineering problem of large size. The work is being done under the supervision of H. Sydney Hancock, the city engineer, with the assistance of Captain John King. The whole scheme resembles that of Glasgow, Scotland, which brings its water by a gravitation system a distance of thirty-four miles from Loch Katrine, made immortal by the pen of Sir Walter Scott.

The cost of Fort William's system will be about $350,000, but the citizens were quite rightly so impressed with the importance of a pure water supply that the by-law in favor of the scheme carried practically unanimously. We hope to have the pure water of Loch Lomond running through our mains within six months, and from that time on I expect that our city will have at least as good a health record as that of any city in Canada. This is quite a large undertaking for a city of the size of Fort William, but I do not think any undertaking which can be handled too heavy when it has for its object the prevention of typhoid fever.

## NEW INCORPORATIONS.

**St. John, N.B.**—C. H. Peters' Sons, $199,000; W. Peters, jr.; F. A. Peters, E. Peters.

**Bolton, Ont.**—Bolton Telephone Company, $20,000; R. Smith, A. A. McFall, F. N. Leavens.

**Selkirk, Ont.**—Holmes Gas Company, $40,000; J. W. Holmes, W. C. Holmes, O. B. Holmes.

**Windsor, Ont.**—Regal Mining Company, $1,000,000. J. H. Means, E. C. Adams, Detroit; E. J. Kerby.

**Smith's Falls, Ont.**—Smith's Falls Pressed Brick Company, $75,000; H. S. Hunter, C. W. McBride, H. F. Smith.

**Beckston, Ont.**—Beckston Rural Telephone Company, $5,000; A J. Cumming, G. Bennett, W. Sloan, South Gower Township.

**Ottawa., Ont.**—Ross-Ballard Mining Company, $100,000; C. E. McCuaig, J. Boucher, J. S. Wilson. Union Construction Company, $40,000; J. O'Leary, P. J. O'Leary, M. O'Leary.

**Montreal.**—H. P. Labelle & Company, $150,000; H. P. Labelle, J. U. Poirier, C. Robert. Montreal Products Company, $500,000; A. Falconer, Westmount; H. S. Williams, W. Bovey, Montreal.

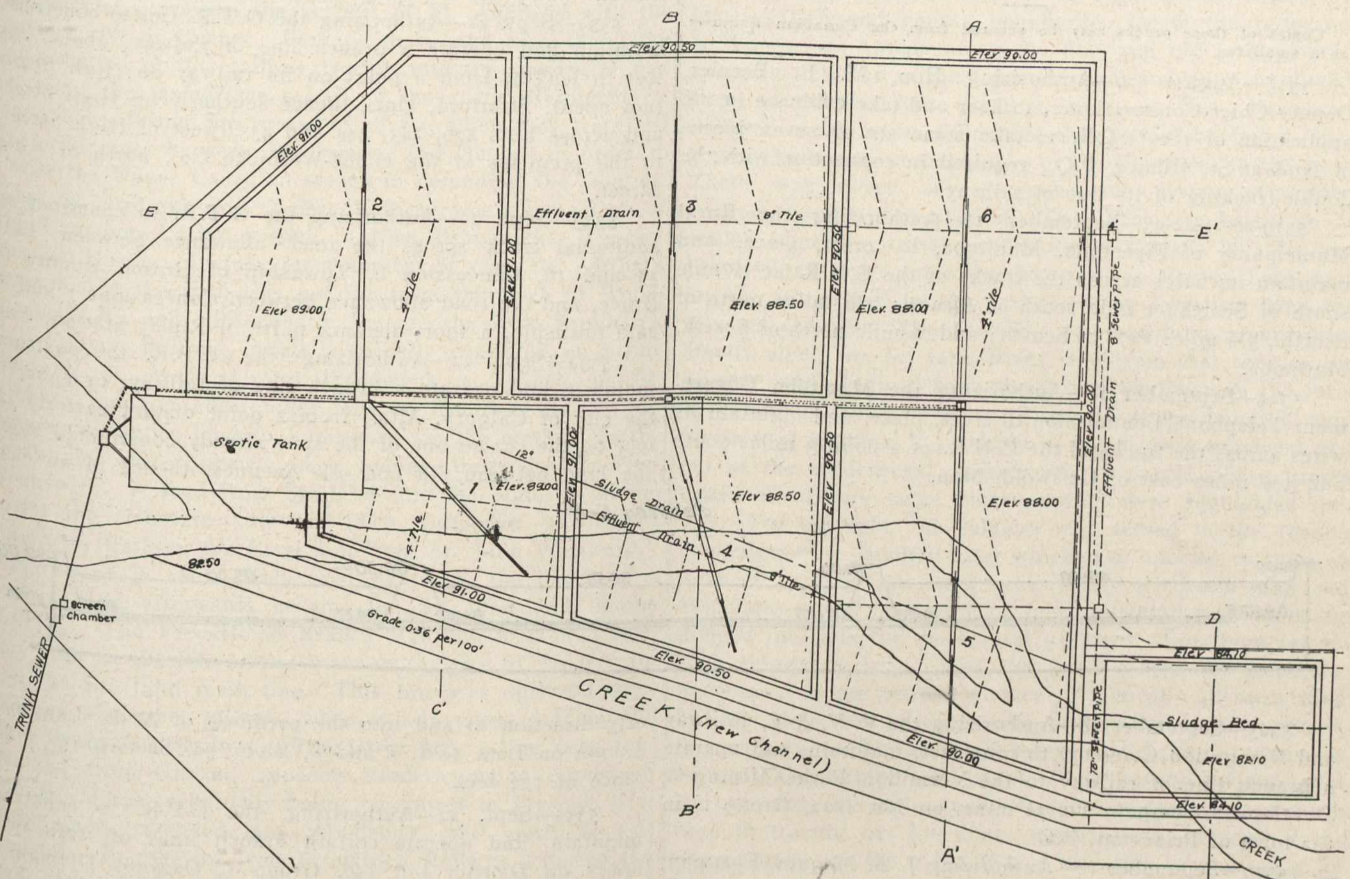
**Toronto.**—G. H. Doran Company, $40,000; G. H. Doran, W. E. Robertson, J. G. Kent. Toronto Cathedral School, $50,000; A. Sweatman, D. Kemp, G. W. Verral, jr. Lorsch & Gamey, $20,000; D. G. Lorsch, R. R. Gamey, S. Johnston.

About 60 per cent. of the total area of Japan is occupied by carefully preserved forests. For many centuries the governing authorities of the Empire have left nothing undone to conserve the forestry areas. At present the forests that are immediately under government supervision aggregate 58,000,000 acres.

## THE WATERLOO SEWAGE PLANT.

The following report of Messrs. Davis & Johnston, Consulting Engineers, Berlin, Ont, gives an idea of the new sewage disposal plant installed at Waterloo, Ont., at a cost of $26,993.08:—

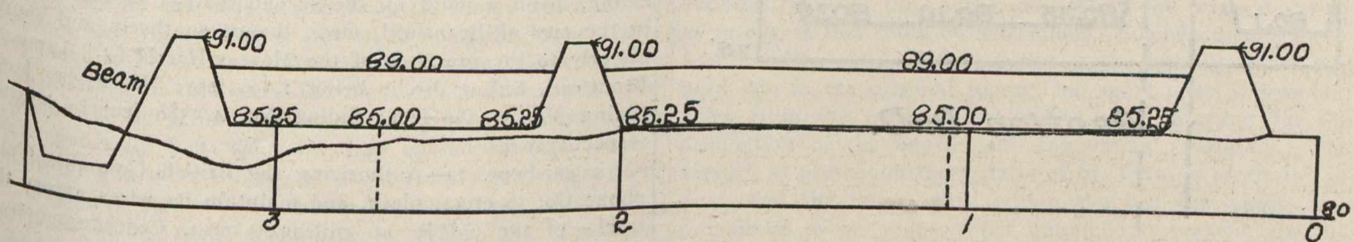
The trunk sewer extension is 4,363 feet in length. Fifteen-inch tile were laid to a fall of 1 in 500. This sewer




Filter Beds.

will, when running full, discharge about four times the present daily flow. The sewage disposal works are located on the site of an abandoned mill pond, and very little excavation was necessary to prepare the beds for the reception of filtering material.

A screen chamber is placed at the end of the trunk sewer on the right bank of the creek. After leaving this chamber the sewage is carried under the creek by a cast-




Section C-C'

iron inverted syphon to a valve chamber, in which are valves regulating the flow into a pair of septic tanks of a combined capacity of 259,000 gallons. These tanks are each 125 feet long, 26 feet wide and 6¼ feet deep. A grit chamber, 10 by 26 by 6 feet, is at the inlet end of each tank. The heavier matter in the sewage is deposited in the grit chamber; the sewage overflows into the main septic tank. In passing through the tanks the sewage flows alternately over and under concrete baffle walls, by means of which it is thoroughly distributed throughout the tanks.

The tanks, screen chamber, and valve chambers are constructed of concrete, the roofs of the tanks being reinforced with steel. The effluent from the tanks flows by gravitation through 15-inch earthenware pipes to the filter-beds, of which there are six. At each bed there is a valve chamber containing controlling valves for turning the sewage on or off the beds.

A sludge bed is provided for the reception of sludge from the tanks. The entire area of the filter beds is 3.03 acres. The filtering material is gravel, four feet in depth, procured from the hills adjacent to the works. A system of underdrainage carries off the filtrate to the creek. The daily flow of sewage, computed at the time the works were placed in commission, was 324,892 gallons, or 89,000 gallons per acre per day.

The following table shows the area of each bed and the amount of sewage each should receive per day. I would recommend, however, that for the present each bed should receive a treble dose, so that it will take three days to make the round of all the beds:—

| Bed. | Area in acres. | Daily dose, gallons. | Daily dose, time. Hrs. | Min. | Double dose, time. Hrs. | Min. | Treble dose, time. Hrs. | Min. |
|---|---|---|---|---|---|---|---|---|
| 1 | .305 | 27,279 | 2 | 0 | 4 | 0 | 6 | 0 |
| 2 | .662 | 59,249 | 4 | 22 | 8 | 44 | 13 | 5 |
| 3 | .844 | 75,538 | 5 | 35 | 11 | 10 | 16 | 46 |
| 4 | .495 | 44,302 | 3 | 16 | 6 | 32 | 9 | 48 |
| 5 | .666 | 59,607 | 4 | 24 | 8 | 48 | 13 | 12 |
| 6 | .663 | 59,338 | 4 | 23 | 8 | 46 | 13 | 9 |

It may be found in the future that some beds are capable of disposing of a larger dose than others, in which case it will be necessary to vary the above proportion.

Before freezing weather comes the whole of the filter beds should be ploughed into ridges at right angles with the distributor, the ridges about 18 inches apart and 12 inches deep. The doses will also require to be more frequent to keep out the frost.

## ORDERS OF THE RAILWAY COMMISSIONERS

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

5318—August 26—Authorizing Hon. M. E. Bernier, Deputy Chief Commissioner, to hear and take evidence in the application of the G.T.R. to take some six or seven pieces of land at St. Hilaire, P.Q., required in connection with the double-tracking of its line of railway.

5319-20-21-22-23—September 18—Authorizing the Rural Municipality of Pipestone, Manitoba, to erect, place, and maintain its wires across the tracks of the C.N.R. at ½ mile south of Scarth; 1 mile south of Agnew; 2½ miles north of Scarth; 5½ miles west of Scarth; and ½ mile north of Scarth, Manitoba.

5324—September 18—Authorizing the Manitoba Government Telephone Commission to erect, place, and maintain its wires across the tracks of the C.N.R. at a point 3 miles south and 3½ miles east of Griswold, Man.

5330—Sept. 22—Approving of the deviation of the G.T.R. branch lines or sidings extending from a point on the Toronto Belt Line Railway, south of Queen Street, Swansea, township of York, Ont., thence northerly, crossing Queen Street, to the premises of the Dominion Sewer Pipe Co., the construction of said spur line having been authorized by Order dated the 10th August, 1906.

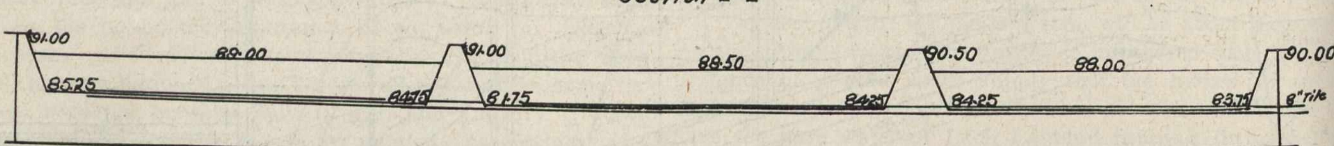
5331—Sept. 22—Authorizing the C.P.R. to operate the interlocking plant where the line known as "Molson's Cut-off" joins the old main line at Molson, Man.

5332—Sept. 22—Authorizing the G.T.R. Co. to construct, maintain and operate a branch line of railway, about 295 feet in length, from a point on its railway on High Street (not open), Stratford, Ont., thence southerly on High Street and across Lots 470, 443, 444 and 433, west of High Street, to the premises of the Globe-Wernicke Co., north of King Street.

5333—Sept. 22—Authorizing the G.T.R. to construct an additional track across the road allowance between Lots 15 and 16, Concession 8, Township of Huron, County of Bruce, and the road allowance between Concessions 7 and 8, said township, a short distance north of Ripley Station, Ont.

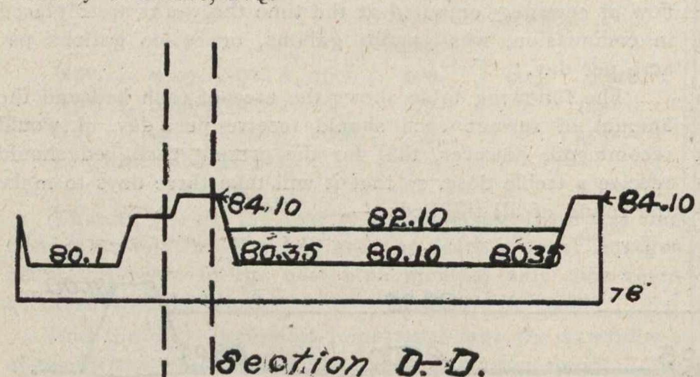
5334—Sept. 22—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway, or spur, in the city of Calgary, Alta., from a point distant easterly 25 feet on the centre line of the spur already constructed along the lane between 8th and 9th Avenues, thence in an easterly direction to and into the premises of A. L. Langman, situate on Lots 5, 6, 7 and 8, Block 50, Section 16, a distance of 172 feet.

Section E-E'




5325—September 18—Authorizing the V. V. & E. Railway and Navigation Company to construct, maintain, and operate a branch line of railway to the Vermilion Forks Mining & Developing Company's coal mine, on Lot 1822, Group 1, in the town of Princeton, B.C.

5326—September 18—Authorizing J. A. Moquin, Eastman, P.Q., to lay a 1½-inch water pipe under the tracks of the C.P.R. in Lot 1, Concession 9th Range, Township of Bolton, County of Brome, P.Q.




5327—Sept. 22—Authorizing the municipality of Wallace to erect, place and maintain its wires across the tracks of the C.N.R. between Sections 15 and 16-10-26, one mile south of Virden, Man.

5328—Sept. 22—Authorizing J. T. Bell, township of Morris, to lay a 3-inch water pipe across the tracks of the G.T.R. Co., just east of the road between Concessions 5 and 6, township of Morris, county of Morris, Ont.

5329—Sept. 22—Authorizing the C.P.R. to construct, maintain, and operate a branch line from a point on the centre line on the down main line track of the said railway at mileage 0.7, thence in a south-westerly direction across the corner of Outremont Avenue and across Manceau Street, to and into the premises of Wilfrid Talbot, in the town of Outremont, P.Q., a distance of 575 feet.

5335—Sept. 22—Authorizing the C.P.R. to construct, maintain, and operate certain branch lines of railway or spurs on District Lot 150, Group 1, Osoyoos Division of Yale District, at Enderby, B.C.

5336—Sept. 22—Authorizing the C.P.R. to construct bridges at the second crossing of Kicking Horse River on its field diversion, first crossing of Kicking Horse River on its field diversion, and at mileage 52.44, on its Chapleau section.

5337—Sept. 22—Authorizing the C.P.R. to construct bridge at mileage 144.4 of the Cranbrook section.

5338—Sept. 22—Authorizing the G.T.R. to construct, maintain, and operate certain branch lines of railway or sidings from a point on the second district of the G.T.R., in the city of Brantford, Ont., thence southerly and southeasterly to the premises of the Massey-Harris Co., Limited, Brantford, Siding No. 1 being 1,059 feet; No. 2, 717 feet; Siding No. 3, 380 feet; Siding No. 4, 580 feet in length, respectively.

5339—Sept. 22—Authorizing the British Columbia Telephone Co. to erect, place, and maintain its wires across the tracks of the C.P.R. at mileage 100.3, Cascade section, British Columbia.

5340 to 5342—Sept. 22—Authorizing the Manitoba Government Telephone Commission to erect, place, and maintain its wires across the tracks of the C.P.R. at Pilot Mound; Montcalm Street, St. Boniface, and 1¾ miles west of Thornhill, Manitoba.

5343—Sept 22—Authorizing the Bell Telephone Co. to erect, place, and maintain its wires across the tracks of the C.P.R. at Yonge and Cottingham Streets, Toronto, Ont.

5344—Sept. 22—Autnorizing the G.T.P.R. to operate its trains over the crossing where its line cross the track of the C.P.R. (Pheasant Hills Branch) in Section 27-29-22 W. second M., Saskatchewan.

5345—Sept. 22—Authorizing the Sarnia Electric Railway Co. to put into operation the interlocking plant at Sarnia, Ont., where the Sarnia Electric Railway crosses the G.T.R.

## RIGHTS OF WAY.*

**By William Ernest M'Mullen, St. John, N.B.**

In the year 1848 the first sod of the St. Andrews and Quebec Railway was turned, and after many vicissitudes the railway was opened for business about the year 1857. This was the first railway in New Brunswick, and, as its name implies, was projected to connect, for military as well as commercial purposes, the seaport of St. Andrews with the ancient city of Quebec. Perhaps those who encouraged the construction of this railway from a military standpoint had in mind the memorable march of the 104th Regiment on snowshoes during the winter of 1813-4, when they traversed the wilderness between Fredericton and Quebec in order to assist the Upper Canadian troops in defending the frontier. This St. Andrews and Quebec Railway was the nucleus of the Canadian Pacific system in New Brunswick. It never reached Quebec. In fact, for a number of years the northern terminus of the road was not far from the town of Woodstock, N.B., and subsequently became the New Brunswick and Canada Railway, which eventually consisted of a line between St. Andrews and Woodstock, a branch to St. Stephen, another eight miles long to Houlton, Maine, and another six miles long to Vanceboro, on the border. In the meantime other railways were being constructed in New Brunswick. A road from St. John into the State of Maine, under the elaborate title of "The European and North American Railway for Extension from St. John Westward," was opened in 1867. This road went into the hands of a receiver and afterwards became the St. John and Maine Railway. The Fredericton Branch Railway, a 22-mile line, was built in the late sixties between the city of Fredericton and the St. John main line. This line was operated until 1883 as a distinct railway, when it was taken over by the New Brunswick Railway. The latter was a line first constructed from Gibson, opposite Fredericton, to Aroostook County, Maine, eventually being continued to Presque Isle, Maine, and extended into Woodstock and north to Edmunston. In 1882 the New Brunswick Railway acquired the New Brunswick and Canada, and in 1883 the St. John and Maine, and the Fredericton Branch. After operating these lines until 1887, the New Brunswick Railway Company leased them to the Canadian Pacific for a thousand years less one. At the time when most of these lines were being located there was a railway hunger in the land. The land itself was worth so little without a railway that owners in many cases freely gave the right-of-way. In other cases the right to traverse properties with the railway track was verbally given, and in many cases at the present time, unless adverse possession can be shown, the right-of-way does not appear to extend beyond the ends of the sleepers. Some deeds of the right-of-way were obtained, but on most of the branch lines it seemed to be the exception rather than the rule when title was obtained in this way. On the Western Extension, however, as the St. John Main Line was commonly called, deeds were generally had when the line passed through settled territory, and after a lapse of about forty years, the writer, in making a right-of-way survey on these lines, was called upon to make their acquaintance. When the Canadian Pacific acquired the New Brunswick Railway System there were practically no reliable track or right-of-way data, such as profiles or plans showing railway lands and alignment. In the old days they seemed to scrape along without these things, but conditions are very different now. Competition is keen, and railways to be successful must be handled systematically in all their various departments. A railway spends money on power, and looks for it again in haulage tolls. The expenditure of power depends upon grades, curves, distance, and physical condition of roadbed, so that where these items can be improved it will mean less power in proportion to the tonnage, and consequently more profits. It will be seen that in order to know exactly where we are in the matter of grades and alignment, and where we would be as regards right-of-way, etc., in the event of any changes, a survey to obtain such information was very necessary. Not only this, but in connection with maintenance work, information is being continually asked for which involves much time and many special trips unless it is properly compiled after a comprehensive survey. It was conditions such as these that recently called for a re-survey of New Brunswick lines. The general scheme of the survey was to make a centre line traverse and tie in right-of-way fences, lot lines, parish and county boundaries, locate the properties of the various owners along the line, run rail levels, obtain approximately the original ground line, and note the dimensions of culverts, etc. Such a survey in New Brunswick involved many more difficulties than would be found in a similar survey in probably any of the Provinces to the west. There was never any comprehensive system of survey adopted by the Government. The Province began to be settled after the British occupation of Canada in 1760, and twenty-three years later the few settlers already here were largely augmented by the arrival of the Loyalists from the revolted colonies. The Loyalists received land grants principally along the St. John River, and from that time to the present land obtained from the Crown has been in the form of grants of any convenient size and shape being a subdivision of nothing but simply so much land surveyed and cut of the wilderness. Sometimes, of course, these grants consisted of very large blocks, which were subdivided into lots. For example, the soldiers who served in the 1812-14 campaign were granted land which was allotted to them in tiers of uniform lots, and occasionally a certain man and associates would be granted a large parcel, which would be divided into lots for the several grantees. But there are no such things as base lines and subdivisions as generally understood in the newer Provinces. Practically all lines, long or short, were run by the needle, and, as might be expected, the compass is the universal instrument used for their re-survey. The nature and extent of my survey did not, as I am sure you will understand, warrant the spending of much time in tracing out lot lines; nevertheless, in some cases where limits of the right-of-way and the proper tying in of my work depended upon determining them, I went to some trouble in doing so. Where party lines were marked by fences, and these checked with the lines on the original Crown Lands plans, they were usually accepted as the best evidence of the location of those lines. In a number of cases there were no fences, but original lines re-surveyed had been marked by blazes, and very frequently there was no trace whatever of an existing line. While the "Act" is silent as to method of re-survey, in laying down these lots upon paper I adopted what I believed the only reasonable one of proportioning surplus or deficiency between known lines and running them on the course intended in the original survey as nearly as this could be determined. Sometimes this direction could be obtained from a line in the vicinity, which had been run in the original survey, but more often it was laid down from the astronomical course after allowing for the declination of the needle and the annual variation. The former, at present in the vicinity of St. John, is about 20° 30' west, and the latter, until within the last few years, was considered to be about 3' per annum. At present the declination appears to be at its maximum, for there is no appreciable annual change.

The system of conveyancing in vogue in this Province gave me no little trouble in locating those portions of the right-of-way for which there were deeds. I do not know of one case in which these properties were located and described with reference to the lines of an original grant. Rarely the parcels were described by metes and bounds, but very frequently the description was similar to the following:—

**Conveyance from James Jones to the E. and N.A. Railway Company.**

All and singular that certain lot, piece and parcel of land situate, lying and being in the parish of Petersville, in the County of Queens and Province of New Brunswick, and described as follows:—

*Paper read before the Ontario Land Surveyors' Association.

Bounded on the north-westerly side by the lands of one James Belyea, on the south-easterly side by the lands of one Thomas Trott, on the north-easterly side by the lands of the said James Jones, and on the south-westerly side by the lands of the said James Jones, the same being a piece of land ninety-nine feet in width, running in a north-westerly and south-easterly direction, the same being a part of the farm now occupied by James Jones and his wife Margaret, and along, across and over which the said the European and North American Railway Company for extension from St. John westward are now building and laying, or intend to build and lay, the railway of the said company, which is to extend from the city of St. John westward to the eastern boundary of the State of Maine.

The difficulties attendant upon the location of this property forty years after the description was written are too apparent to require further explanation. I usually looked up some aged resident who was familiar with the property owners in the locality at that time or failing in this, I would then go to the Registry Office and endeavor to find a record of the grantor's deed. Quite likely the description here would be similar to the one in question in referring to contiguous owners for the bounds. Then the deeds of these owners would be referred to if they could be found. Sometimes people did not bother recording their deeds, and this would add to the difficulty. But in almost every case by enquiry or search the property was located. In the Registry Offices all conveyances are recorded under the names of Grantor and Grantees in alphabetical order. This is the only way in which they are recorded, there being no reference whatever to the original lot or grant, so that you would find the conveyance of John Smith's land in one parish indexed with John Smith's land in another. Registered plans would often have been of assistance in my survey, but these are remarkable by their absence. In the Registry Office for the city and county of St. John, where they have continuous records for the last 120 years, there are about 100 plans. In a couple of other Registry Offices that have been in existence from 80 to 100 years, I could carry all the plans of both offices very comfortably under my arm. I think some of the finest people in Canada live in New Brunswick, but I wish some of the good old-timers had provided a little different system of surveys and records.

For the field work two box cars were fitted up. The one with bunks and a drawing-table, and the other with a dining-table, stove, and quarters for the cook. The party, besides myself, was composed of a transitman and two picketmen, a draughtsman, a leveller and rodman, and three chainmen, who went ahead and paint-marked one rail every hundred feet. These last could cover eight or nine miles a day without much trouble, and, after getting their work well ahead of the party, were recalled to locate right-of-way, fences, culverts, etc. The leveller would cover about four and a half miles per day, and when he got too far ahead of the transit was recalled and ran a spare transit for a while. The transitman was paid $75 per month and draughtsman the same; leveller, $60, and the others, most of them engineering students, $1.35 per day. The cook got $40 per month. The average progress of the field work was a little over two miles a day, and the average cost of the field work, exclusive of car furnishings and inclusive of wages and board, was $14 per mile. The cost of fitting up the cars with stoves, bunks, blankets, mattresses, tables, dishes, etc., amounted to about $150. I was unable to obtain a draughtsman when the party first started out, and when I did he was never able to overtake the field work. This was the source of more or less trouble, and in prosecuting work of this kind again I would see to it that the drawing went along with the transit work, even if the plan had to be started in the middle of the survey. I found also that what seems easy and matter of course to a man who has seen a great deal of service in the field is not always so apparent to an engineering student. These young men are excellent in many ways, and much the better men for their training so far as it has gone, but we sometimes forget that they are yet schoolboys, and look too soon for ripened fruit.

In commencing the track traverse the instrument was plumbed over the zero of the chainage with the telescope directed to the pole. Readings were then taken to each hundred-foot station in succession, and finally to the foresight or turning point. These turns on curves were usually taken about every 500 feet, and from end to end of tangents. The following is the manner of entering the notes in the field books :—

| Station | B. S. | . S. | F. S. | Course | Remarks |
|---|---|---|---|---|---|
| 2324 + 50.5 | 2320 + 09.3 | | | S. 6° 14′ E. | |
| | | 2325 + 00 | | N. 5° 10′ W. | |
| | | 26 + 00 | | N. 2° 15′ W. | |
| | | 27 + 00 | | N. 0° 32′ E. | |
| | | 28 + 00 | | N. 3° 25′ E. | |
| | | | 29 + 00 | N. 6° 30′ E. | |
| 2329 + | 2324 + 50.5 | | | S. 6° 30′ W. | |

Observations for meridian were taken usually at intervals of two to five miles. Most of these were solar, but a number were also taken of the Pole star. The method adopted in observing the sun was as follows: The transit was set at one end of a tangent and sighted to a station at the other, the horizontal limb reading zero. The telescope having previously been levelled, and the index error (if any) noted, it is now directed towards the sun's easterly and lower limb if it be forenoon, or the easterly and upper limb if it be afternoon. After reading both horizontal and vertical limbs, the vertical arc and the lower horizontal plate are set free, the telescope plunged and revolved horizontally 180 degrees, and the first operation repeated. The following is the field book entry and record of the calculation. Latitude and longitude were obtained by scaling from an eight mile to the inch map.

## FIELD NOTES

HOULTON BRANCH JULY 13TH, 1907

| Obs. | Atlan. Std. Time | Limbs | Horizontal | Vertical | Station to Stn | |
|---|---|---|---|---|---|---|
| A. | 3.14 P. | U. E. | 159° 14′ R. | 49°59′ | 41 | 50 |
| B. | 3.21 P. | U. E. | 320° 18′ 30″ – A. | 48°59′ | | |

## CALCULATION

21° 56′ 31″ = Decln. at Noon
0° 00′ 54″ = Corr. for time of obs.

21 55 37 Decln. at time of obs.
(a) 68 4 23 Polar distance.

49° 59′ 00″ = Obs. alt.
49 Refrn.

49° 58′ 11″
6 Parallax

49° 58′ 17″
15 46 Semi. dia.

49° 42′ 31″
(b) 40 17 29 = Co-alt. or Z. dist.

46° 4′ 30″ = Lat.
(c) 43° 55′ 30″ = Co. Lat.

*Formula*

$$\cos.\ \tfrac{1}{2} A = \sqrt{\frac{\sin \tfrac{1}{2}s.\ \sin (\tfrac{1}{2}s. - a)}{\sin b \sin c}}$$

(a) 68° 4′ 23″
(b) Sin 40° 17′ 29″ = 9.810686
(c) " 43° 55′ 30″ = 9.841181

152° 17′ 22″ 9.651867

Sin 76 8 41 = 9.987175
68 4 23

Sin 8° 4′ 18″ = 9.147403

9.134578
9.651867

9.482711
9.741355 = Cos. 56° 32′ 48″

56° 32′ 48″ doubled = 113° 5′ 36″
Horizontal angle = 159° 14′
Semi dia. = 15′ 46″

N. 272° 35′ 22″ E.
A. = N. 87 24 38 W.
B. = N. 87 25 38 W.
Mean N. 87° 25′ 8″ W.

The above is not written for the benefit of the past masters present, but solely for the apprentices. It will be noticed that the calculation is not elaborate, and the work of observing is not troublesome when one has acquired the habit. The writer suggests a method similar to the one described as being exceedingly useful as a check in traverses of any considerable extent. It is hardly necessary to say that observations within an hour of noon are not satisfactory. With the transit carefully packed on a track velocipede, a man, unaided, can take a number of observations over, say, twenty miles within a day. The velocipede was also used for a number of observations taken at night, many of them taken without any assistance. A still night should be selected if possible, and the velocipede loaded with the transit, a small lantern with a reflector in it, and a few candles. It is better to have an assistant hold the lantern for you, but if necessary he can be dispensed with. Coming to the beginning of a tangent, a candle is lighted and set on the rail, then proceeding to the far end of the tangent the transit is plumbed over the rail and sighted to the lighted candle. No care was taken to observe the star at any particular time, such as at the elongation With an ordinary watch and the ample means along a railway of checking it, there is no difficulty in reading the time of an observation to a half minute, and the greatest error which can occur through the noting of the time is at the rate of half a minute of arc per minute of time, and becoming less the more distant the star is from the meridian.

The following are the field notes and calculation in connection with an observation of the Pole star:—

Obs Polaris June 11-12, 1907, between Welsford and Grand Bay.

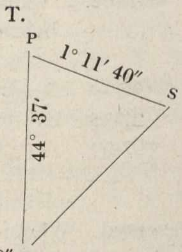
| | Mean Std. | Defln. | Lat. | Location |
|---|---|---|---|---|
| 1. | 8.57 p.m. | 58° 4′ R | 45° 25′ | Tan E. of Bayard |
| | 9.00 p.m. | 58° 6′ R | | |
| 2. | 9.54½ | 24° 44′ R | 45° 23′ | Blagdon |
| | 9.59 | 24° 42½′ R | | |

CALCULATION.—OBS. NO. 2.

$9^h\ 56^m\ 45^s$ mean of obs. times
— 25 30 difference between 60th Mer. and M. S. T.

9 31 15 mean time of obs.
8 8 29 transit of Polaris M. S. T.

1 22 46
$82^m\ 46^s$ ÷ 4 = 20° 41′ 30″ = P
½ P = 10° 20′ 45″




Cos 21° 42′ 40″ = 9.968044
Cos 22 54 20 = 9.964329

0.003715
Cot 10 20 45 = 10.738601

10.742316 = tan 79° 44′ 30″ z

Sin 21° 42′ 40″ = 9.568010
Sin 22 54 20 = 9.590188

9.977822
Cot 10 20 45 = 10.738601

10.716423 = tan 79° 7′ 30″

37′

44° 37′ = co-lat
+ 1° 11′ 40

45 48 40
22 54 20

44° 37′
− 1 11 40

43 25 20
21 42 40

24 43′ 15″ mean defln.
37′

N. 24° 6′ 15″ W

*Formula*

$$\tan \tfrac{1}{2}(s+z) = \frac{\cot \tfrac{1}{2} P \cos \tfrac{1}{2}(a-b)}{\cos \tfrac{1}{2}(a+b)}$$

$$\tan \tfrac{1}{2}(s-z) = \frac{\cot \tfrac{1}{2} P \sin \tfrac{1}{2}(a-b)}{\sin \tfrac{1}{2}(a+b)}$$

The method of plotting by tangents was adopted, and proved satisfactory as regards accuracy and speed. Many favor using latitudes and departures, and certainly there is no better method as regards accuracy, but I do not consider it quite so speedy as the former. In using latitudes and departures with odd distances it will be best to use tables of logarithms and logarithmic cosines and sines. I find these tables preferable to ordinary latitude and departure tables, even when the latter are taken out to minutes. The matter of obtaining the degree of curvature B.C and E.C. is an office job, and often a tedious one, becoming very complicated in the cases of compound and reverse curves. Where the curves were short, however, and the P.I. fell within the right-of-way, they were run to intersection and the external measured. By reference to a table of the elements of a one-degree curve the curvature and tangent distances can be at once obtained with very few figures.

In conclusion, I would say that my little party were very comfortable in their house on wheels, and, so far as the table was concerned, we lacked none of the ordinary requirements of civilized man. I contrast our favorable circumstances in these respects with my memory of the first bush survey—not an unpleasant memory by any means—in which we had to carry everything on the outside before we could wear it within us. A little incident in the matter of obtaining provisions, which may be of value to members of the profession and others, concludes this paper. Fresh beef and mutton was to be had without difficulty, but after a time certain members of the party sighed for a change, and looked with covetous eyes upon the hens which gathered their food beside our cars. Negotiations were opened with their owner without success; the hens were laying and were not for sale. When evening came the river was tried for fish, with no luck, and in a moment of abstraction, or something else, the fisherman left his baited line hanging out of the car window. The rest of the circumstances are very sad—for the parties concerned—but it is necessary to relate them in order to complete the story. The worm—and incidentally the hook—was swallowed by a thoughtless hen. Now, the men of the party were humane if anything, and after a brief consultation it was decided that an operation for the alienation of the hook must be performed in order to relieve the unfortunate fowl of that indigestible barb. The decision was carried into effect without delay, the principal instrument in the surgical operation being the ubiquitous survey axe. Unfortunately, from the standpoint of the hen, the operation was not a success, and she lost the number of her mess. Next day at noon she was accorded a decent, and, for a hen, a very fitting burial, at which most of the party were present and took an active part.

## RAILROAD EARNINGS.

| | Week ending. | 1907. | 1908. | Change. |
|---|---|---|---|---|
| C.P.R. | ........Sept. 21 | $1,426,000 | $1,471,000 | + $45,000 |
| G.T.R. | ........Sept. 21 | 954,411 | 854,563 | — 99,148 |
| T. & N. O. | ....Sept. 14 | 17,000 | 18,500 | + 1,50c |
| Montreal Street | .Sept. 19 | 74,350 | 73,230 | — 1,12c |
| Toronto Street | .Sept. 19 | 70,883 | 70,905 | + 22 |

The September issue of "Concrete and Constructional Engineering" shows the advance in reinforced concrete in this country in such illustrated articles as those dealing with this form of construction on the Great Eastern Railway, the Franco-British Exhibition, etc. It also contains an illustrated article descriptive of a series of reinforced concrete bridges in the United States and some important structures on the Continent.

Among the new uses to which concrete and reinforced concrete are being put we notice chimneys, a reinforced concrete lighthouse and coal bunkers, and last but not least in economical importance, reinforced concrete railway sleepers, which are intended to take the place of timber sleepers, which involve so much renewal.

Among the editorial notes we observe reference to a most important address by Sir Henry Tanner, the principal architect of H.M. Office of Works, on the progress of reinforced concrete in this country; and reference is also made to the newly formed Concrete Institute. Attention is also called to the use of concrete for docks and the much-discussed shipbuilding programme of the Government, for, as the journal indicates, the larger ships of His Majesty's navy certainly require improved dock accommodation.

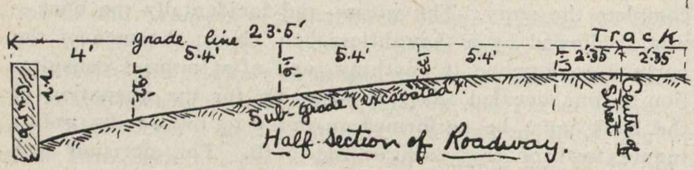
# CORRESPONDENCE

**[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. Ed.]**

## CALCULATING EXCAVATION.

Sir,—Some years ago when engaged in the detail of street improvement work I found the following to be a simple, accurate, and quick method of getting at the amount of excavation necessary for street paving work. In going over some old papers a few days ago I discovered it and, thinking it might be of interest to you and to possibly a number of municipal engineers throughout the country, I give you below a description of it.

I found it very handy, suited to a simple method of keeping a record of work done, and a much more rapid method than calculating the quantities in the ordinary way. This was for a Macadam Roadway.




If natural ground were to grade at each section, area of section would be:—$2 \{ 5 \times \frac{1}{2} (2.2 + 1.92) + 5.4 \times \frac{1}{2} (1.92 + 1.6) + 5.4 \times \frac{1}{2} (1.6 + 1.33) + 5.4 \times \frac{1}{2} (1.33 + 1.17) + 2.35 \times 1.17 \} = 74.5$ sq. ft.

Width of Section Excavated, 47 ft.

| Station. | Ground Elevation. N. side. | Ground Elevation. Centre. | Ground Elevation. S. side. | Average. | Grade. | Above or below grade. | Area to be added or deducted from above. | Area of section. | Cu. feet excavation. |
|---|---|---|---|---|---|---|---|---|---|
| W. Line of Hall St. | 96.03 | 96.39 | 96.57 | 96.35 | 96.20 | +0.15 | + 7.05 | 81.55 | |
| +50 | 97.16 | 97.23 | 96.82 | 97.11 | 97.05 | +0.06 | + 2.82 | 77.32 | 3,972 |
| 1+00 | 97.82 | 98.17 | 96.32 | 97.62 | +97.90 | —0.28 | —13.16 | 61.34 | 3,466 |

etc.,

Yours truly,
Chas. W. Dill.
The Chas. W. Dill & Co.,
Engineering-Contractors,
Toronto, Ont.

September, 1908.

## SYMBOLS FOR PHYSICAL QUANTITIES.

Sir,—Now that there has been some opportunity for discussing this question, may I be permitted to summarize the arguments that have been raised for and against the creation of new symbols?

The most common objection is, "They are like Chinese characters; we could never remember them." But there will be no necessity to remember them. How many of us can remember what symbol Rankine uses for kinetic energy? Is it not sufficient if we see it when we refer to his book? Every considerate writer gives a list of the symbols he uses. If all writers used the same symbols, we should soon become familiar with those with which we are most concerned, and for the rest, we would refer to the list just as at present.

Some objectors do not see why the list we have at present is not sufficient. Let them try to make a list of symbols for the two hundred physical quantities for which symbols are wanted. After they have made up a list to satisfy themselves (if such a thing is possible) let them try to convince someone else to adopt that list.

There are about twenty letters, such as **m** for "mass," **t** for "time," etc., upon which there is almost universal agreement. One or two dozen more stand a fair chance of being agreed upon. Beyond these there is hopeless confusion, simply because all the good letters are exhausted.

As to the difficulty of printing new symbols, it is of interest to know that twenty-five of the leading technical journals of the world published an article containing five new symbols, given as examples without any difficulty. Several of them have expressed the view that there is no difficulty from the printer's point of view. The types supplied to them—which, by the way, cost 1d. for thirty—were all of one size, and yet each paper used for the text of the article its usual standard type. The publisher of the "Elektrotechnische Zeitschrift" thinks that there would be no difficulty in arranging with a type founder to make matrixes from which all printers could be supplied with type. Each printer would keep in stock those types which commonly occurred in his paper, and could get others on short notice. About thirty new symbols would be sufficient for articles on electro-technical science.

Two papers have objected that the symbols cannot be set up on a linotype machine. It is, however, usual at the present time to set up mathematical expressions by hand.

Several critics have pointed out that the new symbols should be bold and simple in outline, so that they cannot be easily mistaken for one another. This is, of course, an important matter to bear in mind.

I agree with M. Galliot that the name of the symbol should be, where possible, the name of the physical unit represented. Where the name of the unit cannot be employed, a word of one syllable might be chosen, as, for instance, "stroke" for the length of a piston stroke.

Some critics say that the number of symbols required would be too great. As to that, we can make just as many as convenient. The symbol became universal almost as soon as it was printed. Let us have a few more as good as that one; we are badly in need of them.

Yours faithfully,
Miles Walker.

Leicester Road, Hale, Cheshire, Sept., 1908.

## SAFE SUPERIMPOSED LOADS.

Sir,—We have noted with some interest the article by Mr. J. Morrow Oxley, Ass. Member C.S., C.E., appearing in your issue of August 21st, page 583. We feel that it is only justice to call attention to the fact, that the table published as well as the formula is rather misleading. The formula

$$W = \frac{619h^2}{l^2}$$

is certainly not based on the city requirements. Further, we can state positively that should a building be designed in accordance with the table of safe loads published with the article, and submitted to the City Building Department, for permit, the permit would be refused and the plans rejected. We are not disputing Mr. Morrow Oxley's deductions as to what may or may not be good construction, simply make the statement as above, that plans based on this formula will not pass the City Building Inspectors.

Yours very truly, Gustave Kahn.

Trussed Concrete Steel Company.

Toronto, September 23rd, 1908.

---

Sir,—If Mr. Gustave Kahn would be good enough to point out in what respect floor slabs designed according to the formula deduced in the article referred to do not comply with the City Building By-Laws, I am sure he will do a valuable service to the reinforced concrete designers of the city.

Yours truly, J. Morrow Oxley.

September 30th, 1908.

## ENGINEERING SOCIETIES.

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, E. A. Evans, Quebec; 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.

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.

TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—96 King Street West, Toronto. Chairman, C. H. Mitchell; Secretary, T. C. Irving, Jr., Traders Bank Building.

MANITOBA BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Friday of each month, October to April, in University of Manitoba.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, J. G. Sing; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months. October 8th, Price Automatic Signal System, Mr. H. W. Price.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, W. G. Miller, Toronto; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, C. T. Pulfer, London, Ont.; Secretary-Treasurer, Alfred E. Uren, 62 Church Street, Toronto.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO BRANCH).—W. G. Chace, Secretary, Confederation Life Building, Toronto.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, H. L. Holman; Secretary, Calvin W. Rice.

## SOCIETY NOTE.

**American Society of Mechanical Engineers.**

The season of professional meetings of the American Society of Mechanical Engineers will be opened on Tuesday evening, October 13th, by a meeting of the Gas Power Section in the Engineering Societies building at 29 West 39th Street, New York.

Mr H. L. Doherty, chairman of the Meetings Committee of the Section, will present a report for discussion outlining plans for future work, and there will also be a discussion of standards to be used in gas power work.

Two papers will be read, one by D. A. Harvoy on gas producer plants, with data upon costs, performance, etc., and one by N. T. Harrington, giving the results of tests to determine the loss of fuel weight in a freshly charged producer, due to increase of ash contents in the fuel bed. The first paper will be illustrated by lantern slides, showing actual plants and plans for the arrangement of apparatus.

## HOUSEHOLD SEWAGE DISPOSAL.

The question of sewage disposal and the utilization of waste are both problems which now engage the attention of municipalities, institutions and places where a number of people live in close proximity and of individuals who, living in country districts where old-fashioned methods still prevail, are aware of the dangers around them and the risks they are taking. To the latter class some practical and inexpensive method of disposing of sewage will always appeal.

A well-known Chicago civil engineer, Mr. Burton J. Ashley, moved to Morgan Park, a Chicago suburb, in a territory where there were no sewers or water mains, and among the many sanitary improvements which he made was a system of purifying and disposing of sewage wastes. Its evolution was what is known widely as the Ashley system and found especially adapted to residences, though used on a large scale also.

His idea consists in using an underground watertight tank, usually constructed of brick or concrete, which receives the sewage from the house. Here the first essential process of sewage purification takes place, which is brought about through the destructive agency of anaerobic bacteria, those that live and thrive without air or oxygen. These anaerobes are natural agents of decomposition anywhere acting in the centre of a hot fermenting manure pile or in a septic tank. The process is, therefore, a natural one—nature's own method—and fills a benign purpose too great almost to be fully appreciated.

The tank is so constructed and gauged on the inside as to give these bacteria the most favorable conditions possible, for without such conditions bacterial activity would cease or even refuse to begin. It greatly intensifies and accelerates decomposition and causes the organic solids contained in sewage to be quickly and effectually broken up and hydrolized (turned to fluid), which is the first step toward successful purification. This septicized fluid is now in the most favorable condition for oxidation and nitrification, which is the second and final purification that converts the liquids back into pure water again. The septicizing of the sewage by means of the septic tank effects about one-half of the purification, and the nitrification duct or bacteria bed completes the purification, the result being water. The water is then absorbed by the soil with which the nitrification duct is in direct contact.

This system is so simple that it can be installed where there is but an ordinary lot, and is out of sight and mind.

## A NEW LEATHER BELTING.

A leather belting composed of a number of strips of leather sewn together, is the production of an English house who have entered the Canadian market in this field. Laminated belting, as it is called, is supposed to possess many advantages, among them being the possibility of removing a strip of leather completely and thereby the belt seldom requires shortening. No adhesive matter is used in its composition, the strips are placed edgewise so the belt runs on the inside fibre of the leather, no dressing is required. Though thick and strong, the leather is flexible, and will easily adapt itself to crown or flat faced pulleys. The system of splicing the belt is very simple, but secure, and it is practicable to have an endless belt without an element of danger from a crooked splice. Mr. J. W. Williamson of 54 Notre Dame Street East, Montreal, is the agent for this article which is called Hendry's Patent Laminated Leather Belting.

# 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.

**Ontario.**

PORT ARTHUR.—Tender for Dredging at Port Arthur, Ont., will be received until Friday, October 9, 1908, at 4 p.m., for dredging required at Port Arthur, in the Province of Ontario. Nap. Tessier, Secretary, Department of Public Works.

OTTAWA.—Tenders will be received until October, 22nd, 1908, for the works connected with the construction of Section No. 7, Ontario—Rice Lake Division of the Trent Valley Canal. L. K. Jones, secretary. (Advertised in the Canadian Engineer.)

ST. CATHARINES.—Tender for Stone Protection on Summit Level, will be received at this office until 16 o'clock on Monday, the 5th October, 1908. Plans, specifications and the form of the contract to be entered into can be seen on and after Friday, 25th September, 1908, at the office of the Superintending Engineer, Welland Canal, St Catharines, Ont., at which place forms of tender may be obtained. J. W. Pugsley, Acting Secretary, Department of Railways and Canals.

HAMILTON.—Tender for combined gas and electric light fixtures, Armoury, Hamilton, Ont., will be received at this office until 4 p.m. on Thursday, October 8th, 1908, for combined gas and electric light fixtures at the Armoury, Hamilton, Ont. Plans and specification can be seen and forms of tender obtained at this department, and on application to Messrs. Whitton & Stewart, architects, Hamilton, Ont. Nap. Tessier, Secretary, Department of Public Works, Ottawa.

**Manitoba.**

WINNIPEG.—Tender for locomotive shops will be received at the office of the Commissioners of the Transcontinental Railway, at Ottawa, until twelve o'clock noon of the 8th day of October, 1908, for the construction and erection complete, in accordance with the plans and specifications of the Commissioners, of locomotive shops east of Winnipeg. P. E. Ryan, Secretary, the Commissioners of the Transcontinental Railway, Ottawa.

WINNIPEG.—Tender for filling will be received at the office of the Commissioners of the Transcontinental Railway at Ottawa, until twelve o'clock noon of the 8th day of October, 1908, for the filling required in connection with the preparation of site for shops on the Transcontinental Railway, about six miles east of Winnipeg. Plans, details and specifications may be seen and forms of tender obtained at the office of Mr. Hugh D. Lumsden, Chief Engineer, Ottawa, Ont., and Mr. S. R. Poulin, District Engineer, Winnipeg Man. P. E. Ryan, Secretary, the Commissioners of the Transcontinental Railway.

## CONTRACTS AWARDED.

**Nova Scotia.**

PORT HASTINGS.—Mr. W. J. Laundry, Antigonish, has been awarded the contract for the erection of a public wharf and warehouse for the Dominion Government at Port Hastings. His tender was $10,500.

**Quebec.**

QUEBEC.—The contract for coal was awarded by the city council as follows: To Messrs. A. K. Hansen & Co., 100 tons of Scotch anthracite, egg or stove size, at $6.60 a ton, and 100 tons of Scotch anthracite, furnace size, at $6.60, to the Archer Co., Limited, the balance required of egg or stove size, Lackawana, at $6.89, and the balance of furnace size, Lackawana, to Messrs. A. R. Pruneau & Co. at $6.65. The contract for firewood was awarded to Mr. Edouard Gravel at the price stated in his tender, viz., birch at $6.75 and maple at $7.15.

**Ontario.**

PORT ARTHUR.—The tender of Wells & Emmerson for heavy scrap copper and cast scrap iron was accepted. The price to be paid is 10 cents a pound for the copper and $12 a ton for the iron.

WELLAND.—Mr. J. F. Connoly of Toronto has secured the contract for building a large sewer in Ward 1 and 2, Welland. The price will be $51,000. He is now completing a sewer in Ward 4, costing about $20,000.

OAKVILLE.—The Oakville Waterworks and Electric Commission awarded the contract of putting in the Oakville waterworks system to Messrs. Moogk & Company, of Waterloo, Ont. Contracts have also been made with the Hamilton Cataract Power Company for power for the town's system of electric lighting, and men are now at work installing the new system.

**Manitoba.**

WINNIPEG.—The Dominion Bridge Company have secured the contracts for the fabricating of the structural steel work in connection with the Dominion Government Buildings at Dauphin and Yorkton. Samuel Brown is the contractor, and the cost of each building is in the neighborhood of $45,000. The steel will all be shopped in Winnipeg.

**Alberta.**

LETHBRIDGE.—The Canadian Pacific Railway Company has let the contract for the construction of a bridge over the Old Man River, between Lethbridge and Macleod, Alta. The estimated cost of the new bridge is $300,000. Thomas Kelly & Sons, of Winnipeg, have been awarded the contract for the concrete work, which consists of the building of thirty-five massive piers over which will span the bridging 2,000 feet in length.

**Foreign.**

TORRINGTON, CONN.—The completed equipment of this new power house station for the Warrenton Woolen Co., Torrington, Conn., which is to be furnished in accordance with plans and specifications by Charles T. Main, engineer, Boston, will consist of three 72-inch Bigelow horizontal return tubular boilers, a feed water heater, and an auxiliary heater arranged for connection to a future economizer, a 19 x 36-inch Cooper-Corliss horizontal simple non-condensing engine, direct connected to a 250 K. W. Crocker-Wheeler alternating current generator. No piping will appear in the engine room, all steam being taken from below the floor. The economizer, when installed, will heat water for manufacturing purposes, a tank being provided in the dye house and the system so arranged that the water will circulate through the economiser and be stored in the tank.

## RAILWAYS—STEAM AND ELECTRIC.

**New Brunswick.**

ST. JOHN.—Hon. Mr. Pugsley stated yesterday that the government is calling for tenders for dredging Courtenay Bay, and that the work will begin immediately. He said the work was most important and would take some time. This is the proposed site of the Trunk Pacific terminals.

**Quebec.**

MONTREAL.—The Dominion Iron and Steel Company have received an order for 9,000 tons of 80-lbs. rails for an Indian Railway. The rails are to be rolled about the middle of October, and are to be shipped direct by steamer Couriche.

MONTREAL.—Mr. J. P. Mullarkey has been awarded the contract by Messrs Mackenzie & Mann for the construction of the extension of the Canadian Northern Quebec Railway, from the St. Jacques village to Rawdon, a distance of about ten miles. The work of construction has already begun, and it is expected that the line will be finished this year.

**Ontario.**

WELLAND.—The builders of the electric railway bridge at Welland have met with an unexpected difficulty. The structure is to rest on piles. The first pile was sent down thirty feet and went as easily the last two feet as the first. Another thirty-foot pile was fastened to the top of it and the sixty-foot pile was driven down. And still the bottom was not reached.

**Manitoba.**

WINNIPEG.—J. W. Stewart, of the firm of Foley, Welch & Stewart, has left for Kenora. This trip of Mr. Stewart marks the completion of the work done by Foley Brothers & Larson in connection with the double tracking of the C.P.R. In Kenora he will close up the office of the company and will look after certain details in connection with the completion of that work. It is almost three years since the contract for this important undertaking was awarded to the firm and three years was agreed on as the period in which the work was to be completed.

WINNIPEG.—F. J. George, engineer at the head of the C.P.R. construction, has returned to Saskatoon after a long period spent in the West, which includes supervision of the closing up of the line running westward. On September 19th steel laying was completed into Wilkie, the first divisional point West of Saskatoon, and the farthest point west to which the company will operate this year. With the line into Wilkie there remains 130 miles of grade between that point and Battle River still to be supplied with the rails before the trains will be running right through. No effort will be made to reach Battle River with the steel from the east this year. The bridge at the river is completed and trains run all the way from there into Wetaskiwin. There remains about three weeks' work of grading on the 130 miles of gap. Since early in the season the C.P.R. had given up all intention of making Battle River with the steel this year.

**Saskatchewan.**

PRINCE ALBERT.—The activity of the C.N.R. here is creating a good impression. The work of grading the track up to the traffic and railroad bridge is nearly completed, and the false work for putting on the steel is well on its way across the river. When President Mackenzie was here a short time ago, he promised that the grading of the road through Shellbrook would be started this fall. His promise will likely be carried out, as Contractor Mann is here looking over the ground with a view to tendering on the work of grading. This line when completed will strike the main line at Battleford.

## TELEPHONY.

**Ontario.**

HAMILTON.—The by-law giving a five-year exclusive franchise to the Bell Telephone Company was given a two weeks' hoist at the City Council on September 28th. For $4,000 a year and 150 telephones for the use of the city at $25 a year each, the company asked for an exclusive franchise. Hugh Baker, manager of the company, said the company would not reduce its rates of $45 a year for business and $30 a year for house phones.

DELHI.—The rural telephone company is busy erecting poles on the streets, and expects to be ready for business in a short time.

HARROW.—The private telephone line extending from Harrow to points in the Township of Colchester, has been connected with the lines of the Bell Telephone Company at Harrow.

## LIGHT, HEAT, AND POWER.

**Ontario.**

WEST TORONTO.—A by-law was passed accepting the Inter-Urban Company in place of the Stark Electric Company, who had the lighting contract, upon condition that the Inter-Urban Company waive any protection they may enjoy under the Conmee Act.

NIAGARA FALLS.—Robert C. Board, secretary and treasurer of the Ontario Power Company of Canada, has returned from Pittsburg, where he was negotiating the purchase of a generator and switchboard from the Westinghouse Company, the contract involving an expense of $70,000.

**British Columbia.**

VICTORIA.—It is believed that W. Meredith, the engineer who has been in charge of the surveys at Jordan Meadows on behalf of the B. C. Electric Company, will report favorably on the suitability of that water for a power supply.

## SEWERAGE AND WATERWORKS.

**Quebec.**

MONTREAL.—Suit for $25,000 damages has been brought by the Montreal Water and Power Company against the Royal Spinning Company and the Town of St. Paul, mis-en-cause. The Water and Power Company claims that it has an exclusive right to supply water to the town of St. Paul for domestic and industrial purposes, and, therefore, resents the granting to the Royal Spinning Company of the right to lay pipes to carry its own water supply from the canal.

**Ontario.**

TOTTENHAM.—Galt & Smith, consulting engineers, Toronto, have prepared a report for the Town Council on a possible waterworks system. The scheme, if adopted, would call for an expenditure of some $25,000.

## MISCELLANEOUS.

**Quebec.**

MAISONNEUVE.—As a result of long-drawn-out negotiations and difficulties the town of Maisonneuve, through its attorneys, Messrs. Taillon, Bonin and Morin, has brought suit against the Montreal Gas Company, to cancel the contract under which the company supplies the citizens of the town with gas.

**Ontario.**

CORNWALL.—That W. H. Magwood, engineer in charge of the construction of a municipal drainage system in Cornwall township, had no right to grant the contractors a progress estimate on the work, is the claim of Cornwall township in their appeal from the decision of the Drainage Referee at Ottawa, by which the contractors, Barret Bros., were given judgment for the full amount of the estimate, $7,061, and costs. The township had paid $3,000 of the amount before they objected to the estimate.

OTTAWA.—All the parts for the civic asphalt plant have now arrived in the city and the plant will be in operation in about a week. It was put out of commission some time ago by the fire and for the work which was urgent the city had to hire the Foley plant, which for the four days cost the city $200.

BERLIN.—The County Council of Waterloo has received word from the Minister of Public Works approving of their by-law to expend $6,000 on county roads.

NEWMARKET.—The York Construction Company are rushing work on the Newmarket extension of the Trent Canal. They have now completed the excavation for the first lock, and the Concrete Pole Company of St. Catharines are placing the concrete.

**British Columbia.**

VICTORIA.—The government is having plans prepared for a structure to replace the bridge over the Elk River at Fernie, which was burnt down in the recent conflagration. Plans are also being drawn for a new bridge over the Elk River at Hosmer, and for the new court house at Fernie.

# ENGINEER'S LIBRARY

## STANDARDS OF TECHNICAL PUBLICITY.

Under this title, Walter B. Snow, publicity engineer, of Boston, Mass., presents an interesting picture of American methods in a recent article in the "American Exporter," from which the following is quoted:—

"In America, above all other countries, publicity is recognized as the handmaid of business success. But the fact is fundamental that no sale was ever made in the wide world unless the buyer first learned that the seller had something to sell. No less fundamental is the fact that no legitimate business was ever based upon the ignorance of its customers.

"The high standard of technical publicity which to-day prevails in America is the result of relatively rapid development; a token, doubtless, of the insatiable energy of its people. It expresses a recognition of the fundamental principle of all advertising—that in the broadest sense it should be considered as an investment and not as an item of expense. The advertiser should not ask how much does it cost, but how much does it earn.

"America's leadership in publicity has been marked by the educational feature. This is especially true of advertising to and by manufacturers. The country teems with trade journals devoted to the technicalities of particular trades, and to the details of manufacture and sale. In those particularly devoted to engineering, in the widest acceptance of the term, are to be found the best examples of technical advertising. Here the manufacturer, or perchance the engineer, may speak his own language to men who understand its technicalities. What is more, he may be assured that he will find readers. Rare, indeed, is the case where manufacturers or engineers worthy of the name are not subscribers to one or more journals in their particular field. Such subscribers, particularly among the manufacurers, are also advertisers in some of the trade or technical journals which reach the consumers of their products. As a consequence a considerable number of publications in varied lines pass under the eyes of each manufacturer who advertises. From one class of publications he learns what other manufacturers produce that might be helpful to him in the conduct of his office and shop; from others he is able to judge of conditions in the various industries for which his products are destined.

"Nowhere else are trade papers prepared and published with such care as in America. From the editorial standpoint the leading engineering papers are of exceptionally high order. The presentation of excellent illustrations, both in the reading and advertising columns, is made possible by the use of high-grade paper and careful printing. The half-tone process of reproduction may, therefore, be employed without fear that the effect of fine engravings will be lost in the printing. Some papers go so far as to request original half-tones for use in the advertising columns or as originals for electrotypes, which they will make at their own expense.

"The leading papers maintain staffs of advertising writers at the service of their advertisers without charge. In every way they study to encourage the advertiser to exert his best efforts in the presentation of his products. The result is greater frequency of change of copy than occurs in any other class of journals. So good from a technical standpoint is some of this advertising that readers have been led to collect and preserve it for its educational value."

## BOOK REVIEWS.

**Machine Design.**—Construction and Drawing, a text-book for the use of young engineers, by Henry J. Spooner, C.E., M.I., Mech. E., A.M.I.C.E., F.G.S., Hon. M.J.I.E., etc., Director and Professor of Mechanical Engineering in the Polytechic School of Engineering, Regent, St., London. Published by Messrs. Longmans, Green & Company, 39 Paternoster Row, London and New York, p.p. 654. Ill., 1,424. Tables, 78. Price 10s. 6d. net.

Although there are several good books on the subject, the manner in which this is treated, the immense amount of matter covered, and the up-to-dateness of the work place it in a premier position. The book was mainly prepared as a text-book and is evolved from the author's regular lecture work and from his notes and experience gained as an apprentice student, professor and engineer. The first five chapters are devoted to drawing, of which the first part is intended to acquaint the student with the use of instruments, these directions are good and the treatment seems calculated to teach the art of making working drawings in a rational manner. The remaining chapters treat more particularly with the design and construction of machine details with illustrations suitable for drawing exercises and suggestions throughout as to the best method of treatment. Chapters VI. and X. deals with the design in detail of shafting, crank shafts, cranks, journals, couplings, clutches, keys, pins, etc. Rivetted joints is thoroughly discussed in Chapter X., giving details of design and standard practice. Bolts, nuts, screws, etc., are covered in detail in Chapter XII., discussing the practical merits of the various types with tables of dimensions, breaking strength, etc.; wedged in between the description and design of machine details is a chapter on pipe and pipe connections. The design and practical use of cotters, cottered joints, pin or knuckle joints, pitch chains, gear drains, bearings, journals, hangers, etc., are dealt with in detail in the next three chapters. Roller and ball bearings are fully treated in Chapter XVI., with an appendix of the literature on ball and roller bearings. Chapter XVII. is devoted to the design and recent and important improvements in spur gearing with their applications to modern machinery. Chapters XVIII., XIX., XX., and XXI., deal with the distribution and transmission of power by friction gearing, belt, textile, and wire rope drivers, with a discussion in Chapter XX. of their relative efficiencies. Material used in construction of machines is discussed with tables; Chapter XXX. deals with machine frames and the disposition of the metal, this is an important matter which is very often omitted. The book is well illustrated with cuts, problems, and at the end of the majority of the chapters, there is placed numerous exercises both for design and sketching; too much importance cannot be placed on the cultivation by the student of clear freehand sketching. There are many useful tables in connection with the various facts of machines and apparatus discussed, also the properties of the newer steels is described with their uses in the construction of modern machines. Although the underlying principles of machine design remain the same the application of them changes due to the change of materials and methods of construction, in this matter the book is made up-to-date, by including a treatment of the improved machines and details of workshop processes and methods which influence modern design. The book forms a thorough and comprehensive treatise on machine design, and will be found useful in the draughting-room as well as in the class-room.

F. A. G.

**Concrete Construction: Methods and Cost.**—By Halbert P. Gillette, M. Am. Soc. C.E., Am. Inst. M.E., Managing Editor "Engineering Contracting," and Charles S. Hill, C.E., Associate Editor "Engineering Contracting." New York and Chicago: The Myron C. Clark Publishing Co. Cloth, 6 x 9 ins., pp. 690, 306 illustrations in the text and thirty-seven tables; $5 net.

This is a work which might be described as a compilation of recent articles relating to construction in concrete, plain and reinforced, edited and added to by the authors.

As noted in the preface, "the authors have handled the subject of concrete construction solely from the viewpoint of the builder of concrete structures." The question of design is not touched upon except as it affects the methods of carrying out the construction. But to quote again from the preface: "It seems plain that no designer of concrete structures can be a really good designer without having a profound knowledge of methods of construction and of detailed costs." It is this knowledge which the book aims to give.

A large proportion of the matter contained in the book has already appeared in the previous works of the authors and in the technical journals, and to one familiar with concrete literature there are only a few sections that are really new. The old material has, however, been put into a form that increases its value for reference, and makes comparison more simple between several jobs of the same type. The book is well illustrated with outline drawings, but the halftones, of which there are several, are not very good.

The great value of the book lies in the fact that it contains in a convenient volume information on all forms of concrete work that, when it has been in print at all, has hitherto been scattered through dozens of numbers of various journals and difficult to find for reference. The analysis of costs is clear and complete, with all unit prices given, so that the costs may be applied to work at any time and place. The methods described cover the work of some of the best-known and most successful contractors, as well as work on which the contractor was inexperienced and lost money. In cases of the latter kind the reasons for failure are pointed out, and serve to emphasize some points often neglected.

The scope of the work embraces practically all forms of concrete construction common in American practice and a few that are not common. English and European practice is hardly touched upon. If printed cost data are ever of value to the man who has not seen the work, the data given here are valuable, for they are very complete and thorough. In conclusion, it may be said that the work will be useful for every designer and constructor in concrete, particularly when work of a nature unfamiliar to him is put in his hands. J. M. O.

**The King's Highway.**—By Reginald Ryves, A.M. Inst. C.E. The St. Bride's Press, Limited, 24 Bride Lane, Fleet Street, London, E.C. Size 9 x 12 pp. 100, diagrams 34. Price $1.25.

This publication, which deals with the nature, purpose and development of roads and road systems, is well written, well illustrated, and contains much valuable information for the highway engineer.

The author, who is now engaged in the Public Works Department of the Madras Presidency, was formerly on the staff of the "Surveyor and Municipal and County Engineer," in which journal the series of articles, now issued in book form, originally appeared. Since its appearance in serial form the text has been expanded and thoroughly revised, and the numerous diagrams and illustrations which are given adequately elucidate the matter.

The diagrams and illustrations are much superior to those frequently found in such works. They make clear at once the value and practicability of each scheme illustrated.

Besides a table of contents there is a carefully prepared index.

The first three chapters are taken up with introduction, foreign road systems, and foreign practice.

Chapter IV. discusses Road Administration in the United Kingdom, and in Chapter V. the report of a Commission appointed in 1903 to enquire into the Administration of English and Welsh Highways is the subject of many suggestions.

Chapter VI. deals with highway law. The remaining chapters take up the engineering features of highway building.

Chapter VIII. deals with the question of proper width. The author dislikes the idea of a standard width, claiming that the width of road should be adapted to the requirements. Chapter IX. refers to the selection of materials, the effect of water, weathering, self-restoration and route-making principals.

In Chapter X., in discussing road lamps and carriage lamps, many good suggesions are made. For calculating the illuminating power of lamps on road surfaces the following formula is given; The illuminating power in candle-feet is $\frac{h \times \text{candle-power}}{l^3}$ when h is the height of the lamp and l its slant distance from spot under consideration.

Special Roads is the subject of Chapter XI. In Chapter XII. to maintenance and repair six pages are devoted. The effect of different rollers, danger and damage of rolling, cost of maintenance and effect of watering are discussed.

Chapters XIII. and XIV. are devoted to road stone and their testing. A table giving the co-efficient of wear, resistance and cementation value of sixteen different road materials is of value.

The remaining chapters treat in a general way of wheels, dust prevention, bridges, and the effect of the elements on the highway.

## PUBLICATIONS RECEIVED.

**Some Canadian Industrial Problems.**—Papers read before the Canadian Section of the Society of Chemical Industry. The Carswell Co., Toronto. Size 6 x 9, pp. 70.

**Report of Bureau of Mines, Ontario, 1907.**—Part II. of Vol. XVI., containing the third edition of Prof. W. G. Miller's report on "The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, a list of the mining companies incorporated 1904-8, and a translation by Geo. R. Mickle, the "Early History of the Cobalt Industry in Saxony." Thos. W. Gibson, Deputy Minister of Mines, Toronto, Ont.

**Municipal Bulletin No. 2.**—A report by the Bureau of Industries of Ontario, giving the population, assessed values, exemptions, taxations, debenture debts and sinking funds of the various Ontario municipalities of Ontario. Issued by the Department of Agriculture.

**Ontario Land Surveyors.**—The Annual Report for 1907 and the Proceedings of the sixteenth annual meeting, held in Toronto, February, 1908. Contains reports of standing committees and ten papers, also biographical sketches. Killaly Gamble, secretary, Temple Building, Toronto, Ont. Size 6 x 9, pp. 200.

**Telephones.**—Report of Mr. Francis Dagger, employed as Provincial Telephone Expert, with respect to the development of the telephone service in the Province of Saskatchewan. Regina: Department of Railways, Regina, Sask., 1908; pp. 44.

**Maintenance-of-Way.**—Proceedings of the ninth annual Convention of the American Railway Engineering and Maintenance of Way Association held at Chicago, March, 1908. Vol. IX. Size 6 x 9, pp. 915. Illustrated. W. D. Pence, Madison, Wis., editor; E. H. Fritch, Chicago, Ill., secretary.

## CATALOGUES.

**Suspension Furnaces.**—A handsome book, published by the Continental Iron Works, Brooklyn, New York, well illustrated, and containing fifteen complete drawings, showing design and construction of the Morrison Suspension Furnace. It also contains a form of specification for internal furnace boilers. Size 9 x 12 cloth, pp. 70.

**Boring Mills.**—The Niles-Bement-Pond Co., 111 Broadway, New York, illustrate what fifty years' experience in the building of boring mills may do. The catalogue gives specifications and principal dimensions of their various machines. Size 9 x 12. Illustrated.

**Surveying Instruments.**—W. F. Stanley & Co., 286 High Holborn, London, W.C., send a fully illustrated catalogue of surveying instruments, drawing instruments, meteorological instruments, barometers, telescopes, etc. Size 6 x 9, pp. 200.

**Steam Shovels.**—The Browning Standard Revolving Steam Shovels are well described and their parts and workings well illustrated in a booklet issued by the Browning Manufacturing Co., Mansfield, Ohio. These shovels can work in any part of the circle. Size 6 x 9, pp. 12.

## PERSONAL NOTES

FETHERSTONHAUGH & CO., Patent Solicitors, have removed their Toronto office from the Bank of Commerce Building to the new Royal Bank Building, 10 King Street East, Toronto.

MR. GEORGE WHITEHOUSE, divisional engineer of the Government Railways of the Transvaal and the Orange Free State, passed through Winnipeg, Man., last week. Mr. Whitehouse has been making an exteneded trip through America, making an examination of the railway systems of the country, with a view to the improvement of the Government Railways of South Africa. The railways have a mileage of between seven and eight thousand miles, all under Government control. Mr. Whitehouse spoke highly of the roadbed and equipment of the Canadian Pacific, over which he had travelled, but stated that the main lines of South Africa compared favorably with it. The rates charged for passenger transportation in South Africa are six, four and two cents per mile for first class, second class and third class respectively. The latter is used almost exclusively by the Kaffirs. Mr. Whitehouse stated that there was little employment for unskilled labor in South Africa, but that general business conditions were improving.

MR. J. M. ROBERTSON, mechanical superintendent and superintendent of shops for the Montreal Light, Heat & Power Company, has tendered his resignation to take effect at the end of September. Mr. Robertson has been connected with the Power Company or its predecessors for more than thirteen years, having been appointed assistant electrical engineer of the Royal Electric Company in 1895. Aside from an absence of about a year, during which time he was in charge of the electrical and mechanical work of the Montreal Park and Island Railway Company, he has been connected with the company continuously since that time, having during this period been identified with nearly every department of the company's business. The department in which his work is perhaps best known is that of alternating current power supply, of which department he took charge at its inception, and for the great development of which he has been largely responsible. Mr. Robertson intends entering the consulting engineering field, and is opening an office in Montreal, where he will be prepared to undertake engineering work in either mechanical or electrical lines.

## MARKET CONDITIONS.

Toronto, October 1st, 1908.

Building materials cannot be called active. While there is some demand for cement and pressed brick in other cities, both are quiet in Toronto, where building construction, which has been active mainly in small dwellings, is just now slack. Lumber continues to move in moderate volume, the market being decidedly strong, though prices are not quotably changed. Structural steel is quiet and but little pig iron moving, but in heavy metal goods and builders' hardware business is fairly good. Prices are so low generally that any decided or prolonged demand must send them up.

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 moderate demand.

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

**Boiler Plates.**—¼-inch and heavier, $2.40. No special activity. Boiler heads 25c. per 100 pounds advance on plate.

**Boiler Tubes.**—Demand limited. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $12.10; 3½-inch, $15.30; 4-inch, $19.45 per 100 feet.

**Building Paper.**—Plain, 30c. per roll; tarred, 40c. per roll. Decidedly more active.

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

**Cement.**—While retail dealers report activity in small orders, the feeling among wholesalers continues despondent. The price is still low. We quote:—1,000 barrel lots at $1.95 per barrel, including the bags, which is equal to $1.55 to $1.60 without bags.

**Coal Tar.**—In improved request; $3.50 per barrel the ruling price.

**Copper Ingot.**—Fluctuating in the States, a little higher in London, the feeling here confident. We still quote, 14¼c.

**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.**—There is much more demand and a better feeling. Price $1.80 per 100 pounds.

**Fire Bricks.**—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. Demand continues fair.

**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 or 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; 22-24-gauge, $3.70.

**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; ¾-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. Rather more movement following the natural fall demand.

**Lead.**—Prices steady at $3.90, and the feeling more regular.

**Lime.**—In adequate supply and moderate movement. Price for large lots at kilns outside city 21c. 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; Southern pine, moderately firm; Norway pine rather easy. Hemlock moves steadily in small quantities. British Columbia shingles still $3.20; lath, No. 1, $4; No. 2, $3.50; spruce flooring, $25. The market has a much firmer tone this week; transactions are not extensive, but there is a fairly steady if moderate consumptive demand.

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

**Pitch.**—An active trade at 70c. per 100 pounds. The stock is low, and holders are firm.

**Pig Iron.**—Very little movement and prices practically unchanged. Clarence quotes at $19.50 for No. 3; Cleveland, $19.50 to $20; in Canadian pig, Hamilton quotes $19.50 to $20.00.

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

**Sewer Pipe.**—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; 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.**—The United States market is strong and a little higher. Less irregular here at 30 to 32½c.

**Zinc Spelter.**—Business very good at unchanged prices, say, $4.90 to $5.

* * * *

Montreal, September 30th, 1908.

Advices from the United States state that postponement of deliveries of pig iron, already bought, has become a feature of the market which is not to be ignored. It is an argument against the present furnace capacity remaining in blast, inasmuch as they cannot do so without accumulating stocks, and it goes to show that there cannot be any important movement in the market for some time. Slightly lower prices on all grades are possible, although it is not thought that the decline will be of much consequence. Consumption is now about as low as it is likely to become and the next change should be favorable to an increase. It is thought that before production increases, demand will have to bring out higher prices.

Local stocks are light and inquiries are mostly for small lots, the aggregate of these sold during the past few weeks being only of moderate volume. The Dominion Iron and Steel Company reports having booked order for shipment to India, of 9,000 tons of steel rails. The price is not mentioned, but the contract was secured in competition with the world.

Very few changes have taken place throughout the following price lists:—

**Antimony.**—The market is steady, at 9½ to 10c.

**Bar Iron and Steel.**—Prices are steady all round, and trade is decidedly dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $1.90; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.95 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.

**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, $1.50 per 100 pounds; felt paper, $2.25 per 100 pounds; tar sheathing, No. 1, 50c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 40c. per roll of 400 square feet. No. 2, 26c. (See also Roofing.)

**Cement—Canadian and American.**—Canadian cement, $1.65 to $1.75 per barrel, in cotton bags, and $1.90 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

**Cement—English and European.**—English cement is steady at $1.70 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $2 to $2.20 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.75 to $1.85 per barrel in bags, and $2.05 to $2.20 per barrel, 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 14¼ to 15c. per pound. 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.**—Canadian pig iron is offered at $18 for best, down to $17 for lower grades, while imported iron in car lots, on cars, on dock, Montreal, is as follows, for larger lots lower prices would be taken: No. 1 Summerlee, $20.25 to $20.75 per ton; No. 2 selected Summerlee, $19.75 to $20.25; Cleveland, $18.50; and No. 3 Clarence, $18; Carron, special, $20.25 to $20.75; Carron, soft, $19.25 to $19.75.

**Laths.**—See Lumber, etc.

**Lead.**—Trail lead is weak, but prices hold steady, at $3.60 to $3.70 per 100 pounds, ex-store.

**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, $18 to $22 per 1,000 feet; white pine, mill culls, $22 to $25. Spruce, 1-in. by 4-in. and up, $16 to $18 per 1,000 ft.; mill culls, $14 to $16. Hemlock, log run, culls out, $14 to $16. Railway Ties: Standard Railway ties, hemlock or cedar, 35 to 45c. each, on a 5c. rate to Montreal. Telegraph Poles: Seven-inch top, cedar poles, 25-ft. poles, $1.35 to $1.50 each; 30-ft., $1.75 to $2; 35-ft., $2.75 to $3.25 each, at manufacturers' points, with 5c. freight rate to Montreal. Laths: Quotations, per 1,000 laths, at points carrying $1.50 freight rate to Montreal, $2 to $3. Shingles: Cedar shingles, same conditions as laths, X, $1.50; XX, $2.50; XXX, $3.

**Nails.**—Demand for nails is moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

**Pipe—Cast Iron**—The market is strengthening and dealers look for higher prices shortly. Meantime former quotations hold: $33 for 8-inch pipe and larger; $34 for 6-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

**Pipe.—Wrought and Galvanized.**—The market is quiet and steady at last week's range: ¼-inch, $5.50 with 63 per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; 2½-inch, $57.50; 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

**Railway Ties.**—See lumber, etc.

**Roofing.**—Ready roofing, two-ply, 60c. per roll; three-ply, 80c. per roll of 100 square feet. (See also Building Paper.)

**Rope.**—Prices are steady, at 9½c. per lb. for sisal, and 12½c. for Manila.

**Shingles.**—See lumber, etc.

**Spikes.**—Railway spikes are in dull demand and prices are lower at $2.40 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 per 100 pounds, base of ⅝ x 10-inch and ⅝ x 12-inch.

**Steel Shafting.**—Prices are steady at the list, less 25 per cent. Demand is on the dull side.

**Steel Plates.**—The market is steady. Quotations are: $2.25 for 3-16, $2.25 for ⅛, and $2.10 for ¼ and thicker; 12-gauge being $2.30; 14-gauge, $2.05; and 16-gauge, $2.10.

**Tar and Pitch.**—Coal tar, $4 per barrel of 40 gallons, weighing about 500 pounds; roofing pitch, No. 1, $1 per 100 pounds; pine tar, $4 per barrel of 40 gallons; pine pitch, $4 per barrel of 180 to 200 pounds.

**Telegraph Poles.**—See lumber, etc.

* * * *

Winnipeg, September 30th, 1908.

**Anvils.**—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¼c.; anvil and vise combined, each, $5.50.

**Bar Iron.**—$2.30 to $2.60.

**Bar Iron.**—$2.50 to $2.60.

**Beams and Channels.**—$3 to $3.25 per 100 up to 15-inch.

**Building Paper.**—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c

**Bricks.**—$11, $12, $13 per 1,000, three grades.

**Cement.**—$2.65 to $2.75 per barrel.

**Chain.**—Coil, proof, ¼-inch, $7; 5-16-inch, $5.50; ⅜-inch, $4.90; 7-16-inch, $4.75; ½-inch, $4.40; ⅝-inch, $4.20; ¾-inch, $4.05; logging chain, 5-16-inch, $6.50; ⅜-inch, $6; ¼-inch, $8.50; jack iron, single, per dozen yards 15c. to 75c.; double, 25c. to $1; trace-chains, per dozen, $5.25 to $6.

**Dynamite.**—$11 to $13 per case.

**Hair.**—Plaster's, 80 to 90 cents per bale.

## DESIGNS FOR STEAM BOILER.

Among the more recent inventions covering improvements on steam boilers for heating and power purposes the following design presents several features of interest. One of the claims for this design is that of the large amount of heating surface in actual contact with the fire. This the manufacturers claim is at least 100 per cent. more than is obtained in the ordinary cast-iron sectional boiler. It is also claimed that this design removes all danger from rust between sections, and that no rubber packings are required.

Another feature of interest is the large chamber over the fire for the combustion of gases. As may be seen from the accompanying section, the hot gases pass through the secondary heate r after leaving the firepot. The smoke pipe, which constitutes the lower portion of the secondary combustion chamber, takes off the cooled gases. In the steam dome an outer chamber receives the water forced over in the case of a heavy fire and conveys it back to the firepot. The same principle used in this heating boiler is now being applied by the manufacturers to power purposes, in which a system of free circulation with short passages is being employed. Provision is made for taking the mud and impurities that collect from the water by keeping the water practically still in the boiler, which contains the bulk of the water, and which is furthest removed from the fire, where it will settle and can be drawn off. In the firepot section the quick circulation provided keeps impurities from collecting. These designs are made to occupy about the same space as the average boiler; they are made in small sections, and are easily shipped and handled. This design of boiler can be set in brickwork or an outer casing lined with a non-conducting material.

The cost is said to be about equal to that of the ordinary boilers now in use. Tests have been made on a small scale, and have proven entirely satisfactory, verifying the advantages claimed for this type of boiler. The principle is also being applied to hot water heating, in which case the steam dome is removed and a larger surface exposed in the secondary heater. The hot water from the firepot passes direct into the radiators without mixing with the rest of the water in the boiler. The return pipes from the radiators enter the outer ring of the secondary chamber, through which the gases pass before they enter the chimney. The design employed here does away entirely with flat sections and the associated injuries from rust.

Messrs. Norris and Williams, 507 Clinton Street, Toronto, the manufacturers, are now engaged in putting these designs through a thorough test, and hope shortly to place them all upon the market. Patents covering Canada, England, Germany and France have been granted, with other patents pending. Messrs. Reid & Brown, Esplanade, Toronto, have charge of the construction work.

---

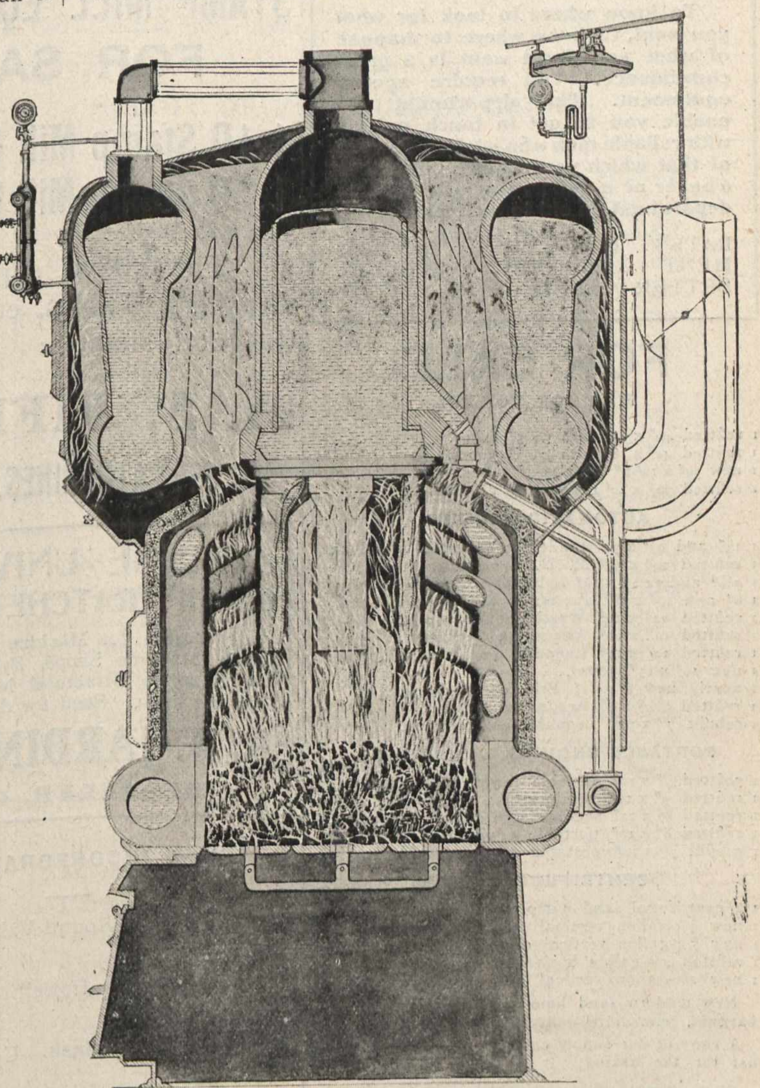
The returns of the Suez Canal traffic for 1907 show the number of ships belonging to the United Kingdom and foreign countries, respectively, which passed through the canal in the last three years were as follows:

| | United Kingdom. | Other Countries. | Total. |
|---|---|---|---|
| 1905 | 2,484 | 1,632 | 4,116 |
| 1906 | 2,333 | 1,642 | 3,975 |
| 1907 | 2,651 | 1,616 | 4,267 |

The total net tonnage for the past year shows an increase of 1,282,930, as compared with that of 1906, and of 1,594,329 over that of 1905. British tonnage increased by 1,195,937—from 8,299,931 to 9,495,868. German tonnage, which is next in importance, rose from a total of 2,113,484 in 1905 to 2,155,552 in 1906, and to 2,253,651 in 1907.

## PROGRESS ON THE PANAMA CANAL.

The grand total of excavation on the Panama Canal during the month of August was 3,252,506 cubic yards, all of which, except 100,035 cubic yards, was taken from the canal prism. This is 83,666 cubic yards more than the highest previous record for excavation in the rainy season, that of July,



Section of Steam Boiler.

1908, and 227,764 cubic yards short of the highest record, that of March, 1908. Of the grand total of August excavation 1,876,515 cubic yards were dry excavation and 1,375,991 by dredges. The average rainfall in August for the territory in which excavation is in progress was 11.91 inches, as compared with 11.14 inches in previous month and with 12.27 inches in August, 1907.

### NEW INCORPORATIONS.

**Unity, Sask.**—Round Valley Coal Company.

**Howell, Sask.**—Howell Supply Company.

**Moose Jaw, Sask.**—Coast Lumber Company.

**Saskatoon, Sask.**—North-West Exploration Company.

**Dundurn, Sask.**—Schwager Schwanbeck Grain Company.

**Milestone, Sask.**—Farmers' North-East Telephone Company, of Milestone. Gray Milestone Telephone Company.

**British Columbia.**—British Columbia Refining Company, $300,000. Cariboo Timber Company, $300,000. Duncans Lumber Company, $25,000. Great Granite Development Syndicate, $500,000. Vancouver Fiber Company, $600,000. Westward Ho Publishing Company, $50,000.



The Canadian Electrical and Motor Company's exhibit at the Canadian National Exhibition was divided in two, owing to their not being able to obtain sufficient space. Their exhibit in Machinery Hall consisted of one 25 k.w., belted type, 125 volt generator, manufactured under the patents of W. A. Johnson. The peculiar feature of this generator, as well as of the alternating current generator manufactured under similar principle of construction, is that they can be short circuited under any condition of operation without injury to either the direct current or alternating current generators. The driving power, be it engine or water wheel, being relieved of the load as long as the short circuit continues across the generator terminals or line. The generator above referred to, was short circuited probably 100 times a day during the Exhibition. A similar generator was operated by a gas engine, in the exhibit of the Canadian Gas Power Launches Co., Limited, in the Process Building. The first mentioned generator operated one of Mr. Johnson's Multispeed motors, with which change of speed is obtained by moving a handle attached to the magnetic parts of the frame and without the use of any resistance coils. The saving in operating printing presses and many machine tools, would pay for the motor within two years when compared with ordinary variable speed motors. This company also had another exhibit in the Process Building, where one of their 75 horse-power direct current generators was directly driven by flexible coupling attached to a Weber 75 horse-power 280 revolution upright, 2 cylinder gas engine, which in turn was supplied by a Weber gas producing generator. A Multispeed motor was also shown in operation in this exhibit. The operation of these motors without rheostats and the short circuiting of the generators, attracted a great deal of attention from the electrical and mechanical visitors among whom were several college professors and each and all admitted that they had never seen similar results in any electrical machine.

### HEIGHTS OF LARGE BRIDGES.

| | |
|---|---|
| Height of old Quebec Bridge... | 150 feet above high water. |
| Tower Bridge, London........ | 143 feet above high water. |
| Baltic Canal Bridge ......... | 137 feet above high water. |
| East River, New York......... | 135 feet above high water. |
| Manchester Ship Canal ....... | 75 feet above high water. |