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DEAD WEIGHT AND LIVE LOAD

SOME COMPARISONS OF WEIGHTS AND CAPACITIES IN THE FREIGHT AND PASSENGER SERVICE OF RAILROADS IN CANADA, GREAT BRITAIN AND UNITED STATES.

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WHEN one drops a letter into a post-box he seldom reflects that part of what he pays for with the two-cent stamp is really to facilitate handling, and has nothing to do with the subject of his communication. An ordinary business man's envelope for "letter-size" paper is probably about one-twelfth of an ounce and each sheet of paper is possible one-sixteenth of an ounce in weight. It therefore happens that one envelope may contain fourteen sheets of paper, and the whole be below the one ounce which goes for two cents. If this proportion is true, the weight of the envelope is to its contents as 1 is to 14, or, roughly, about seven per cent.

When it comes to the ratio of dead weight or tare to capacity or live load or paying weight, in connection with railway cars, the same style of reasoning applies. The vehicle is the envelope and the paying load is the letter, and the more "letter" you can send and the less "envelope" required the better you are off, because you have less "incidental" expense in the matter. The tare and capacity of cars used here and in the United States differs from those of Great Britain, because the kind of traffic and the method of handling commodities in the countries differ very considerably.

Here and in the United States, the traffic is carried most frequently in box cars, which are permanently roofed and weather-proof. Rough freight or heavy materials are carried in gondolas or on flats. The haulage of shipments of coal, ore or other rough freight often takes place in localities where a huge consignment is carried for long distances without breaking bulk. Freight carried in box or refrigerator cars is best handled where "car-load" lots are insisted on, so that the vehicle may "earn" as much as possible when in service.

In the United Kingdom freight traffic approximates more to what we would call a "magnified express business." A merchant in Manchester, for example, may order a small consignment from a London house, perhaps by wire, and expects his goods to reach him on the following day. Knowing that he can get what he wants on short notice, he probably keeps only a small stock on hand in any case, and the railway company must handle this kind of business without attempting to hold their wagons for "car-load" lots. In fact, the 10-ton capacity goods wagon in England carries, on the average, about three tons.

A year or so ago, a writer in the "American Railway Number" of the London Times, said that "the modern freight car carried 2½ times its own weight and a train of the largest freight cars will transport to the sea-board the product of 5,000 acres of wheat fields." This is, of course, a splendid performance, but the cars carrying 2½ times their own weight have a percentage of tare to contents of 40 per cent. This is much above the post office rate, but it must be remembered that the paper envelope in the mails only makes one trip and is then destroyed, whereas the railway vehicle goes over the road many times and carries a large number of consignments before being relegated to the scrap heap.

Bulletin No. 31, issued by the Bureau of Railway Economics at Washington, D.C., gives the increase of freight car capacity as 28 tons in 1902, up to 36 tons in 1910. This is an increase of a ton a year. The increase has been brought about by the growth in the volume of business in the United States, and the appearance of steady improvement, then apparent, gave rise to the humorous couplet:

"Dear little box-car, don't you cry,
You'll be a freight-house by and by."

The freight-house on wheels, however, never materialized and much of the prosperity of the Republic was destroyed by laws directed against railroads, enacted by State legislatures which were dominated by a spirit hostile to the "common carrier." There is, however, a reasonable prospect of the return of good times this year.

Our illustrations show, among others, some modern examples. A Norfolk and Western high-side steel hopper gondola, No. 76154, has a capacity of 115,000 lbs., and the tare weight is 41,800 lbs. This gives a ratio of "envelope" to "letter" of 36.3 per cent. The North-Eastern Railway of England, with an open steel wagon, No. 100090, like our gondolas, has a capacity of 40 long tons, or 89,600 lbs., and a tare of 16 long tons, 1 cwt., or 35,840 lbs. This gives a ratio of dead weight to paying load of 40 per cent.

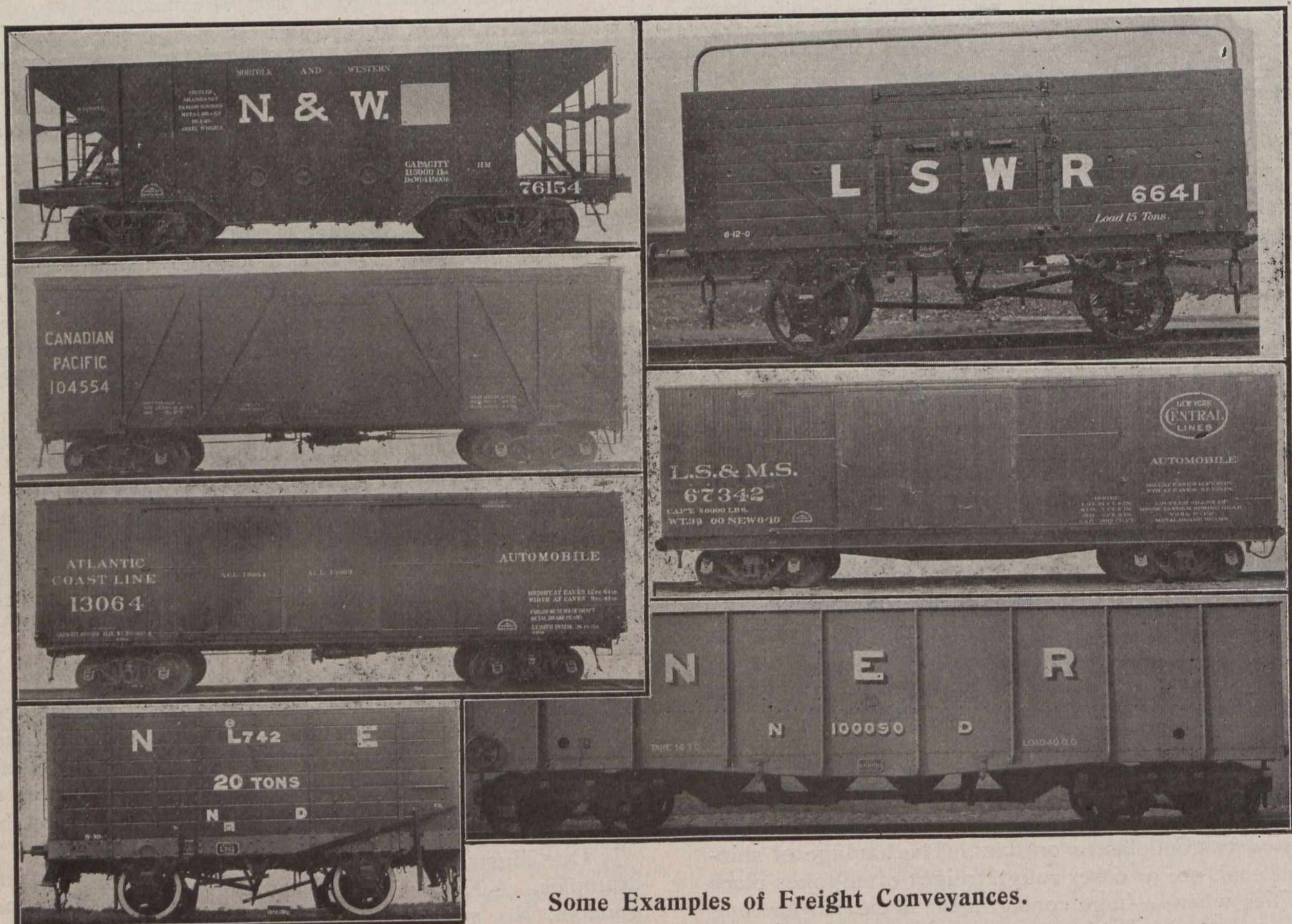
C.P. Box No. 104554, when similarly examined, is seen to have a capacity of 80,000 lbs. and a tare of 38,300 lbs. This gives a ratio of tare to load of 48 per cent. London and South-Western open goods wagon No. 6641, of 15 tons capacity, 33,600 lbs., and tare of 14,784 lbs., gives a ratio of tare to load of 44 per cent. A.C.L. Box 130064, used for the carriage of automobiles, has a tare of 38,000 lbs. and a capacity of 60,000 lbs. The ratio between the two is, therefore, 63 per cent. It must be observed that this is what might almost be called a special car, as an automobile takes up space rather than weight.

A Great Western Railway of England, 10-ton covered goods wagon (shown as nearly as may be, by a L.T. and S.E., somewhat similar vehicle) has a tare of 15,232 lbs. and capacity of 22,400 lbs., and gives a 68 per cent. ratio. Erie Box 107831, with tare 40,200 lbs. and capacity 80,000 lbs., gives a ratio of dead weight to load of 50.25 per cent.

North-Eastern Railway of England open goods wagon No. L. 742, with tare 20,048 lbs. and a capacity of 20 long tons or 44,800 lbs., gives a ratio between the two of 44.75 per cent. L.S. & M.S. Auto-Box 67342, with a tare of 39,000 lbs. and capacity 80,000 lbs., shows a ratio of 48.75 per cent., and London, Tilbury and South End Railway (English) open 10-ton goods wagon No. 1411, with tare 13,272 lbs. and capacity 22,400 lbs., gives a proportion of dead weight to live load of 50.9 per cent.

gregate tare is 99,176 lbs., giving an average of 46.60 per cent.

In these two cases there is not much to choose from, but it may be remarked that the Canadian and United States cars contain much greater volume than do those of the United Kingdom, and the former are subject to interchange among the various roads, a practice almost unknown on the other side of the water. This tends to increase hard usage. Weather conditions here are more severe, and everywhere shunting on this continent is far more detrimental to cars than it is abroad. The percentages stand almost even, but with the larger business done here, under severe conditions of service, against the handicap of snow, cold, more numerous grades, sharper curves, and with the strains incidental to long trains and



Some Examples of Freight Conveyances.

(1) N. & W. high-side steel hopper gondola; capacity 115,000 lbs.
(2) C.P.R. box car; capacity 80,000 lbs.
(3) A.C.L. box car (automobile doors); capacity 60,000 lbs.
(4) N.E.R. (English) open goods wagon; capacity 44,800 lbs.
(5) L. & S.W.R. (English) open goods wagon; capacity 33,600 lbs.
(6) L.S. & M.S. box car (automobile doors); capacity 80,000 lbs.
(7) N.E.R. (English) open steel goods wagon; capacitv 89,600 lbs.

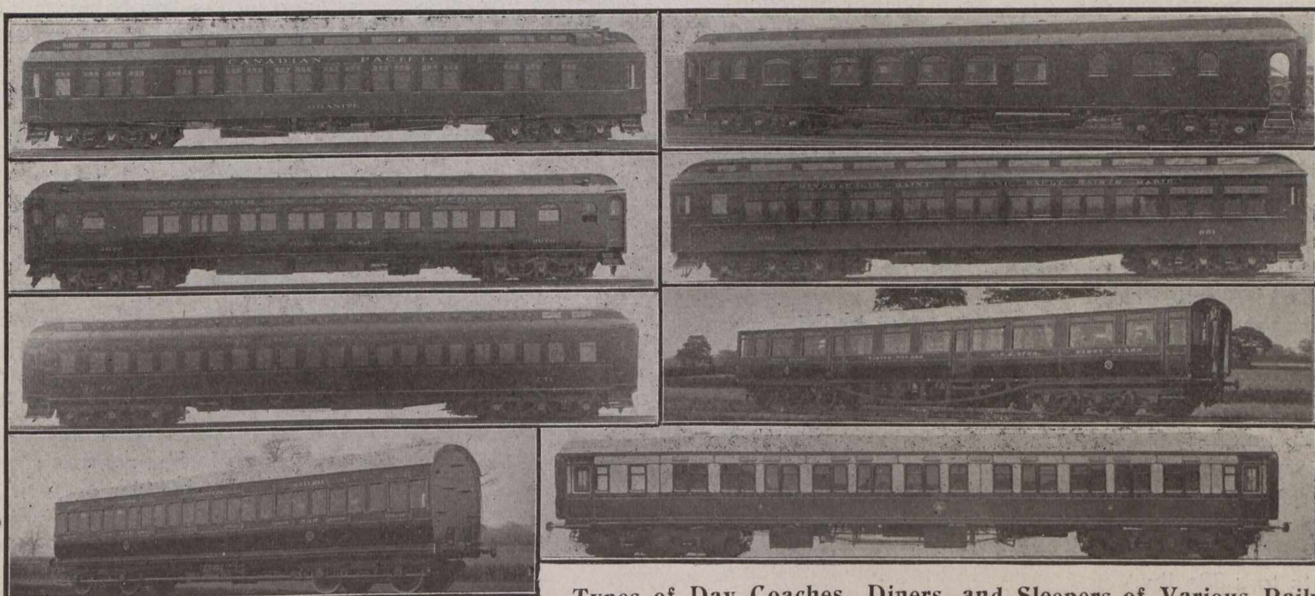
In these examples we have five Canadian and United States and five British vehicles, and though they are not strictly comparable, because each differs widely in certain particulars from the others, yet a rough and ready comparison may be attempted. The total capacity of the five Canadian and United States cars is 415,000 lbs. and the aggregate tares amount to 197,300 lbs. The ratio of aggregate tare to aggregate capacity gives a percentage of 47.54; and in like manner the five British goods wagons show an aggregate capacity of 212,800 lbs., and the ag-

heavy engines, the actual "work" done by the American freight car, carrying more weight per vehicle, cannot be accurately determined by the simple survey of the mathematical ratio representing the proportion of dead weight to live load.

When day coaches and sleepers are taken into account, it is at once obvious that value of the paying "load" cannot be computed by weight, either physical or "moral." It is usually determined by the distance travelled and the accommodation provided. All persons are considered as practically equal and one dollar as good as another. The relative seating capacity, when compared with dead weight, varies with each coach and in each country. The "value" of each traveller in terms of "pound-miles" is not anything like as uniform a method of rating as the distance passed over or the "dollar-equal-dollar" system would seem to indicate. In other words the dead weight hauled per passenger becomes an important item when the mileage of each coach comes to be made up for a year of continuous service. There are certain things done by railways which cost money and weight and space, which have for their sole object the hope of attracting business, such as the observation platforms on certain coaches or the introduction of library cars on trains. From a purely transportation point of view these things are useless, but as "business-getters," they may be very effective adjuncts.

New York, New Haven & Hartford sleeping car No. 2070 is all wood. The body weighs 99,600 lbs., and the trucks together weigh 44,000 lbs., or a total of 143,600 lbs. There are 16 sections and at night there is accommodation for 32 persons. As a day-coach, which is its maximum load, 64 persons can be carried, and taken this way, a dead weight of 2,243 lbs., for each passenger, is hauled over the road.

The Canadian Pacific Railway sleeper "Granite" is all wood and has two six-wheel trucks, which taken together weigh 40,400 lbs. The body weighs 90,800 lbs., making a total of 131,200 lbs. There are twelve sections, each capable of carrying four persons when the car is used in the day time. Allowing for four persons in the drawing room, the dead weight per passenger is 2,523 lbs. Intercolonial railway sleeper "Sydney" has ten sec-



Types of Day Coaches, Diners and Sleepers of Various Railways.

(1) C.P.R. sleeper "Granite"; weight, 131,200 lbs; carries 52 day passengers.
(2) N.Y., N.H. & H.R.R. sleeper; weight, 143,600 lbs.; carries 64 day passengers.
(3) N.Y.C. day coach; weight, 142,600 lbs.; carries 84 passengers.
(4) N.E.R. (English) bogie, third-class carriage; weight, 64,400 lbs.; carries 80 passengers.
(5) Intercolonial sleeping car "Sydney"; weight, 130,000 lbs.; carries 44 day passengers.
(6) M., St. P. & S. Ste. M. day coach; weight, 126,500 lbs.; carries 76 passengers.
(7) N.E.R. (English) corridor composite dining saloon; weight, 91,840 lbs.; carries 26 passengers.
(8) G.W.R. (English) sleeper; weight, 93,632 lbs.; carries 12 night passengers.

As a typical example of a modern day-coach, first-class, New York Central Lines (Big Four) No. 751 may be considered. This car is an all-steel vehicle, mounted on two six-wheel trucks. The body of the car by itself weighs 98,500 lbs. and the trucks weigh together 44,100 lbs. The total weight on the track is, of course, 140,600 lbs., and seating capacity is provided for 84 persons. There is, therefore, 1,697 lbs. dead weight for each passenger, supposing the car to be full. Another day-coach, No. 991, on the Minneapolis, St. Paul & Sault Ste. Marie, is a coach with steel exterior and wooden finish, seats, etc., inside. The car body weighs 84,000 lbs. The pair of six-wheel trucks together weigh 42,500 lbs. and the vehicle stands on the track weighing 126,500 lbs. and can carry 76 persons. The dead weight per passenger in this case is 1,664 lbs., which is very close to that of the Big Four coach just mentioned. The average, when the weight of the two cars are added together, for the 160 passengers carried by them, is 1,680 lbs.

tions and a drawing room. As a day-coach, i.e., with all available space filled, there is comfortable room for probably 44 persons, and estimating the total weight of the car at 130,000 lbs., a dead weight of 2,954 lbs. per passenger is hauled.

The sleeping cars here enumerated have together a gross weight of 404,800 lbs., and carry, when each is full up to maximum capacity, an aggregate of 160 persons. The average dead weight per passenger then becomes 2,523 lbs. This is practically equal to the Canadian Pacific sleeper "Granite," which thus represents a typical case.

British passenger rolling stock presents some interesting varieties, though comparison with Canadian and United States coaches is difficult, owing to a variety of circumstances. The Pullman car has been introduced into Great Britain but has never been popular. This is not due to any idea of inferiority of design, equipment or comfort, but because the English do not care to travel "in bulk," if one may so say, when they are able to pay for the comparative privacy of the compartment. This is no more an example of prejudice than is the preference of the people of the United States, who do not care to be "penned up" in small groups. People on both sides of the Atlantic are gradually modifying their likes and dislikes, as the British are now willing to dine all together in a restaurant car while on the rail, and the traveller on this side is not altogether adverse to the "boudoir" car.

Midland Railway (English) corridor composite (1st and 3rd) No. 2865, weighs 67,720 lbs., and carries 34 passengers. It therefore has a dead weight per passenger of 1,992 lbs. London and South-Western Railway (English) corridor composite (1st and 2nd) coach No. 859, weighs 64,400 lbs., and carries 34 passengers, thus giving a dead weight for each of 1,894 lbs. North-Eastern Railway (English) No. 838, (all 3rd class) weighs 53,312 lbs., and carries 80 passengers. The dead weight for each is 666.4 lbs. These three coaches have an aggregate weight of 185,432 lbs., carry in all 148 passengers, and have an average dead weight per person of 1,252 lbs.

Great Western Railway (English) corridor sleeping car No. 9082 (all 1st class) weighs 93,632 lbs. and accommodates 12 persons. Its dead weight for each goes as high as 7,803 lbs. It is interesting to note from the engraving that this vehicle has the words "sleeping car" on each side. The word "car" is apparently beginning to be used in Great Britain to signify railway rolling stock, as over there the word "motor" is used to indicate what we call an automobile. North-Eastern Railway (English) diner (1st and 3rd) No. 3753, is a corridor composite carriage, weighing 91,840 lbs. and accommodates 26 persons, i.e., 13 of each class. The dead weight per passenger is therefore 3,532 lbs. This N.E. diner No. 3753 and G.W.R. sleeper No. 9082 have an aggregate weight of 185,472 lbs. and together transport 38 passengers, thus the average dead weight per passenger amounts to 4,880 lbs.

The North-Eastern diner is mounted on two six-wheel trucks and, like all other British corridor cars, has what we would call a vestibule at each end. The body is supported on steel frames, and the lower chord is bent down into the form of a bow-string girder. The windows are wide and high and the absence of a running-board along the side is noticeable. Each of the vestibule doors and the two in the side are provided with short steps, almost on the level of the door sill. The Great Western sleeper has no side doors, the two vestibule doors being provided with short steps.

The British form of composite carriage, by which the different classes of passengers are included in the same vehicle, has the advantage of being more in service in certain sections of the country than if each car carried only one class. Where there is steady and regular traffic the single class car is satisfactory, but where traffic fluctuates or where the "classes" presenting themselves at a station do not always appear in approximately the same proportions, the coach carrying more than one class is likely to have a sufficient number on board to constitute a "paying load," if it can be used at all. Whatever security by form or construction, or whatever safety service may be used, all patrons, regardless of "class," are benefited thereby.

Analyzing what figures are before us, it appears that Canadian and United States day coaches show an average of 1,680 lbs. hauled for each passenger carried, while the British day and corridor carriages show 1,252 lbs. per passenger. The Canadian and United States sleepers show 2,780 lbs. and the British sleeper and diner give 4,880 lbs. The British day coaches have less dead weight than ours, and this is to be expected, as British carriages are proverbially light in construction compared to those on this side. The better showing apparently made by American sleepers is probably due to the fact that the sleeper has here been taken with every section holding four persons. As a matter of fact, this does not occur in practice. If each section only held two persons, the average dead weight would be 5,560 lbs. and, taken day in and day out, this probably approximates to actual performance on many trips. A fairer estimate would seem to be the average of the maximum and minimum figures, or 4,170 lbs. average dead weight per passenger.

The British figure is largely modified by the sleeper and diner, here instanced, being very restricted in accommodation for passengers, and it is probable that the British average is much better. These examples not only show the difficulty of making a fair comparison, but demonstrate again, if that were needed, how unreliable is the inductive method where the evidence to be considered is inadequate. The number of examples available is too small and magazine space too crowded for the results of extended investigation, except in the most condensed form. The point, however, stands out clearly that the question of dead weight in railway rolling stock of all kinds plays an important part in economic operating. There are many and important factors to be taken into consideration, and there is before the student an inviting field for research, which perhaps this presentation of the subject may help. The British and American systems are the result of evolution and it is probable that many things which at first sight appear to be glaring contrasts, may shade down to mere differences of practice, or turn out to be like variations which appear in the same species due to local conditions or to the influence of the habitat.

CORROSION OF NICKEL, CHROMIUM AND NICKEL-CHROMIUM STEELS.

Some corrosion tests are described by J. N. Friend, J. L. Bentley and W. C. West in "Engineering," Vol. 93, p. 753, in which disks were prepared of carbon steels, to serve as standards, of nickel steels, of chromium steels, and of nickel-chromium steels, each 0.7 cm. thick and 2.8 cm. in diameter. These disks were kept nearly immersed in tap-water for 64 days, in sea-water for 60 days, in 0.5 per cent. sulphuric acid for 60 days, in 0.5 per cent. sulphuric acid for 53 days, and they were exposed to alternate wet and dry tests for 52 days. The acceleration tests in 0.5 per cent. sulphuric acid gave misleading results, and the two standard steels which showed practically equal corrosion in all the other tests, showed 100 per cent. deviation with 0.5 per cent. sulphuric acid, and with the other steels there were remarkable differences. In some cases there were indications of galvanic action in the chromium and nickel steels in the acid tests, and no chromium nor nickel passed into solution, showing that these elements were the constituents of the cathode. The resistance of chromium steels to corrosion in salt water suggests the use of this metal for ship-building. Nickel steels show marked resistance both to acid and neutral corrosive solutions, the resistance increasing with increased nickel content.

PROPORTIONING OF CONCRETE.

IN correctly made concrete the amount of sand should be just sufficient to fill the voids in the coarse material, and the amount of cement just sufficient to fill the voids in the mixture of sand and coarse material and to coat all the particles with very thin jointing layers. It is a rational assumption that such concrete will give a maximum of strength with the minimum of cost, and if such assumption be justified by experimental results it follows at once that the proportioning of concrete-forming materials is of the utmost importance. Greater strengths can be obtained by the use of excess of cement, as in the case of the ordinary mix of 1:2:4, but the increase in strength is less than the increase of cost of materials and is, therefore, only justified in particular cases.

The strength of any concrete will depend not only upon the materials and their proportions, but also upon the method of using those materials. Any void in a mass of ¾-in. coarse material may be filled in many ways. Firstly, it may be filled with cement and sand mortar, as in the 1:2:4 concrete; secondly, it may be filled with a piece of stone which practically fills the whole space; and thirdly, it may be filled with a number of stones which vary in size with a minimum amount of cement and sand mortar. The first filling is composed almost wholly of joints, and on that account is weak; the second filling is strong, owing to the absence of joints, but it is impracticable; but the third is a compromise which is not only practicable but also strong. It will be seen that the amount of the variations in size or the grading will depend upon the nature and quality of the work required. On the one hand there will be good but costly filling and on the other a cheap but still good filling, and whether the gradiation be large or small the filling will be better than one of cement and sand mortar only.

With a view to testing the effect of "proportioning" upon the strength and other properties, and also the cost of concrete, John A. Davenport and Prof. S. W. Perrott, of the civil engineering department of Liverpool University, drew up a series of experiments, the intention being to test compressive strength, modulus of rupture, specific gravity, water resistance, and fire resistance. Various difficulties arose in the course of the work which prevented the inclusion of specific gravity, water resistance and fire resistance tests. The results were contained in a paper recently presented by them at a meeting of The Concrete Institute, and entitled "Sand and Coarse Material and Proportioning Concrete."

The series involve 216 test pieces, to which must be added others prepared for water and fire resistance and specific gravity tests, but which could not be tested in the time available. The voids were measured in a patent apparatus designed by Mr. Davenport, which gives results to 1/5 of 1%; and which was found to be independent of the observer. The preliminary data comprised tests on Portland cement, size of granite chips, volume of chips per batch, percentage volume of voids in chips, sizes of river-sand used, volume of sand used per batch, percentage volume of voids in sand, and the volume of cement used per batch. Regarding the latter item it must be noted that no allowance was made for the excess cement required for jointing, only the amount required to fill the voids being used. Had time permitted it, the correct allowance in each case would have been ascertained and additional tests made therewith. The limited time made it impossible to test the cement before using it for the concrete testpieces, the brand only suggesting its probable good qualities.

The batches were hand-mixed by engineering students and as no special means of testing the thoroughness of the mix were adopted, the resulting concrete will probably not compare favorably with machine-mixed concrete so far as uniformity of results go. Every care was exercised, however, in mixing to get all the materials thoroughly intermixed and apparently uniform. This proved to be the case when the specimens were tested. The moulds were made of planed boards, bolted together with gangs, damped before using, and lined with paper on the under side to facilitate removal. In spite of this, several pieces were damaged in removal, due more particularly to the relatively small sections used.

Immediately after mixing, the moulds were filled and left in a tool shed till required for testing. They were wetted regularly every three or four days.

It was found that the ratio of compressive to tensile strength varied more in the one-month than in the three-month tests, and is not sufficiently uniform to base any conclusions upon, beyond the fact that such ratio is not constant. It is considered by the authors, however, that this ratio should be more or less constant as the failure, whether compressive or tensile, depends upon the adhesive strength of the cement.

The ratios of strength at three months to strength at one month were more or less uniform, more particularly in the case of comparative strengths. In the case of 1:2:4 concrete the modulus of rupture appears to increase more rapidly than the compressive strength, while in the other series with cement accurately proportioned, the compressive strength increases more rapidly than the modulus of rupture, as out of six series only one runs the other way, probably due to rather dry mixing of those three-month test pieces.

Although the cement tests are unsatisfactory, it will be possible to compare the strengths and costs of the concrete in the different series, as they will probably all be affected to the same extent. The most important point brought out by such comparison is the fact that for accurate proportions, the ratio of cost of cement to total cost is practically constant for all gradings taken in the tests, so that when the graded coarse material is used the total cost need only be further considered. Of course, the total cost is always the final criterion as regards economy, and it may be suggested that the ratio cost of cement to total cost need not be considered. But the relative values of total cost obtained may be altered when additional tests are made at other ages, and it is difficult to say whether they will be affected by the ratio, so that if it can be shown conclusively that this ratio is constant or nearly so, the total cost, age and proportions need only be dealt with.

The authors did not feel justified in attempting to generalize from the results which they obtained, as they considered such results did no more than open up the subject of proportioning and grading in relation to cost. They had no hesitation, however, in saying that the figures given by them show conclusively that the subject is well worth being made the object of special research.

It is announced at Ghent, Belgium, that the third section of the railway line of the Great Lakes will, it is estimated, be completed as far as the shore of Lake Tanganyika, during the second half of the current year as only 50 kilometers of rails remain to be placed and several bridges to be completed.

PROTECTION OF STEEL GIRDERS FROM SMOKE.

The problem of protecting steel work from locomotive smoke has been coped with by the city of Baltimore in an unusual but, up to the present, satisfactory manner. The city engineer, Mr. H. K. McCay, gives a brief description in "Municipal Engineering" of the method followed to protect the steel viaducts directly over railroad tracks throughout the city from the detrimental influence of the gases and cinders from locomotives.

The city of Baltimore is divided by a stream of water which flows from the northwest to the southeast through the most populated districts of this city. The various railroads have utilized the valley of this stream for the purpose of ingress to and egress from the city, laying their tracks along and parallel therewith. Union station, used by the Pennsylvania, Western Maryland and Northern Central railroads, is practically on the banks of this stream. In order to carry the north and south streets in Baltimore across this stream and across the railroad tracks it was necessary to construct at a great deal of expense, five bridges, namely: Guilford avenue, Calvert, St. Paul and Charles streets, and Maryland avenue. Most of these bridges span the railroad tracks at a height which prevents the gas from the engines destroying the steel, but on two bridges, namely, the Calvert and St. Paul street, the clearance is such that the blasts from the engines destroy any protection that is put over the lower members to protect them.

The Calvert street bridge is a magnificent structure, 62 feet in width, with a total length of about 600 feet. The spans are the bow spring type of truss, and made almost entirely of wrought iron. This bridge was built in the year 1878, and cost approximately $220,000. There is a clear span over the railroad tracks of about 146 feet, and a clearance over the Pennsylvania tracks of 23 feet. The author found, as stated above, that the lower members of this bridge became badly corroded from the gases of the locomotives, as many as five hundred of these engines passing under this bridge each day. It had been the practice of the city engineer's department to paint these bridges each year, either with coal tar paint or with the very best red lead paint obtainable. He also found it was nearly impossible to use the ordinary scaffolding to allow time for the paint to harden, therefore he constructed a closed scaffolding, and swung the same beneath the bridge, cleaned off the lower members very carefully and repainted with two coats of paint, allowing the scaffolding to remain as a protection for a week or ten days until the paint thoroughly hardened. In spite of all this protection, it was found that the paint would not stand the blast from the engines, and the lower members, in order to preserve them, had to be painted each year.

Mr. McCay therefore decided to encase the lower members of the bridge in concrete, and careful computation was made as to whether the weight of the concrete would alter the stresses and strains as calculated for this bridge. He found, by removing some ornamental castings, which were of no vital moment to the bridge, that a comparatively thin coat of concrete could be placed on the bridge without increasing the stress or strain, and, if anything, improve the stability of the lower members, thereby reducing to some extent the vibration.

The lower members of the north span consist of nine built-up steel girders, with a surface area of approximately 5,000 square feet. The specifications called for concrete to be put over these members to a thickness of 1½ inches. These girders were carefully cleaned by means of sand blasting and acids, so that all of the old paint was removed, and the steel surface carefully exposed. Wire mesh reinforcement was carried all around the beams, and a coat of "gunite," 1½ inches in thickness, was applied; the gunite following the contour of these beams. The reinforcement is held away from the face of the steel by means of ½-inch iron rods, as it was found that the channel method was not satisfactory.

The total area, as mentioned above, was about 5,000 square feet for the north span of this bridge, and the contract was let at $1.25 per square foot. An additional area has recently been advertised and the contract let at an expense of 95 cents per square foot.

The grout placed by means of the cement gun proved very dense and thick and there is absolutely no danger of gases from the engines penetrating the steel through this grout and Mr. McCay is of the belief that the city of Baltimore has gotten rid of a very expensive renewal item by the adoption of this method.

NITRITE TEST FOR POLLUTION.

In a paper which he read at the recent convention in Philadelphia of the American Water Works Association, Mr. W. M. Booth outlined his use of the nitrite test in tracing a source of pollution in a supply of drinking water, and endeavored to show from experimental results the relation between the nitrites and the existence of the source of probable pollution in a number of cases of springs, wells, streams and lakes. In the instance in question, the author, who has for some time made occasional analyses of a certain water supply at a matter of record, found the nitrites unusually high, accompanied by high ammonias and colonies of bacteria on gelatine. A simple drive well was driven about 8 feet into the ground at numerous points around the wells from which the supply was drawn, and tests for nitrite made on the water pumped from these. By noting which wells showed the highest nitrite, he was able to locate a large amount of decomposing animal matter. The nitrite in the waters from the several wells varied from nothing and .002 to as high as .046 and .044, the latter being found near the putrifying matter referred to.

TIMBERS PRESERVED IN SALT.

In replacing a trestle recently burned along the north shore of Great Salt Lake, according to the "Railway Age-Gazette" engineers found piles perfectly sound after 43 years of service. At another point on the lake, piles 18 in. thick, set 29 years ago, are similarly preserved with salt which has penetrated to their very centre. Timbers in trestles across Salt Lake, placed in 1902, appear to be as good as when they were driven. They have been preserved well above water line by the salt dashed on them by the waves. The first transcontinental telegraph line was abandoned when the railroad was built, and the old poles were sawed off at the ground. An engineer who recently examined the butts in the salt desert near Fish Springs found that, although fifty years had passed since the poles were cut off, the old butts were perfectly sound.

Telephone companies in the Salt Lake valley use salt for preserving poles. When set up, about a bushel of salt is placed around the pole on the ground. The reason why the waters of Salt Lake act as a strong preservative, as distinguished from ocean waters, is because the lake water contains so much more salt, being practically a saturated solution.

MODERN BITUMINOUS SURFACES AND BITUMINOUS PAVEMENTS.*

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ALTHOUGH bituminous pavements have been in use in American municipalities for nearly fifty years, the introduction of modern bituminous surfaces and bituminous pavements in the construction of highways outside of built-up districts is of comparatively recent origin in America, dating from about 1906. This point is well illustrated by the fact that in 1908 the total yardage of bituminous surfaces and bituminous pavements constructed under the jurisdiction of the eight leading state highway departments in the eastern part of the United States was only 416,700. Since that period the growth of the use of bituminous materials in the construction and maintenance of roads and pavements has been exceedingly rapid.

In order to avoid misunderstandings, the various methods of using bituminous materials referred to in this paper will be explained by the following definitions:—

Bituminous surfaces are those consisting of superficial coats of bituminous materials with or without the addition of stone or slag chips, gravel, sand or materials of a similar character.

Bituminous macadam pavements are those consisting of broken stone and bituminous materials incorporated together by penetration methods.

Bituminous gravel pavements are those consisting of gravel and bituminous materials incorporated together by penetration methods.

Bituminous concrete pavements are those having a wearing surface composed of stone, gravel, sand, etc., or combinations thereof, and bituminous materials incorporated together by mixing methods.

The definitions of bituminous surfaces and bituminous concrete pavements quoted above have been advocated for adoption in the reports of the special committee on "Bituminous Materials for Road Construction and Standards for Their Test and Use" of the American Society of Civil Engineers, whereas the fundamentals of the above definition of bituminous macadam pavements are embodied in the following quotation from the 1913 report of the association for standardizing paving specifications: "If the stone is spread in place and the bituminous cement or binder applied afterwards, the resulting product is bituminous macadam." As sheet asphalt pavements have been in use for many years and as the essentials of good construction have been well established, this type of bituminous pavement will not be dealt with in this paper.

Bituminous Surfaces—Since the formulation of the fundamental principles of the successful construction of tar surfaces by the engineers of the Department of Roads and Bridges of France in 1903, bituminous surfaces have been used extensively in Europe. As an illustration, might be cited the construction of five million square yards of tar surfaces in one county of England, in 1911, under the supervision of the county surveyor of Kent, H. P. Maybury, M.Inst.C.E. During the past eight years American engineers have used bituminous materials in this method of construction and maintenance of roads and pavements.

In the case of broken stone and gravel roads, the most efficient method of procedure is to thoroughly clean the surface by sweeping with hand brooms or horse sweepers and hand brooms, the final sweeping being done with bass or other fine fibre brooms. The bituminous material, which is generally heated, is applied to the surface in amounts varying from one-quarter to one-half gallon per square yard with the aid of pouring cans, hose attached to tanks, hand-drawn gravity distributors, horse-drawn or motor truck gravity or pressure distributors. Some kind of mineral coating is generally applied to cover the bituminous material. The degree of cleanliness of the surface obtained by sweeping will depend to a large extent upon the details of the original construction. It has been found that a road with a thoroughly rolled and well puddled broken stone wearing surface composed of road metal from one inch to two and one-half inches in longest dimension may be easily cleaned and the essential adhesion of the bituminous surface readily secured. This method is characteristic of the modern practice of many of the foremost English and French engineers.

Considerable development has taken place in the use of different kinds of bituminous materials. Tars, both of the water-gas and coal-gas types, continue to be used to a large extent. Without doubt the most comprehensive specifications for the construction of bituminous surfaces with tar are those adopted by the Road Board of England. There has been noted a growing objection to the use of certain asphaltic oils which require from two to three weeks to "set up" to such an extent that tracking will not occur.

Bituminous Macadam and Bituminous Gravel Pavements.—Bituminous macadam and bituminous gravel pavements are of many types, one of the primary differences in construction being the use of one or two applications of the bituminous material. The efficacy of many of the types depends upon the combinations of sizes of broken stone or gravel and the combinations of bituminous materials used when two applications are employed. Variations in types also exist dependent upon the manner in which the different courses may be filled and the treatment of the filled course prior to the application of the bituminous material. The one-application method is very similar in its simplest form to the construction of a bituminous surface except that the bituminous material is applied upon a much more open surface. In the case of the two-application method in certain instances an attempt is made to build up a two-course pavement, while in others the second application is in reality used as a seal coat.

Two of the main difficulties in the construction of bituminous macadam pavements have been to secure a thoroughly compacted wearing course of non-segregated broken stone and the uniform application of the bituminous cement so that the broken stones of the wearing surface would be uniformly bound together. In connection with the above statement should be noted the following excerpt from the 1914 report of the special committee of the American Society of Civil Engineers:—

"An important factor for successful results (in the construction of bituminous pavements by the penetration method) is the thorough compaction by rolling of the road metal before the spreading of the bituminous material."

Two methods which have given satisfactory results will be cited as examples of modern practice.

When the metalling in the wearing course consists of a naturally graded aggregate ranging in sizes from one-half inch to an inch and one-quarter, it has been found unnecessary to further fill the voids by the application of a finer product before the first application of the bitu-

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minous material. The character of the product referred to above is shown by the following mechanical analysis:

Percentage passing	½ inch screen	18.9
" "	¾ " "	43.1
" "	1 " "	34.4
" "	1¼ " "	3.6
		100.0

After the wearing course has been thoroughly rolled, from one and one-quarter to one and three-quarters gallons to the square yard of bituminous material is uniformly distributed. Stone chips, free from dust, are then distributed to fill the surface voids. After the chips are rolled a seal coat of one-half to one gallon per square yard of bituminous material is applied. The pavement is finished by the rolling of a second application of stone chips.

As the second method, will be described what the writer considers the most satisfactory type of bituminous macadam pavement at present constructed in England. The bituminous pavement referred to is known by the name of "Pitchmac," and was designed by the city engineer of Liverpool, John A. Brodie, M.Inst.C.E. The following description of the standard method employed in Liverpool is given by Mr. Brodie:

"Pitch grouted macadam has been found to give most satisfactory results in streets of medium and light traffic, and is now being largely used in place of ordinary macadam, and also of more expensive pavements. It is laid to a depth of from 3½ inches to 4½ inches, in two layers. Welsh granite macadam is used, broken to a 2½ inch gauge for the lower layer and to 1½ inch for the top surface. Each layer is put down dry and continually rolled before and after the grouting of pitch and sand mixture has been applied, until the surface is thoroughly consolidated. The foundation is generally of hand-pitched rock, 10 inches deep as for ordinary macadam, but in some cases a bed of 6-inch concrete has been used on main roads. Pitch macadam is also being much used as a surface covering for old boulder pavements, many of which still exist in Liverpool in old streets where the traffic is very small. The cost of pitch macadam may be taken at 1s. (24 cents) per square yard per inch of depth."

Bituminous Concrete Pavements.—Bituminous concrete pavements other than sheet asphalt and pavements laid by companies as proprietary articles have received more attention during the past three years than at any time since the days of Abbot, Leverich, Scrimshaw and Van Camp. Less fear of litigation proceedings and the introduction of economical mixing machines equipped with heating attachments have exerted a marked influence. But, furthermore, the rapidly growing recognition of the inherent advantages of bituminous pavements constructed by the mixing method has been largely instrumental in its adoption for traffic conditions for which it is believed to be economical and suitable. Bituminous concrete pavements in which broken stone forms an integral part of the mineral aggregate, may be divided into three classes

It is self-evident that the simplest type is one having a mineral aggregate composed of one product of a crusher, that is, similar to the product, in the usual type of portable crushing and screening plant, which passes over one screen and through the larger holes of the adjacent screen. This broken stone, in certain cases, may be somewhat uniform in size, but usually such is not the case. In the writer's opinion, an essential element in the construction of this type of bituminous concrete pavement consists in using a product of a crusher which will have a range from an inch to an inch and a quarter in its sizes. As an illustration will be cited a mechanical analysis of a product which was obtained from a plant where the broken stone passed over a one-half inch screen and through a one and one-quarter inch screen.

Percentage passing	⅛ inch screen	1.2
" "	¼ " "	4.2
" "	½ " "	34.7
" "	¾ " "	40.6
" "	1 " "	17.3
" "	1¼ " "	2.0
		100.0

It is apparent that the above product would not be referred to as composed of uniformly sized stone. It is of interest to note that certain bituminous concrete pavements, having a width of twenty-five feet, constructed with this product of broken stone in 1911 have been subjected to an average daily mixed traffic of two thousand to three thousand vehicles and are at present in excellent condition with no maintenance charges to date.

This type of bituminous concrete pavement has been constructed for many years by using either one or, in certain cases, several courses of broken stone mixed with bituminous cement. As an illustration of the latter method will be cited the practice of one large construction company which builds this type of pavement. The first, or bottom course, of metal coated with bituminous cement ranges from one and one-quarter inches to two and one-half inches; the second course, from one-half inch to one and one-quarter inches; and the third course, from one-quarter inch to one-half inch. The pavement is finished with a dressing of uncoated chips.

Asphalts, tars and tar-asphalt compounds have been used for the bituminous cement. In some cases one kind of bituminous material has been used in the mix and another kind for the seal coat; one of the most common combinations being the use of tar in the mix and asphalt for the seal coat.

As illustrative of some of the details of construction of this type of bituminous concrete pavement which should be covered in contracts, excerpts from specifications recently drafted by Mr. Prevost Hubbard and the writer for the New York Department of Efficiency and Economy will be cited. It should be borne in mind that the temperatures and other limitations specified apply to the bituminous cements and mineral aggregate covered in other sections of the specifications.

"Broken stone for the bituminous concrete shall be heated, as directed, before entering the mixer, to between 66°C. (150°F.) and 149°C. (300°F.) in revolving dryers in which no flame shall be permitted to come in contact with the broken stone and in which the broken stone shall be continuously agitated during the heating.

"The asphalt cement or refined tar shall be heated in kettles so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. Asphalt cement shall be heated as directed to a temperature between 135°C. (275°F.) and 177°C. (350°F.). All asphalt cement heated beyond 177°C. (350°F.), either before or during mixing with the broken stone, shall be rejected. Refined tar shall be heated as directed to a temperature between 93°C. (200°F.) and 135°C. (275°F.). All tar heated beyond 135°C. (275°F.), either before or during mixing with the broken stone, shall be rejected.

"When thoroughly heated to the temperature directed, the asphalt cement or refined tar and the broken stone for the bituminous concrete shall be mixed so that the resulting mixture shall contain between five (5) and seven and one-half (7½) per cent. by weight of bitumen as directed. A mixer shall be used, having revolving blades, and so designed and operated as to produce and discharge a thoroughly coated and uniform mixture of nonsegregated broken stone and asphalt cement. When discharged, mixtures of asphalt cement and broken stone shall have a temperature not more than 149°C. (300°F.), and not less than 93°C. (200°F.), as directed. When discharged, mixtures of refined tar and broken stone shall have a temperature not more than 121°C. (250°F.), and not less than 66°C. (150°F.), as directed.

"The bituminous concrete, heated and prepared as specified, shall be delivered direct from the mixer to the point of deposition on the foundation in trucks or wagons, provided with canvas covers for retaining the heat. As delivered the bituminous concrete shall have a temperature of at least 66°C. (150°F.). Material having a lower temperature than this shall not be laid upon the foundation.

"Rollers used on the bituminous concrete and the seal coat shall be well balanced, self-propelled, tandem rollers, weighing between ten (10) and twelve (12) tons each. Each shall have a compression under the rear roller of between two hundred (200) and three hundred and fifty (350) pounds per linear inch of roll, and shall be provided with an ash pan, which shall prevent ashes dropping onto the bituminous concrete or seal coat.

"As soon as possible after the compaction of the bituminous concrete, when the surface is clean and dry, a seal coat of the hot asphalt cement shall be evenly distributed over the bituminous concrete and spread by means of squeegees as directed. The asphalt cement shall be applied at a temperature not less than 135°C. (275°F.), nor more than 177°C. (350°F.), at a rate of one-half (½) to one (1) gallon per square yard, as directed. A thin, uniform layer of dry, clean, No. 1 broken stone (stone chips) shall be immmdiately spread over the asphalt cement, as directed, by machines or skilled workmen. The spreading of the No. 1 broken stone shall not lag more than twenty (20) feet behind the placing of the asphalt cement coating. Number 1 broken stone shall not be placed on the wearing course before the asphalt cement of the seal coat is applied. The surface of the bituminous concrete shall be kept scrupulously clean until the seat coat is applied, and the contractor shall not permit any hauling over the wearing course before the completion of the seal coat.

"No bituminous concrete shall be mixed or placed between October 1 and May 15, except by written permission, and no bituminous concrete shall be mixed or placed when the air temperature in the shade is below 10°C. (50°F.), or when the foundation is damp or otherwise unsatisfactory."

The second type usually consists of the broken stone composing one product of a crusher and sand or other fine mineral matter mixed together with a bituminous cement. The wearing surface of this mix is sometimes finished by rolling in fine stone chips but generally a seal coat is used together with fine mineral matter for a top dressing. When constructed on a commercial scale, the mineral aggregate is always heated and mixed in a specially constructed machine. Usually the same grade and type of bituminous material is used for the mix and the seal coat.

In the third type of bituminous concrete pavement the composition of the mineral aggregate is definitely covered in properly drawn specifications. As an example may be cited the following method of covering the composition of the mineral aggregate of Warrenite, a proprietary pavement of the Warren Brothers Company, which was used by William H. Connell, chief of the Bureau of Highways, in drafting specifications for the City of Philadelphia.

"Material passing 1¼-inch screen and retained on No. 2 sieve, 40 to 60 per cent. Material passing No. 2 sieve and retained on No. 4 sieve, 10 to 20 per cent. Material passing No. 4 sieve and retained on No. 10 sieve, 10 to 5 per cent. Material passing No. 10 sieve and retained on No. 30 sieve, 10 to 5 per cent. Material passing No. 80 sieve at least 25 per cent.. of which will pass a No. 200 sieve, 10 to 5 per cent. The balance, to pass No. 30 sieve and be retained on No. 80 sieve."

The 1914 specifications of the State of New Jersey contain the following description of the grading of a bituminous concrete pavement similar to the one given above.

Size of Screen.	Percentages, Minimum.	Maximum.
Passing 1½" and retained on 1"	0	15
Passing 1", retained on ½"	40	50
Passing ½" and retained on ¼"	10	25
Passing ¼" and retained on a 10-mesh sieve.	8	15
Passing 10 and retained on a 30-mesh sieve..	12	22
Passing 30 and retained on a 80-mesh sieve..	5	15
Passing 80 and retained on a 200-mesh sieve.	3	8
Passing a 200-mesh sieve	2	8
Bitumen content	6.5	8.5

As another illustration might be cited the well-known Topeka specification, which covers a definite grading of a mixture of broken stone and sand. The Topeka grading is as follows:

Percentage of bitumen	from 7 to 11
Percentage of mineral aggregate passing 200 mesh screen	from 5 to 11
Percentage of mineral aggregate passing 40 mesh screen	from 18 to 30
Percentage of mineral aggregate passing 10 mesh screen	from 25 to 55
Percentage of mineral aggregate passing 4 mesh screen	from 8 to 22
Percentage of mineral aggregate passing 2 mesh screen	less than 10

In the construction of all types of bituminous concrete pavements, in addition to the requirements covering the properties of the bituminous cement and the quality and character of the mineral aggregate, certain essential features should be given careful consideration. The following citations from the 1914 report of the special committee of the American Society of Civil Engineers are specially pertinent:

"Where the character of the traffic justifies the use of a bituminous concrete pavement, the same conditions demand an extraordinarily strong foundation therefor.

"The amount of bituminous material to be used in any case will depend upon the peculiar conditions of that case, such as the kind of road metal and of bituminous material, the character of the aggregate, the climatic conditions, etc.

"The character of the mineral aggregate to be used may be controlled by local conditions, but the best results can only be obtained by the use of the best materials. Excessive sizes or excessive variations in the size of the mineral particles, should be avoided, and the utmost care must be taken to avoid the segregation of the different size particles.

"Mixing machines should be used, and hand-mixing methods should be avoided wherever practicable.

"In the use of a heated aggregate for the construction of a bituminous concrete pavement, non-uniformity or excess in the heating of stone should be avoided.

"Where bituminous pavements are laid, the edges should be protected and a sudden transition from the pavement to any softer shoulder material avoided by means of cement, concrete or other edgings and such reinforcement of the shoulder material as may be necessary."

DIAGRAM OF CONCRETE MATERIALS.

In *The Canadian Engineer* of May 21st, 1914, there appeared a diagram for obtaining quantities of materials required per cubic yard of concrete. This diagram was prepared by R. O. Wynne-Roberts, Consulting Engineer, Regina. A number of extra copies of this diagram have been printed and mounted on stiff board. They should be found of value in estimating quantities and costs. Some may desire to have a copy, mounted as above, on hand for easy reference, thus obviating the necessity of removing a page from the issue in which it was published. Upon receipt of 10 cents to defray postage expense, one of these will be mailed to any address.

DEATH RATE OF WATER BACTERIA.

INFORMATION pertaining to the destruction of bacteria in drinking water and in polluted rivers and streams has come to be regarded as being an important necessity in every community. This, largely for the reason that the knowledge of the danger of pathogenic bacteria to the health of water-users has become widespread.

There enters into the investigation of the degree of pollution and the danger resulting therefrom, the question of the longevity of B. coli. This is necessary in determining the length of time a sample of water may be kept prior to analysis. It is also useful in a determination of the volume to be used in such analysis.

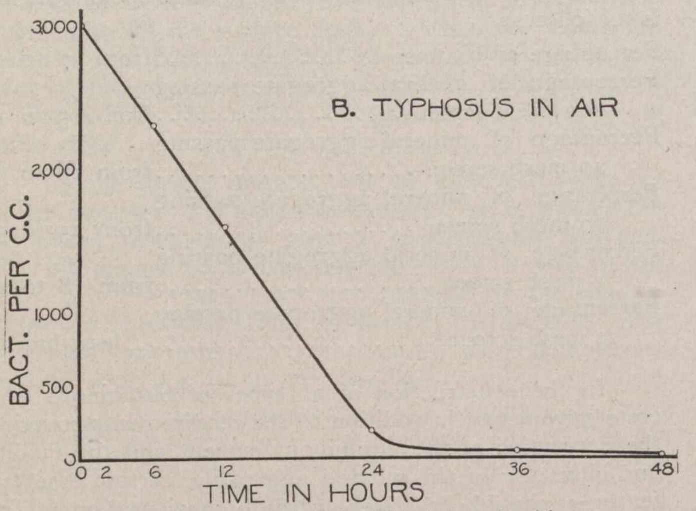


Fig. 1.—Death of B. Typhosus in Air.

In a paper recently prepared by Dr. Otto Rahn, assistant professor of bacteriology, University of Illinois, and Mr. M. E. Hinds, assistant chemist of Illinois State Water Survey, the results are given of experiments made to determine the rate, manner and factors influencing the death of bacteria in drinking water and polluted streams. This paper was presented at a meeting of the Illinois Water Supply Association. From it the following information is secured:

As a number of uncertain factors would be involved in working with a natural water or sewage, it was thought best to work first on pure water under known conditions and to vary the conditions until they finally approached those found in natural waters. The water used for this work was ammonia free, which, however, contained a very small amount of nitrogen. It is purer than ordinary distilled water, being redistilled twice, and is the purest grade of water obtainable unless a large amount of labor is spent on its preparation.

Table I.—Theoretical Number of Cells Present at End of 60 Hours and for Each 6-Hour Interval.

Hours.	Theoretical number of cells.	Actual number of cells.
0	1,000,000	315,000
6	100,000	40,000
12	10,000	937
18	1,000	—
24	100	Less than 1
30	10	
36	1	
42	.1	
48	.01	
54	.001	
60	.0001	

The rate of death of B. typhosus as found by different observers is variable, probably due to different experimental conditions. Of the many contradictory statements concerning the death rate, it is difficult to determine which one is correct as most of the data appear to be reliable. This leaves us in doubt as to whether death is due to lack of food, presence or absence of oxygen, temperature changes or antagonism of other bacteria.

During the last seven years we have learned that bacteria under unfavorable conditions die gradually. Of the total number, a certain percentage will die in a unit of time and of the number surviving the same percentage will die in the next unit of time. As far as we know, this law holds true with all causes of death, whether by disinfectants, light, drying or heat. We know of no exception.

It was only natural to expect this same regularity of death to hold true in the case of B. typhosus and B. coli in pure water. The experiments showed this to be the case. The reduction in the case of B. typhosus was 89.3 per cent. in six hours, that is, after six hours' time only about 10 per cent. of the original number survived. Assuming 1,000,000 cells to be present in the beginning, we find the numbers remaining as shown in Table I., which is based on a reduction of 90 per cent. in each six-hour period.

It is easily seen that we never come to an absolute zero. There are always some bacteria left alive, but the number soon becomes so small, that for practical purposes, we might consider them absent. Table I. shows a reduction in 60 hours from 1,000,000 per c.c. to less than 1 per gallon. Whether such water would be considered safe for use, is questionable. In 96 hours, we would have less than one typhoid bacterium per 1,000,000 gals. Such water would probably be safe. Certainly, no bacteriological or other analysis could discover the bacterium.

B. coli does not die quite as fast as B. typhosus, about 72 hours being necessary to reduce their number from 1,000,000 per c.c. to 1 per gal. Kruse states that B. coli is found a normal inhabitant of all waters, whether good or bad. We can find it, if we only take a large enough sample.

Knowing the facts, we tried to find the cause of death. It is probable that the death of B. coli and B. typhosus in pure water is due to starvation. A sample of tap water was sterilized and inoculated with B. coli and proved to be a fair medium for growth. An initial number of 1,500,000 increased slowly to 3,000,000 in twelve days and then slowly decreased, over half the original number being still present at the end of five weeks, when the experiment was discontinued. At the same time a sample of deep well water with a very high mineral residue was sterilized and inoculated with about 2,000,000 B. coli per c.c. and only 1 per c.c. was found at the end of two days. This death rate was higher than in very pure water. Only a trace of organic nitrogen was present.

It is very important from a practical viewpoint to decide whether or not dissolved oxygen plays any part in the rate of the death of bacteria in water. Whipple and Mayer found B. typhosus died about 20 times as fast without oxygen as with it, and B. coli died about twice as fast. The absence of oxygen was secured by keeping the tubes in an atmosphere of nitrogen and hydrogen. This would suggest a suffocation of bacteria. In our work we have been unable to get the same results with B. coli, as in all of our tests the death rate was lower without oxygen. Our work on B. typhosus bears out the previous work in that the death rate is higher in nitrogen than in air, but the difference is slight as compared with Whipple's, perhaps due to a different strain, perhaps to different water. Figure 2 shows the difference in death rate in air, hydrogen and nitrogen.

The temperature of the water has a direct bearing on the death rate. Even though B. coli and B. typhosus both grow much better at 37° C. than at 20° C., when cultivated under growing conditions, they also die faster at the higher temperature. With B. coli we have found the rate of death to increase 1.8 times with each 10° rise in temperature. Growth and death of bacteria must be looked upon as chemical reactions, and, therefore, must proceed faster at higher temperature within certain limits. In work with B. typhosus in Lake Michigan water, Russell found the death rate increased eight times from freezing to 12° C.

In 1911 Ruediger determined the rate of death of B. coli and B. typhosus in river water under natural conditions both in summer and in winter. He attributes the

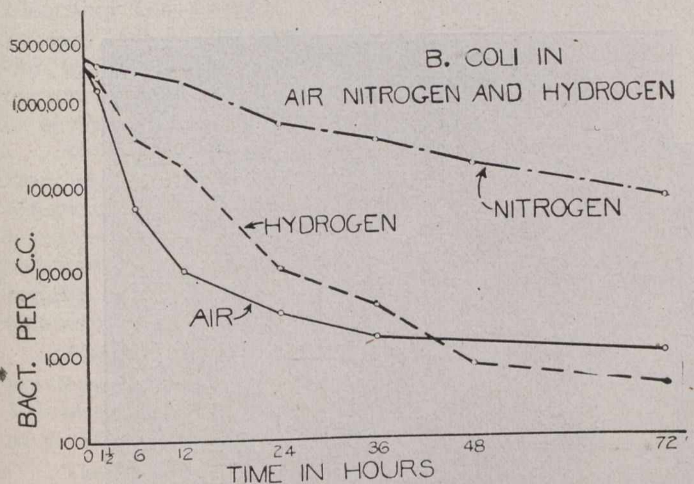


Fig. 2.—Death of B. Coli in Air, Nitrogen and Hydrogen.

faster death rate in summer to the effect of light and to saprophitic plants. We can account for the change in death rate as a change due to the difference in temperature.

Conclusions.—In pure, natural water and in redistilled water, B. coli and B. typhosus die from starvation in the gradual, regular manner observed with other causes of death.

The rate of death increases with the temperature.

The presence of oxygen under these conditions, seems to be harmful for B. coli, but beneficial to B. typhosus.

Further work is to be done on the effect of organic matter, mineral matter, other organisms and the temperature coefficient under these varying conditions.

A NEW STADIA CIRCLE,

THE subsequent computations necessary to reduce observed stadia distances to the correct horizontal and vertical distances have long been a source of trouble and labor to the surveyor. Many arrangements, such as charts, tables, and slide-rules, have been devised to minimize this work, but all have been somewhat complicated and have presented a fruitful source of error. For this reason stadia measurements have not found the universal application which their accuracy and convenience would presuppose.

In the new K. and E. stadia circle an arrangement is presented which will undoubtedly stimulate the use of stadia measurements in all branches of surveying. Not only does this arrangement facilitate the taking of field notes, but it reduces the calculations of these notes to simple arithmetical processes, and, furthermore, the arrangement does not encumber the instrument with complicated and delicate equipment.

The usual method of taking stadia measurements is to observe the interval intercepted on a rod by the stadia hairs and the angle of depression or elevation of the telescope. With this data the observer is then enabled, by using the formulas $H = S \cos.^2 a$, and $V = \frac{s}{2} \sin. 2\,a$, to compute the correct horizontal distance and elevation of the point in question. The mechanical means devised for the solution of these formulas have greatly simplified the plotting of notes, but their use still involves considerable labor and necessitates the carrying of extra equipment into the field.

This new stadia circle is a modification of the regular transit circle, whereby the degree graduations on two opposite segments are replaced by special graduations which give directly the per cent. of the observed stadia distance represented by the horizontal and vertical components.

Through an arc of approximately 60° at the right and left-hand sides of the circle the degree graduations are replaced by the special stadia graduations. At the index marked "Hor." is read the percentage factor to be applied to the observed stadia distance to obtain the correct horizontal distance. At the index marked "Vert." is read the percentage factor to be applied to the observed stadia distance to obtain the difference in elevation between the rod and instrument. Complication in the calculations is avoided by bringing the centre cross hair of the telescope to target or mark on the rod, which has been placed at instrument height before reading H. and V.

Example.—Suppose the observed stadia distance to be 480 feet and the telescope, when sighted on target, to be inclined at such an angle that the reading at the Hor. index is .97 and at the Vert. index .17. Then the correct horizontal distance would be 480 x .97 = 465.6 ft., and the difference in elevation would be 480 x .17 = 81.6 ft.

The simplicity of this arrangement would seem to raise doubts as to its accuracy, but the position of each special graduation is theoretically correct, and exhaustive tests of the instrument throughout the full range of the stadia graduations have proved the device to be practically free from error.

Over a long series of tests by different observers the average error in the reading of the horizontal correction factor was found to be 0.05, which in a 500 ft. sight would introduce an error of 0.25 ft. in the computed horizontal distance. The same trials applied in the reading of the vertical correction factor disclosed an average error of 0.02, which in a 500-ft. sight would introduce an error of 0.10 ft.

By the method of least squares the average error in reading was computed to be: Horizontal + or — 0.09; Vertical + or — 0.07. These larger errors, in a 500 ft. sight would affect the computation of the horizontal and vertical distances by + or — 0.45 and + or — 0.35 ft., respectively, and as the allowable error in stadia work is 1 per cent., it will be readily seen that, in accuracy, this stadia circle compares favorably with any method of computation now used.

USE OF LIQUID CHLORINE AT PHILADELPHIA AND OTHER PLACES.

THE Torresdale intake of the Philadelphia waterworks is in the Delaware River, about 12 miles above the business centre of the city. A review of the results obtained by the filter plant, which has now been in operation at Torresdale for nearly seven years, was given in a paper read by Francis D. West, chemist in charge of the Torresdale Laboratory, and J. S. V. Siddons, superintendent of the filters, before the New England Waterworks Association at its annual convention in September last. The paper contained a general summary of the results obtained with the use of calcium hypo- at hand, viz., the results obtained with liquid chlorine, the following information respecting the former process is given:

Bleach was first used at Torresdale in the form of hypochlorite of soda produced electrolytically, during September, 1909. Two cells manufactured by the National Laundry Company were used. A current of 35 amperes at 110 volts was used to decompose a brine solution. The temperature of the bleach solution averaged 110 deg. F. The chlorine and the soda were allowed to recombine, and the temperature was so high that chlorates were formed.

The bleach was applied directly in front of the inlet valve of one of the pre-filters operated at a 20-million-gallon rate, or one-fourth normal. The conclusions were, in part, that the bacterial efficiency of the filter was considerably less than that of filters operated at four times the rate without treatment.

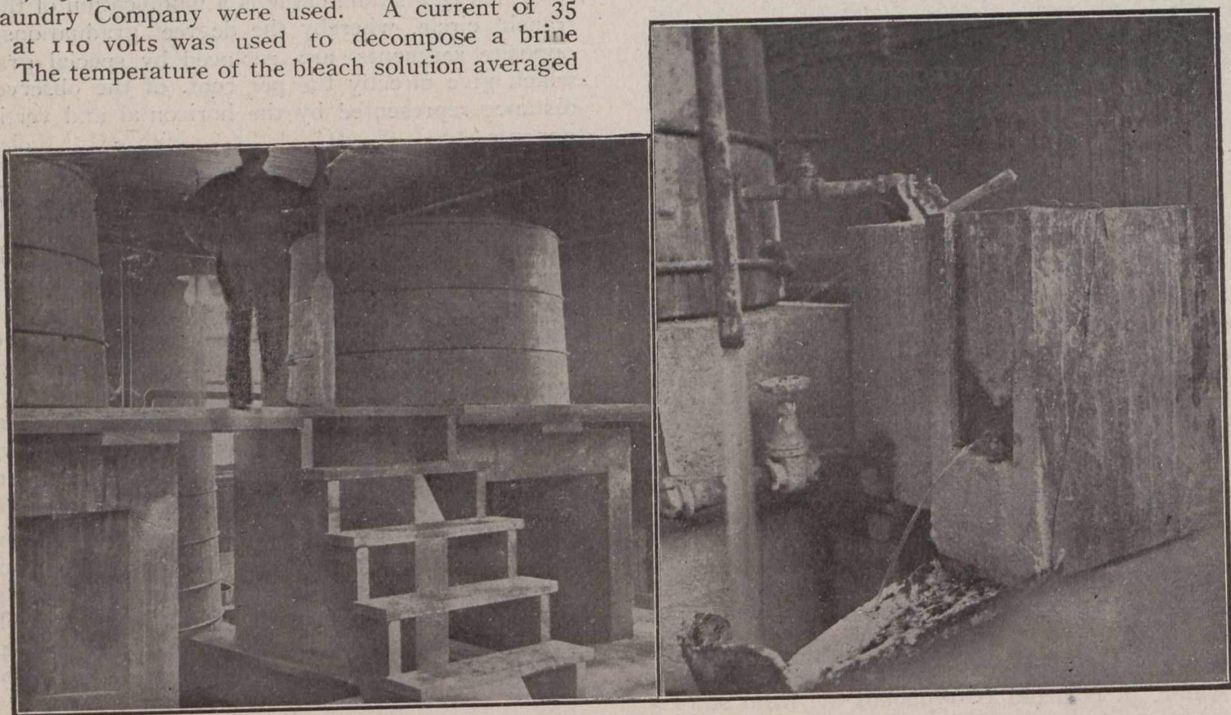
Hypochlorite was again used in December, 1910. Due to the fact that the bacterial efficiency of slow sand filters decreases materially in cold weather, and the fœcal organism, B. coli communis, was present in the filtered water, it was decided to use chloride of lime to disinfect the water in the filtered water basin. Treatment was continued until April, 1911, and stopped until December, when it was again started and used without interruption until February, 1913.

The bleach plant at first consisted of two cedar mixing tanks about 5 ft. in diameter and 4 ft. deep, and one solution tank of the same dimensions, together with a yellow pine orifice tank 2 ft. to a side, which was soon changed to a concrete tank of the same dimensions. After five months' continual service the tanks became so badly perforated that they could no longer be used and were replaced by new tanks lined with 3 in. of concrete.

Fig. 1 shows the mixing and solution tanks and Fig. 2 the orifice tank. Mixing was done by hand, each mix receiving about 2 hours' agitation. From two to six mixes were made a day.

For further details respecting the operation of the plant the reader is referred to the paper mentioned above.

In another paper presented at the recent convention of the American Waterworks Association, Mr. West deals in detail with the use of liquid chlorine. In the course of his paper he presents the following objections to the use of hypochlorite of calcium and the method by which it was applied at the Torresdale filters:



Views of Torresdale Bleach Plant. Fig. 1 (left)—Mixing and Solution Tanks. Fig. 2 (right)—Orifice Tank.

(1) Variation in the strength of solution, due to variable quantities of available chlorine in the powder, and to the variation in the readiness with which the bleach mixes with water.

(2) Interruption to feed of solution, caused by corrosion of orifice or stopping of flow by lumps of sludge or choking of delivery pipe.

(3) Tastes and odors which create in all probability the most serious objection.

Historical Sketch of the Use of Liquid Chlorine in United States.—The credit for the introduction of liquid chlorine for water disinfection belongs to Major C. R. Darnell, who first tried it in June, 1910. He applied the chlorine in the form of a dry gas to the water to be treated. He later carried out a series of tests with an apparatus with a capacity of 500 gal. per hour.

In June, 1912, Dr. Geo. Ornstein constructed an experimental apparatus for the use of chlorine gas for water and sewage sterilization employing a principle entirely different from Major Darnell, involving the absorption of the gas in water prior to its application to the fluid to be treated.

In September, 1912, S. M. Van Loan, Ass't-Chief Engineer, Philadelphia Bureau of Water, assisted by Geo. E. Thomas, chemist, Belmont Laboratory, experimented with liquid chlorine on a large scale at Belmont filter plant. They fed the chlorine into the filtered water basin in the form of gas, regulating the quantity by loss in weight of the containers; about 46 lbs. per day being applied to 36,000,000 gals. of water. With the approach of cold weather, the difficulty of freezing was encountered. Later the cylinder was jacketed and heated by a lamp.

Early in November, John A. Kienle, then chief engineer of the water department of Wilmington, Del., worked along similar lines at the Wilmington plant. By the use of high- and low-pressure valves he was able to regulate the flow of gas. His results were presented at the 1913 convention of the American Water Works Association. He worked in conjunction with the Electro-Bleaching Gas Company, who installed their apparatus January, 1913. This apparatus makes use of an absorption tower, whereby the chlorine is absorbed by a small amount of flowing water which carries it into the supply to be treated.

About the same time Dr. D. Jackson was experimenting at Ridgewood reservoir, Brooklyn, and shortly afterward put out the Leavitt-Jackson liquid chlorine machine. This machine operates on the basis of a balanced beam, feeding the gas according to loss in weight. The gas is fed directly into the water to be treated similarly to the Darnell apparatus.

The first complete set of results for a continued period are those from the Niagara Falls plant operated by the Western New York Filtration Company, under direction of H. F. Huy.

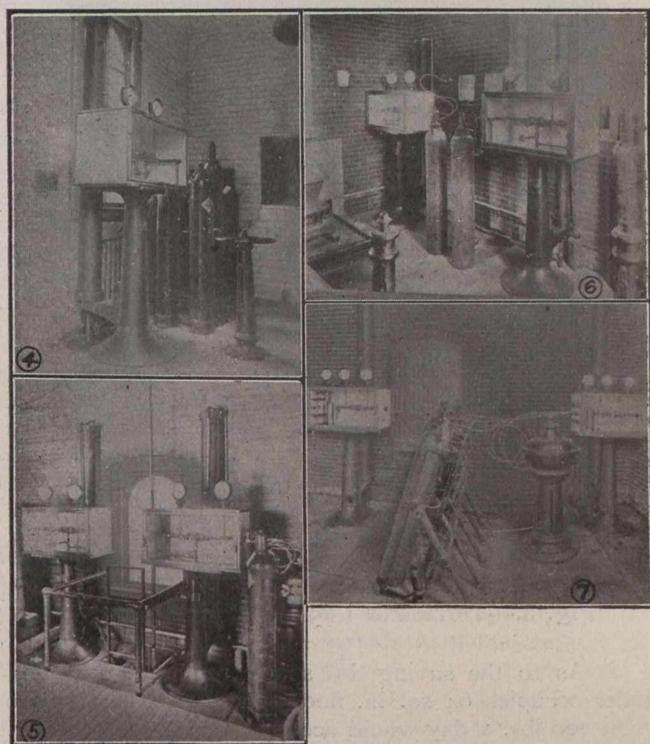
The first permanent liquid chlorine plant in Philadelphia was installed at Queen Lane filter plant September, 1913. A contract for 10 plants, two at each of the five filter plants, was awarded the Electro-Bleaching Gas Company for $9,750. The plants were installed during October and November, 1913; that at Torresdale starting November 25th. Fig. 3 shows the present liquid chlorine installation at Torresdale. Figs. 4, 5, 6 and 7 show similar plants at Queen Lane, Upper and Lower Roxboro and Belmont, respectively.

General Description of Apparatus.—From 4 to 8 cylinders of liquid chlorine are connected by means of flexible copper coils to a manifold with a valve for each cylinder. The manifold is connected with a gauge used to determine initial pressures. Beyond this gauge are two regulating valves; the first reducing the initial pressure to about 15 lbs. per sq. in. and the second regulating the pressure through a range sufficient to give the desired amount of gas. A low-pressure gauge, calibrated empirically, indicates the flow. The gas then passes through a ⅜-in. hard rubber pipe to the bottom of the first absorption tower. This tower is 8 ft. high and is filled with coke to give surface, and is sealed. The excess gas passes through a second pipe to the bottom of a second tower.

These towers, as well as all other parts from this point on, are made of hard rubber. Water is admitted through the top of the towers.

The chlorinated water passes through a horizontal pipe 58 ft. long 4 in. in diam. connected with eight drops ¾ in. in diam. extending to within one foot of the bottom of the chamber and protected from the current by 1½-in. iron casings. About three feet of flexible rubber hose is attached to the ends of these pipes. The ends of the hose are kept in motion by the swirl of the current.

Original Apparatus and Changes Thereto.—Owing to the large quantity of chlorine needed (as high as 10 lbs. per hour) it was planned to feed the chlorine in liquid form through the cylinder valve having an evaporator placed next to the high-pressure valve. This was done to prevent freezing owing to the reduction in temperature due to the rapid evaporation. Cradles were provided for inverting the cylinders. The evaporator was prevented from freezing by having a constant flow of water passing around it.



Views of Liquid Chlorine Installations at the Schuylkill River Plants in Philadelphia. Fig. 4—At Queen Lane; Fig. 5—At Upper Roxborough; Fig. 6—At Lower Roxborough; and Fig. 7—At Belmont.

From almost the start trouble was experienced. The needle and regulating valves of the apparatus gradually choked up with the impurities in the chlorine cylinders chiefly ferric chloride mixed with an oil-like substance with the consistency of petroleum. Liquid chlorine was allowed to pass through the feed pipe of the tower, corroding and choking this up, and found its way through the coil in the evaporator where it came in contact with the water used for cooling and the whole apparatus went out of commission.

When it was found impossible to supply the gas in this manner the cylinders were used vertically and an electrically heated cabinet with automatic thermostatic control was installed. This keeps the cylinders at a temperature of 75 deg. F., and but little trouble with freezing is experienced.

Results at Various Plants.—The paper then outlined the results from treatment at Torresdale, Belmont, Upper and Lower Roxborough, Queen Lane, Niagara Falls, N.Y., Wilmington, N.C., and Wilmington, Del.; comparing, whenever possible, in each case the chlorine with corresponding hypo data. It also included results of liquid chlorine treatment with unfiltered water at Montreal. The Torresdale comparative results are given in the table at the foot of this page.

Advantages of Liquid Chlorine Over Chloride of Lime.—The author then dealt with the claims made for liquid chlorine, an analysis of which may prove of value.

(1) Liquid chlorine is an absolutely pure chemical, concentrated in small cylinders while chloride of lime is bulky, requiring large space for storing.

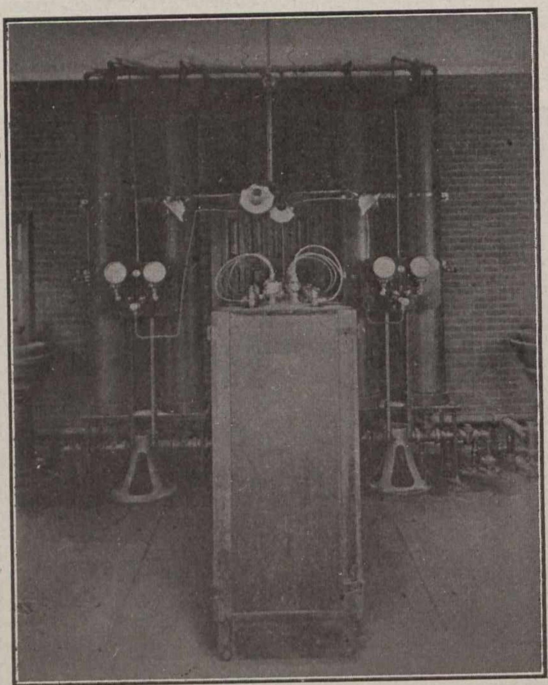


Fig. 3.—Torresdale Liquid Chlorine Plant.

(2) As to the saving in space required, a 100-lb. cylinder occupies 64 sq. in. floor space. A stock for 50 days at 200 lbs. a day would occupy a space of 45 sq. ft., 5 ft. high. About 20,000 lbs. of bleach, enough for but 17 days at 1,200 per day, would occupy (taking the can at 750 lbs. each) 160 sq. ft. On a basis of 6 to 1 about 10 to 11 times as much space is required for bleach as for liquid chlorine.

(3) With efficient controlling devices liquid chlorine will eliminate the disagreeable odors and corrosive influences of chloride of lime; consequently the installation may be placed in position where the use of chloride of lime is impossible. Ordinarily this is true. The odor of chlorine at Torresdale is hardly noticeable; but there are times when, due to carelessness or accidents, the atmosphere has been unbearable and chlorine has escaped in large amounts. (This has usually been caused by the failure of the water supply used for absorption and not by the apparatus.)

(4) Liquid chlorine will retain its full efficiency over unlimited time, whereas chloride of lime deteriorates rapidly. This is one of the best arguments for liquid chlorine, especially for small installations.

(5) The floor space occupied by liquid chlorine plants is small, whereas chloride of lime installations require large mixing tanks, etc. The space occupied at Torresdale for bleach treatment, independent of the space for weighing, was 22 x 16 ft. For the liquid chlorine apparatus the cabinet is 2 x 4.4 ft., and the space occupied by the towers is 10 x 2 ft.

(6) The reaction with liquid chlorine is simple, while that with chloride of lime is complex and less effective at low temperature.

(7) According to Dr. D. Jackson, 1 lb. liquid chlorine equals 9 lb. chloride of lime. According to J. A. Kienle it equals 8 lb. Theoretically, it should equal about 3 lb., but in practice considerable available chlorine is lost and the theoretical amount is nearer 1:4.

Huy, at Niagara Falls, claims to get as good results with 3 lb. of liquid chlorine per day with 6,000,000 gal. of water as he did with 30 lb. of powder. He added 30 lb. to the filter effluent. He adds 9 lb. liquid to the water in the sedimentation basin and 3 lb. to the effluent of the filters. The results are not quite comparable. At Torresdale, liquid chlorine is being used at the rate of about 1:6 to 1:7. It is quite possible that with careless handling and storing of bleach at small plants the figure is nearer 1:8 than 1:6.

(8) No taste or odor appears in water treated with liquid chlorine. Major Darnell states that at least two parts of liquid chlorine, equivalent to 16 lb. per million gal., must be used to give the slightest taste to Potomac River water. Huy stated that when using 5 lb. per million gal. a slight taste was noticed in the laboratory directly after dosing. On a test at Middletown, Conn., 14 lb. per million gal. were used without its being noticed. It is quite possible that if the dosage is heavy enough the water will have a taste, but figuring on a basis of 6:1, 30 lb. of chloride of lime would be needed to correspond to Huy's 5 lb. and 80 lb. to the amount mentioned by Darnell. From a close examination of the literature on

Comparative Results of Treatment With Bleach and Liquid Chlorine at Torresdale.

Date.	Treatment per million gallons.	—Bacteria per cu. cm.— Applied.	Filt.	Treated.	Per cent. removed.	—B. coli in— 1 cu.cm.	10 cu.cm.
Feb. 22-March 31, 1912	9-lb. bleach	17,000	760	260	64	2	13
Feb. 22-March 31, 1914	1.3 lb. liq. cl.	6,800	320	30	90	0	5
Jan. 1-Feb. 28, 1914	4.5 lb. bleach; 0.8 lb. liq. cl.	12,000	710	118	83	0	5
January, 1913	870 lb. bleach; 150 lb. liq. cl.*	13,500	900	227	75	2	5
March, 1913	234 lb. liq. cl.*	7,200	305	27	91	0	3
November, 1913	1620 lb. bleach; 90 lb. liq. cl.*	8,500	170	31	82	1	8
March, 1914	234 lb. liq. cl.*	7,200	305	27	91	0	3
April, 1913	7-lb. bleach	3,320	50	10	80	0	0
April, 1914	1-lb. liq. cl.	2,070	89	11	88	0	1
February, 1914	800 lb. bleach; 1-lb. liq. cl.	7,250	460	99	78	..	4
March, 1914	1.3-lb. liq. cl.	7,200	305	27	91	0	10

*Per day.

chloride of lime and from personal observation, the amount of chloride of lime that will give a taste to water may be estimated at from 7 to 20 lb. per million gal., the average figure being from 10 to 12.

(9) Liquid chlorine does not change the character or the water by the introduction of lime salts. The lime salts will usually amount to not over one part per million.

(10) Liquid chlorine necessitates no labor cost while chloride of lime does. This is true, but a liquid chlorine requires skilled supervision to be operated properly and is not fool-proof.

(11) Liquid chlorine leaves no sludge.

(12) Liquid chlorine will reduce the amount of alum needed for bacterial removal. There can be no question but that in cases where the water is comparatively clear and where alum is used chiefly for bacteria removal if liquid chlorine is used before filtration it will make a marked saving in the cost of alum and in many cases will not only pay for itself but will decrease the general cost of the plant.

A saving of ½ grain per gal. of alum at 1c. per lb. by the use of 1 lb. liquid chlorine per million gal. at 10c. means a saving of 61c. per million gal.

(13) The feed of liquid chlorine is regular from hour to hour while the feed of chloride of lime varies constantly.

Objections to Use of Liquid Chlorine.—The chief objection to the use of liquid chlorine lies in the concentrated energy of the material itself. If liquid chlorine is set free in small enclosures it will cause nausea. With ordinary common sense and judgment on the part of the operator this is not likely to happen. The greatest danger lies in faulty cylinders and faulty valves. If the cylinder valve will not turn off or if the cylinder leaks it must be gotten out to the open air and the chlorine allowed to escape. Careful inspections of cylinders and valves must be made.

When it comes in contact with moisture, liquid chlorine has a very corrosive action, but this has been overcome by the use of hard rubber pipes and towers.

Comparative Costs.—The following estimated comparative figures are submitted:

Chloride of lime costs us from $1.22 to $1.70 per 100 lb.; the usual quotation was $1.34 and the average figure $1.40. We used during 1913 an average of a little over 1,200 lb. a day, or $16.80 a day for powder. Two laborers at 25c. per hour were employed for eight haurs, making a total cost of $20.80 per day, exclusive of repairs, sample collecting, or laboratory analyses.

180 lb. of liquid chlorine would cost, at 10c. per lb., $18 per day. We have now passed the worst conditions of the year, February and March, when we used 234 lb. a day or $23.40 cost. It is expected that we will be able to reduce the amount of liquid chlorine to at least ¾ lb. per million, or 120 lb. a day.

Some supervision and handling of cylinders is required. At present the work is done by a $3 a day mechanic, who also keeps the pre-filters in repair. His wages is charged against the pre-filters. A charge of $1 per day would be fair for this service. This is partly balanced by the discontinuance of laboratory analyses.

The labor cost during 1913 of $4 per day at Torresdale, with its output of 180,000,000 gal., amounted to but 2.2c. per million gal. At Belmont and at Queen Lane the labor cost of about $1.50 per day amounted to 3.8c and 3c. respectively. At Roxborough plants the labor cost averaged over $1 per day for mixing, that at Lower Roxborough cost 10c. per million, and at Upper Roxborough 6.7c. per million. The cost per million gallons at these plants during 1913 amounted to from 16 to 18c. At 1 lb. per million gal. for liquid chlorine the cost would be 10c., or a saving of 6.8c. per million gal. On April 14th the quantity used was reduced to ½ lb. per million gal., or a cost of 5c., a saving of from 11 to 13c.

Belmont and Queen Lane are saving a labor cost of 3.8 and 3c. Belmont is operating at a rate of ½ lb. and Queen Lane at ¾ lb., or about 5 and 7.5c.

In general, the cost of the two processes should be about equal, but liquid chlorine should prove the cheaper of the two.

With the use of liquid chlorine it is necessary to have an accurate determination of the flow of gas; it must be kept in a condition that it will not corrode the apparatus, and a proper absorption of the gas must be obtained. This has been accomplished by the use of absorption towers, which require from 50 to 100 gal. of water per 1 lb. of chlorine used.

While in some instances liquid chlorine may prove more costly than chloride of lime, the regularity with which it can be applied, the more effective the action on pathogenic bacteria, the small compact apparatus and the absence of the odor of chlorine around the plant recommends it as a satisfactory substitute for hypochlorite, possessing as it does all the advantages of the latter and only some of the faults.

It has been shown from experiments conducted in Belgium with a view to discovering the effect of foreign metals on the rolling of zinc, that ingots weighing 40 lb. were prepared by casting together zinc alloys of various metals, with spelter containing lead 1.05 to 1.25, cadmium 0.076 to 0.11, and iron 0.03 to 0.039 per cent. It was found that cadmium is harmful above 0.25 per cent., while with 0.5 per cent. rolling is impossible. In regard to arsenic, 0.02 per cent. markedly increases the hardness, and with 0.03 per cent. the metal is too brittle for practical purposes. Antimony is less objectionable than arsenic as regards hardness, as 0.07 per cent. does not increase the hardness; but 0.02 per cent. is enough to produce a striated surface on the rolled sheet, which makes it unsaleable. Tin is objectionable when above 0.01, and prohibitive at 0.03 per cent. Copper has no hardening effect until it reaches 0.08, and with 0.19 per cent. the zinc is unworkable. A permissible maximum of iron is 0.12 per cent., but this is easily reduced in refining. Though 1 to 1.25 per cent. of lead does not interfere with the rolling, a slight increase not only seriously affects malleability, but the excess of lead remains unalloyed and forms patches on the sheet. The presence of two or more impurities together results in a combination of the injurious effects of each.

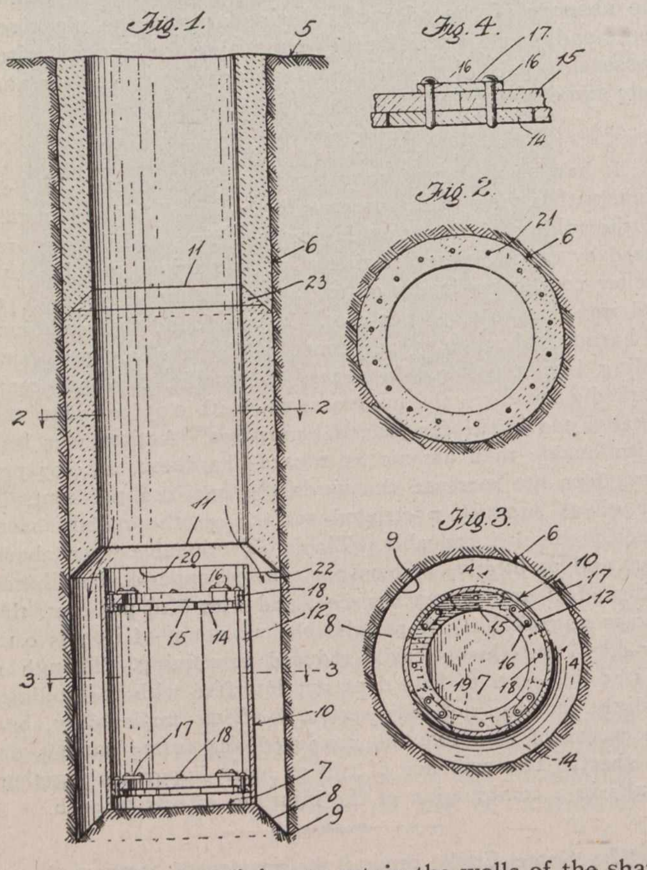
"Le Genie Civil" reports the results of tests made at the Ecole Centrale, Paris, to show that when holes are drilled and then reamed in soft-steel bars the metal materially increases in strength, the average limit of elasticity improving 12.3 per cent. and the average tensile strength 9.2 per cent. This phenomenon is explained thus:—In putting together the parts of a test piece broken under tension, it is found that the two ends do not coincide; and that, while the edges make a good contact, the central parts do not, thus indicating that the rupture begins at the centre, and that the edges have a higher tensile resistance than there is along the axis of the bar. Therefore, if several holes are drilled so as not to injure the material too much, as might be the case with punching, the average tensile strength of the section across the holes, per unit of metal, will be higher than before the holes were drilled, since each hole creates, so to speak, additional edges.

METHOD OF LINING CONCRETE SHAFTS.

A PATENT recently issued in the United States (No. 1089573) relates to a method of lining shafts with concrete, the principal object being to provide a method to eliminate the building of elaborate retaining walls in a well shaft. It is also an object to provide a method by which the concrete may be inserted in sections progressively from the top or ground level downward.

Fig. 1 is a central longitudinal section of a shaft showing two of the sections of concrete introduced, and the form in position ready to place the next succeeding section of the lining. Fig. 2 is a cross-section on the line 2—2 of Fig. 1, viewed in the direction indicated by the arrows. Fig. 3 is a cross-section of the shaft on the line 3—3 of Fig. 1, viewed in the direction indicated by the arrows. Fig. 4 is a detail section on the line 4—4 of Fig. 3, viewed in the direction indicated by the arrows.

Heretofore in the lining of shafts with concrete the shaft has first been sunk or dug the required depth, re-



quiring a temporary lining to retain the walls of the shaft intact and prevent caving in upon the operators. Then this supporting lining either has to be removed or become a loss by being left in the shaft while the forms are inserted and the lining introduced from the bottom upward, the entrance of water in the lower end of the shaft or intermediate positions complicating this process.

This invention overcomes the above difficulties by providing a method by which the shaft is enclosed with the permanent lining as the work progresses downward without great delay, and materially reducing the cost and increasing the efficiency of the structure.

In the drawing, numerals are used to designate the same parts in the different views, 5 designating the surface of the ground, and 6 the shaft vertically dug therein by any suitable means or apparatus, the method preferably used being to dig the shaft a depth equal to the height of the collapsible form preferably used. In practice this form is about 6 ft. in length, depending on the character of the soil through which the shaft is being sunk. The section dug is preferably as indicated, in the lower portion of Fig. 1, so as to provide the platform 7 of a diameter equal to the diameter of the finished shaft, from this point downwardly and outwardly, being excavated to leave the inclined face 8 until the concentric periphery of the major diameter of the shaft is met at the point 9. On this platform 7 the collapsible form 10 is erected, the upper edge of which falls slightly below the inner edge 11 of a previously formed section. The form 10 is preferably formed of a plurality of vertical sections 12 each of which is provided with a flange 14 secured thereto at suitable distances, the flanges, when various sections are placed adjacent one to another, abutting to form the circular configuration or cylinder, upon which flanges are supported the 4 sections of the rim 15, which are held together by suitable means, as pins 16 passed through the locking plate 17 together with the pins 18, which pass through the flanges 14 and the rim 15 intermediate of the locking plates 17. One of these sections is necessarily cut away as indicated in dotted lines at 19 so that this section may be removed to allow the collapse of the form after the concrete has been inserted.

As before stated, the concrete is introduced between the upper edge 20 of the form and the lower inner edge 11 of the previously formed section of the concrete lining, which is preferably reinforced by the vertical rods 21 supported in any well known manner. This upper edge 20 preferably extends a slight distance above the lower edge 22 of the last section of the concrete lining.

The shaft is preferably dug during the day the required depth, then the process of tamping the concrete lining in place is performed, and the concrete left to cure over night, while the man is otherwise occupied. The concrete sufficiently sets to permit the removal of the forms the next morning, and the shaft is sunk the corresponding distance only limited by the length of the form used. The triangular space 23 is filled either before the removal of the form and troweled in position, or inserted afterwards, as may be found preferable.

In an excavation having a lining of this character, the cost over usual constructions has been reduced approximately one-half, together with the material increase in speed of construction, and with greater assurances of safety, the irregular portions of the shaft walls firmly grasping the concrete sections, and preventing sliding as well as the connection to one another by adhesion, or suitable connections between the reinforcing rods.

The method is described to considerable length in "The Mining World" of recent date. Mr. Edward Morlae is the inventor.

A very notable feature of the recent convention of the American Water Works Association was the devoting of an entire day to the interests of the superintendents and others closely associated with the operation and maintenance of waterworks. The morning and afternoon sessions were devoted to the discussion of subjects introduced in the printed "question box" of the association. These subjects, dealing chiefly with water meters, dwelt upon such points as their setting, testing, design, maintenance and repair. Superintendent's day turned out to be a very important one for those dealing with the practical rather than the scientific phases of such work.

Editorial

CONSULTING ENGINEERS AND MUNICIPALITIES.

One regrettable feature of the whole attitude of the public to the engineering profession is that it is the layman himself who has produced the circumstances to which this not overly healthy attitude is to be attributed. So long as he allows political and personal influences to interfere in the selection of engineering assistance, and in the disposition of experts' reports, engineering will not be regarded by the man of the street as belonging to a plane any higher than it is now. Rather than maintaining the title of profession, argument is not lacking in instances where it is so unfortunate as to be lower in repute than the union-protected trades which follow in its wake.

Take, as an example, the consulting engineer—the highest type of which engineering can boast—the profession department as distinguished from the practice. A municipality has before it a project with an engineering problem attached. A consulting expert is called in to make a report upon what engineering it entails and its estimated costs of construction and operation. He gives it a thorough study, wherein his technical training and ability unite with his practical experience, grown out of a series of similar problems during his career, and are applied to the local conditions and requirements. He submits his report, presents his bill, receives his fee, and the transaction is closed. The municipality sought expert advice, got it, paid for it. The solution of the problem is before the peoples' administration board. The next step is to go ahead with the development.

But how prone Canadian civic officials are to question the value of the technical services they have purchased. The plans may fail to suit the inclinations of an aldermanic official or two, and if the influence from this quarter is sufficient the report is sidetracked and the question lies dormant while ratepayers are expecting daily to hear the sound of pick and shovel. Eventually the problem is revived, and another consultant is called. Obviously, he understands that the previous report was unsatisfactory, and that his scheme must have a different basis.

Thus, besides a split in administrative ranks, there are added expenditures, and delays in getting the development under way. There is also a depreciatory effect upon the engineering profession in the minds of the ratepayers, besides a tendency toward breaches of professionalism among engineers themselves.

So many instances of the above state of affairs have developed during the past few years that one may safely acknowledge it a serious detriment to the development of the country and to the welfare of the engineering profession. In many of our towns and cities the application of expert engineering advice to the problems of the day has been shamefully manhandled.

If civic officials are fearful of encountering incompetency in retaining such services and are afterwards dubious of placing dependence upon the advice, whatever it may be, they should not be slow to realize that in the engineering profession itself rests a reliable safeguard against mistakes. The condition is not unlike a transitory stage in the history of England, not so many years removed as to be incomparable. For upwards of a century municipal problems were often subjected to incompetency at the hands of would-be engineers who did not hesitate to attack any problem for a cut-rate fee, and whose schemes frequently resulted in enormous useless expenditures on construction of works which necessitated abandonment after a short period of unsuccessful operation. The establishment of the Local Government Board, equipped with an engineering department whose duties included the thorough examination of every scheme, has resulted in a cessation of such unfortunate occurrences and eliminated the engineering-adventurer.

Canada, with her formidable array of engineering problems, might well establish a similar institution for the purpose of checking risk and excessive expenditure in the engineering work of her municipalities. It should be necessary for every scheme to pass muster, in the minute and exhaustive inspection of a board of officials comprising the best engineering talent in the country. Millions of dollars would be saved; delays, detrimental to the health and comfort of the people, would be dispensed with, and engineers would encounter a more optimistic and encouraging tone among their fellow-men.

Such a board would deal with reports, rejecting or approving of them as their quality merited, and let the city councils choose whom they might as a consultant, his report upon the proposed development would have to depend entirely on its merits.

POWER DEVELOPMENT ON ST. MARY'S RIVER.

Occasional reference has been made in these columns to the work of the International Joint Commission, and to the questions which have at various times been presented to it by the Canadian and United States Governments, since its inception in 1909. The most recent findings of the Commission have been in connection with the applications of the Algoma Steel Corporation, Limited, and the Michigan Northern Power Company for the diversion of water for power purposes and the construction of compensating works in the St. Mary's River at Sault Ste. Marie.

After approximately twenty months of investigation official approval was given in Ottawa last week for the diversion of about 30,000 cubic feet per second on either side.

The primary importance of conserving the present conditions for navigation was evidently the chief contending factor in the extended investigation. Shipping interests on the Great Lakes commanded practically no molestation in the St. Mary's River. With this in mind, the recent judgment is found to possess significant features in the interests of navigation. The diversion for power purposes is contingent upon the erection of sixteen sluice gates across the river to compensate for it. These sluice gates are to be under the absolute control of an international board composed of two engineers representing the governments, and whose duty it will be to maintain Lake Superior at a level best suited to navigation and to the various communities along its shores.

LETTERS TO THE EDITOR.

"Road Building Economics."

Sir,—The writer has read the paper entitled "Road Building Economics," by Mr. Reginald Trautschold, M.E., in your issue of May 14th, but takes exception to some of the author's statements in regard to asphalt paved streets.

The subject "Asphalt Paved Streets" is, to begin with, quite vague, for there are several types of asphalt paving in use to-day and their variations in cost and life are too great to be covered by a single formula. It is presumed, however, that the author refers to the standard sheet asphalt construction consisting of concrete base, binder course and wearing surface.

Mr. Trautschold states that

> "The softening of the paving surface, if subjected to even the summer temperature of many localities, limits the use of this class of roads to cities in the temperate zone, in even which localities the softening of the asphalt surface has much to do with the very high maintenance charge. . . . ."

This statement is indeed a surprise, for it is now well known that such softening, as well as cracking with cold, can be to a great extent taken care of by properly designing the paving mixture.

Asphalt cement, the binding medium, is not a material of fixed characteristics and the engineer has at his disposal not only the various consistencies but the different brands of bituminous materials as well. If he is properly advised as to this feature and the mineral aggregate is properly selected and graded, there is no reason why the sheet asphalt pavement should not be successful even in greater extremes of temperature than now employed. It is noiseless, sanitary and can withstand the heaviest traffic, as is shown by the fact that it is to-day replacing the old stone pavements hitherto considered necessary in business districts.

Your author's formula must certainly be founded upon inferior construction for, with proper materials and supervisions, the life of the sheet asphalt pavement should be considerably over ten years. I quote, for instance, the following statement from the Report of the Engineer Commissioner of the District of Columbia for the year ended June 30th, 1909:

> "Many of the asphalt pavements . . . have been down for from 20 to 37 years, and . . . about 20 years represent the effective and economical life of such pavement."

The District of Columbia was the pioneer in asphalt paving construction and, with its data 40 years' experience, the above testimony would seem most competent. Furthermore, the science has progressed considerably in the five years since the report was written.

A study of these facts and the present competition in bituminous materials will serve to reduce Mr. Trautschold's cost and maintenance charges and show this type of pavement to have, after all, an individual economic value.

LEROY M. LAW.

Baltimore, Md., June 2nd, 1914.

"Determination of Areas of Cross-sections."

Sir,—In your issue of March 12th, 1914, there appears an article by Mr. C. D. Norton entitled "A Method of Determining the Area of Cross-sections." It is a singular coincidence, but the method in question is almost identical with one worked out by the writer over a year ago now, and which early in February, 1914, in the form of a booklet, was published and copyrighted both in Canada and the United States.

A copy of the booklet for your information is sent herewith, and those interested will also find a resumé of the subject matter in it in "Engineering News," issue of May 28, 1914.

Mr. Norton, however, in his article, does not show that it is quite unnecessary to ascertain the actual cuts or fills at the various points on the cross-section for the rod readings as taken, at these points, with far less labor and with less liability to error, can quite as well be used. In the writer's opinion this very point is of vital importance when considering the method from the point of view of a time-saving device.

For instance, on page 6 of the booklet, the information there given for each particular section, of necessity, must be obtained in the field and noted in the level book in one form or another.

In order to obtain the area of the section, however, as it happens, nothing more is required; the very figures given there are used in the calculation. In plain language, each horizontal distance to a point has been multiplied by the difference between the rod readings of the points coming immediately after and before such point, one-half the sum of such multiplications giving the total end area of the sections.

While at first sight the above might appear slightly complicated, it will be found that in practice, once one has become familiar with it, the whole operation is an exceedingly simple one. The difference in the rod readings can usually be obtained mentally and jotted down directly on one page of the level book with corresponding horizontal distance, where at any subsequent time such figures and resulting end areas can very easily be checked by an assistant.

It is the intention to have the booklet mentioned above bound up with other tables in the front of the ordinary blank level book, where, whenever required, the method will be available to all who desire to save time by using it. The cost of the level book to the engineer will not, of course, be increased by this insertion.

E. S. M. LOVELACE,
Consulting Civil Engineer.

Montreal, June 5th, 1914.

It has been reported from Cordova, Alaska, that actual work on the survey of possible routes for the government's railway in Alaska was begun on June 2, when the first stake was driven at Chitana by a reconnaisance party under Henry Deyer, who will survey the route from Chitana, where the Fairbanks railroad leaves Copper River and Northwestern railway to the coal field.

Capitalists of Yokohama are engaged upon the preparation of plans for the construction of a dock at Namamugi, a suburb of Yokohama. According to the plans 344,134 tsubo of water front will be reclaimed and divided into four divisions. The first division will be used for docks, the second for shipbuilding and on the third and fourth several houses will be built. It has been estimated that the expenditure will be Y.2,234,000, and the work is expected to be completed in 5 years.

BULKLEY RIVER BRIDGE, BRITISH COLUMBIA.

ACROSS the Bulkley River at Hagwilgate, near New Hazelton, B.C., has been erected a single span suspension bridge which ranks among the highest of its type in existence, being 250 ft. above the water level. The span is provided with stiffening girders to curtail vibratory and undulating movements under traffic and wind. It is the first of its kind, according to the builders, Messrs. Geo. Cradock & Co., wire rope manufacturers and engineers, of Wakefield, England, to be hung from catenaries of locked coil cables, the latter being claimed not to rotate or lengthen.

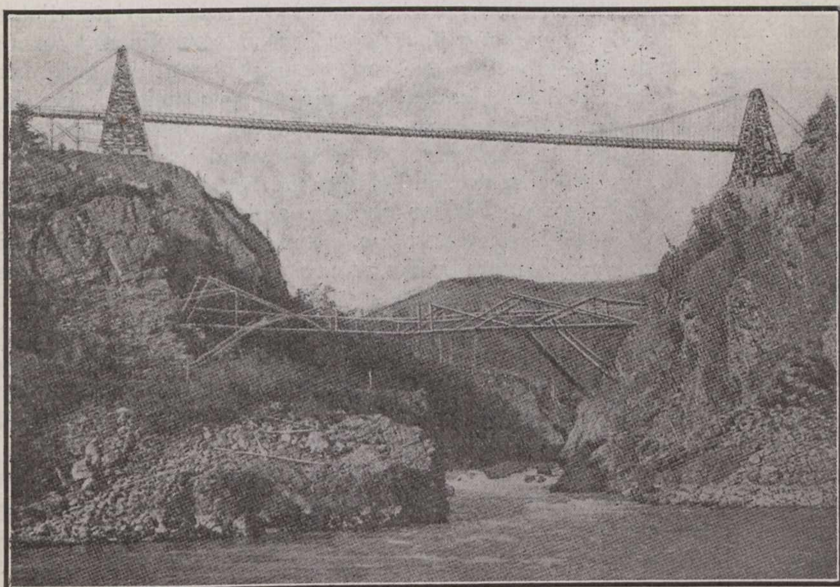


Fig. 1.—View of Bulkley River Suspension Bridge.

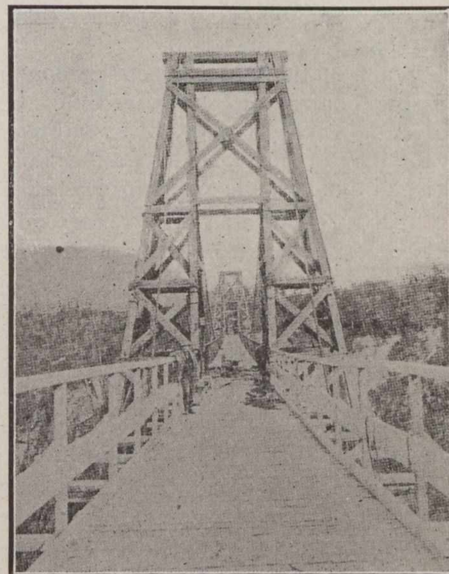


Fig. 2.—View of the Structure from One of the Approaches.

It spans the Bulkley River at a point where it is confined between the walls of a rugged canyon, as shown in Fig. 1. The span itself is 451 ft. in length, the whole structure being over 600 ft. in length when approaches are included, with a roadway 9 ft. in width. The bridge is suspended from timber towers 65½ ft. high, one of which has been mounted upon the solid rock, while the other is furnished with a concrete pier foundation. The cables, 2½ in. in diameter, are each anchored by 3-in. steel bolts embedded in concrete blocks approximately 15 x 20 ft. in dimension. The suspension rods are ¾ of an inch in diameter, and are clamped to the suspension cable at the top, while the bottoms are thickened to ⅞ of an inch and threaded. These rods are placed 4 ft. apart on either side and carry the floor beams, also 4 ft. centre to centre, diagonally braced. These floor beams support 4 x 7-in. stringers, upon which is laid the floor of the bridge consisting of 3 x 4-in. plank. The timber is all of British Columbia fir. Over 50 tons of steel have been used in the construction of the bridge. The coiled locked cable has a tensile strength of 350 tons and the bridge itself is designed to safely carry a rolling load of 18,000 lbs.

The stiffening steel girders forming the sides of the bridge are of lattice type and extend from the floor to the hand-rail.

The contract for the construction of the bridge was awarded in 1912, but owing to the severity of the winter in northern British Columbia no work was attempted before the spring of 1913, whereupon Mr. Percy Cradock, one of the directors of the firm, took charge of the construction. The entire structure was completed in the course of two months after the foundations had been built. Fig. 3 illustrates the hazardous construction work associated with it.

The work was carried out for the New Hazelton Bridge and Power Co., and accommodates the vehicular and pedestrian traffic of the Bulkley valley.

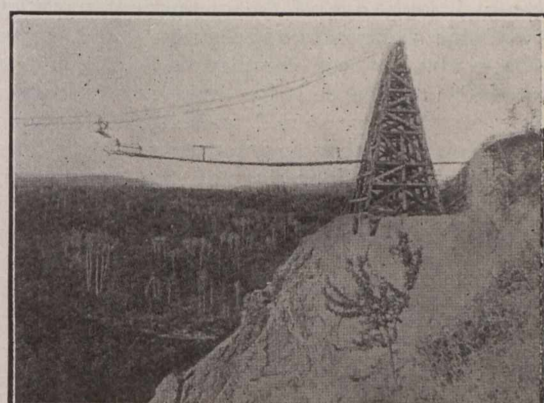


Fig. 3.—Bulkley River Bridge in Early Stage of Construction.

Fig. 1 also shows an old structure which has been used for years as a means of transportation across the river. It was built by Indians and is in striking contrast to the new structure suspended above it. The members of the old Indian structure are held together by wooden pegs, no nails having been used in it.

ROAD IMPROVEMENT COMPETITION IN SASKATCHEWAN.

The annual road drag competition established last year by the Highway Commission of Saskatchewan started on June 1st and will be continued through June, July, August and September. In the early part of October all competing roads will be inspected simultaneously and the prizes awarded according to the points earned during the period of dragging.

THE BULK HANDLING OF CEMENT.*

By H. M. Capron,
President of Marsh-Capron Mfg. Co., Chicago, Ill.

THE use of cement in bulk is comparatively new. The writer's interest and experience with bulk cement started with the mechanical problems involved in handling and storing the cement and other aggregates at the mixing plant, the measuring and conveying them to the mixer, and the mixing and handling of concrete.

Some of the large cement companies, and a few progressive contractors have recently been studying this problem. Like all new ideas, however, its beneficiaries accept it reluctantly, and its advocates are subject to the criticism and ridicule which greets all pioneers.

It is a remarkable commentary on human nature that the people who are to be benefited by a new idea are the slowest to adopt it: and it is equally significant that once a contractor has used bulk cement, he becomes one of its most enthusiastic converts.

It requires no little originality, and a great deal of courage to depart from a custom of years' standing in any line of business, and such departure must of necessity be founded upon logic which is absolutely sound.

Ever since Portland cement became a factor in the contracting business it has been delivered to the ultimate consumer in packages. At first wooden barrels were used, but they were so cumbersome and difficult to handle that a small package was substituted, and now cement is handled almost universally in cloth sacks, or paper bags, four of them constituting the commercial unit, the barrel.

Cement is only one of the component parts of concrete. The fine and coarse aggregates—sand, gravel and stone—have always been handled in bulk, and an inquiring mind uninfluenced by business custom would naturally ask, "Why should cement be delivered in packages when the other aggregates are always used in bulk?" Careful consideration of the subject showed many reasons why cement packages could, and should, be eliminated from a great many classes of concrete work, and to demonstrate the practicability of this new idea, the originators presented it to certain contractors for their favorable consideration, which was at last secured.

The present age is one essentially of conservation, not of conservatism, and if it can be satisfactorily shown that there is an economic waste in packing cement in sacks only to reduce it to the bulk condition before it can be used, the attention of every contractor who must necessarily pay for this packing and unpacking of cement is immediately challenged. If the contractor can be relieved of this expense and can at the same time purchase his cement for a smaller figure, it is obvious that there will be larger margin of profit for him in his work, and those who adopt this method first will have the greatest advantage over their competitors.

The cement company which developed this idea offers cement in bulk for 42 cents per barrel less than the price of cement in cloth sacks. Forty cents of this is, of course, represented by the cloth sacks themselves, and two cents represents the saving to the cement company in packing and loading cement in bulk. Therefore, as far as the manufacturer is concerned, the only saving in this method is in elimination of the cloth sacks which would otherwise be used. This, of course, relieves the manufacturer of the cost of counting, inspecting, cleaning, and repairing these sacks when they are returned to the mill by the contractor for credit. On the other hand, new machinery is necessary to load and weigh bulk cement when it is placed in cars. A device called a weightometer has been adapted for this purpose. This machine consists of a belt upon which the cement is conveyed into the car. This belt passes through the weightometer and all the cement on it is automatically weighed and recorded by the machine, so that the operator can tell by a glance at the dial exactly how many pounds of cement have passed through the machine into the car. A car of bulk cement, therefore, in being loaded, is weighed as a unit. When it is loaded, figuring as is done in the United States, 376 pounds to the barrel of cement, and assuming that the car is to contain 250 barrels, the belt is stopped when the dial registers 94,000 pounds, and the entire car is thus weighed in one operation. If the same car is loaded with cement in cloth sacks, 1,000 sacks would be required, and likewise the necessity of weighing 1,000 separate objects. Thus the liability of error in weighing is reduced from 1,000 chances to one. It is, of course, the object of every honest manufacturer of cement to furnish correct weight, and cement in bulk represents the most satisfactory way of doing this.

Some doubt may be raised as to the difficulty in protecting the cement from moisture, both in transit from the mill and at the mixing plant, but this has proved to be purely theoretical.

The damage to bulk cement in transit by reason of a leaky car is by actual experiment shown to be 50% of the damage the same amount of water would inflict if falling on cement in cloth sacks. The reason for this is that when water comes in contact with the cotton cloth, by capillary attraction it spreads to the adjacent sacks so that a leak in a car roof will frequently ruin a whole tier of sacks from top to bottom of the car, and damage a large part of the cement contained in these sacks. If water falls on bulk cement it is absorbed immediately where it falls and the resulting damage consists of a crust of cement depending in size on the amount of water, and the damage is confined to the spot immediately under the leak, and all the damaged cement can be lifted from the car in this cake.

Experience has shown that the handling of bulk cement does not raise as much dust as cement in cloth sacks. The cement sifts through the sacks with the many handlings so the natural cohesion between the particles is broken and the dust is blown away or falls off. The method of handling it in bulk saves all this waste. The method of handling, of course, varies with the physical conditions surrounding the work.

In the early stages of the development of bulk cement shipment, the material was handled successfully and in large quantities by contractors who did not spend a single cent on special equipment. They reasoned that if they could handle and measure the sand and stone (which is 90% of the concrete job) by means of wheelbarrows, they could handle and measure the 10% of cement that it would require, with equal accuracy and facility. A great many jobs of considerable magnitude are still being carried on in this way, but naturally the possibilities of bulk cement in saving labor and increasing the output of a concreting plant may be more fully realized by means of equipment more particularly adapted to the work. When the work is adjacent to a railroad track and the size of the job warrants it, a bin may be constructed

*Read at the First Canadian and International Good Roads Congress in Montreal, May 21, 1914.

alongside the track into which the bulk cement is conveyed by means of the bucket elevator. On one side of this bin is built a hopper for the coarse aggregate, and on the other side one for the fine aggregate. Both of these aggregates feed from the bottom of their respective hoppers, through spouts, into the mixer hopper. Experience has shown that a non-tilting type of concrete mixer lends itself best to a plant of this kind, as it requires less head room. These aggregates are handled from the cars into these hoppers by a clam-shell operated by a standard hoisting engine or by the same bucket elevator used in elevating the cement.

The bulk cement is moved from the car by a scraper similar to that used for unloading grain. With this the cement is scraped from the door of the car into the chute which feeds into the bottom of the elevator leg. From the bin the cement falls by gravity through a measuring box into the mixer hopper. Thus we see that the only labor connected with delivering the cement into the mixer is that required to unload the car with the device above described. Two men in one hour can easily unload a car containing 250 barrels of cement in bulk. By this method the contractor is saved the cost of the labor which otherwise would be necessary to perform the following activities:—

1. Carry the cement, sack by sack, from the car to the storage shed, and pile in shed.

2. Carry the cement, sack by sack, from the storage shed to the mixer platform.

3. Untie each sack and empty the cement, sack by sack, into the mixer hopper.

4. Shake out the empty sacks over the mixer-hopper to relieve them of all their contents.

5. Lay the sacks aside to be bundled.

6. Bundle the empty sacks for shipment to the mill.

7. Remove the bundles of empty sacks to the storage shed to await the accumulation of a shipment.

8. Load the bundles of empty sacks into a car for shipment to the mill, prepaying the freight on them. Then ensues a long wait while the sacks go to the mill, and are counted and inspected there before a credit can be issued on them and a cheque sent to the contractor for the value of the good sacks found in the shipment.

In every one of these eight stages the sacks are liable to damage by abuse of careless workmen, by exposure to the weather, and in many other ways. Sacks also make convenient aprons for workmen, tool bags, cushions for drivers to sit on, and it is reported that even shirts made of cement sack are stylish among some workmen. The loss on a job of this kind in all of its many phases, is variously estimated by contractors at from five to ten cents per barrel on the amount of cement used.

Every contractor who handles Portland cement recognizes that the empty cement sack is the most fruitful source of dispute with the manufacturer, of loss on the job, and of general inconvenience in handling cement. Everyone will instantly recognize that the elimination of the sack on the job would be a great boon. If, besides securing the advantages incident to removing the sack entirely from the work, the contractor finds himself relieved of a large item for labor in handling these sacks, both full and empty, there is no question that his best interests demand that he use cement in bulk wherever feasible. Where the mixing plant is removed from the railroad track 100 ft. or more, belt conveyers have been used to take the cement from the car to the elevator connected with the overhead bin. The fine and coarse aggregates may be handled over the same belt into bins provided for them, so that the gravity-feed into the mixer hopper can be applied to all of the materials going into the mixer. The number of laborers saved by this kind of an arrangement varies with the magnitude of the job and in any case the saving well repays the contractor for the installation of the necessary handling machinery and for the construction of these overhead bins. But, as already stated, the physical conditions of each job will require an arrangement best suited for its individual need. Cement in bulk takes up less room on the job, which is sometimes very desirable. Take as an illustration a large paving job which came to the writer's attention recently. This job requires 30,000 barrels of cement which means 120,000 sacks. At 10 cents per sack it takes $12,000 more to finance the job than if the cement were delivered in bulk. This bag money is tied up until credit is received from the manufacturer for sacks returned and every contractor knows how long it takes to get this credit.

Figure the average loss of sacks and interest on money invested in this case as 10 cents per barrel, or $3,000 actual loss, to say nothing of extra labor required in handling all these sacks; in any case the amount of capital necessary to finance the job is materially reduced.

It is quite evident that this subject is worthy of study by all contractors on large work.

TOWN PLANNING.

"Conservation," issued monthly by the Conservation Commission of Canada, makes the following statements and definitions about the subject of town planning:

It is the selection of the site and environment, and the adaptation of the same for settlement by an intelligent method, having in view health, amenity and convenience.

It is not a fad, but simply an orderly method of doing what must be done in any case.

It means life for the babies, and better health for each person in the town.

It assures to mothers and children as healthful homes and home environment as the factory act provides healthy workshops for mechanics.

It supplies suitable streets for all sections, whether residential or industrial.

It provides for cheap and rapid transportation.

It gives the children playgrounds in lieu of dusty streets and dirty lanes.

It prevents the undue encroachment of business upon residential areas.

It allocates to factories their proper place.

It is an important factor in giving a higher morality to the people.

It bestows on the many advantages at present only possible to the few, giving to the poor blessings denied them under existing methods.

It pays, because it is of economic value to the municipality permitting it to acquire property, which is sure to enhance in value at a minimum of cost.

It is what all should work and strive for, ennobles citizenship and elevates the nation.

The 1914 convention committee of the American Electric Railway Association, acting with the committee of the American Electric Railway Manufacturers' Association, has decided upon Atlantic City as the location for the 1914 convention. The dates are October 12 to 16.

FACTORS IN ROAD ECONOMY.*

By Will P. Blair,
Secretary, National Paving Brick Manufacturers' Association, Cleveland, O.

WHAT is the economic value of a road? By what shall it be measured? Shall it be measured by comparison with other roads or with roads built of other materials, or shall it be reckoned upon its own merits separate and apart from any comparison? Comparisons are said to be odious and are therefore interpreted as coming within a class of criticism that to some seems objectionable. The writer sometimes thinks, however, that the relative merit of paving material ought to be brought out by the sharpest kind of contrast. Unquestionably in the discussion of pavements and their worth, had they heretofore been considered in such meetings as this and through the columns of papers that are devoted to road and street building upon their relative worth, the public would by this time have been saved thousands of dollars. Much of the money that has been wasted in experiments would have been saved by the force and influence of a discriminating reason and sound judgment.

If a paving material possesses worth, the time has come when the public should know it; if unworthy in any way, the truth is worth more now than a season of repenting.

There are involved in the economy of a road: Its first cost; its use, and its up-keep. These elements of economy bear a close and distinct relation to each other. Each must sustain a harmony of relationship with all combined. The cost, therefore, must be commensurate with its use and its use must be sufficient to justify its up-keep. Its up-keep must be within bounds justifying its maintenance.

There are other elements in the matter of road economy that must be considered. The effect of the road itself upon abutting property, whether detrimental or injurious. The effect upon its users in a way that pertains to their comfort and pleasure.

Whether or not the time has come when the official charged with responsibility shall assert his professional judgment; whether the time has come when data that ought to constitute the basis of that judgment will be supplied and used both as to the grade quality of the improvement and the uses to which it may be subjected, is doubtless a question, because neither is done. Whether all pavements that are offered to the public are established in their proper economical place or not is exceedingly doubtful.

Aside from quality, aside from cost and maintenance, local supply of that which may be used is necessarily a matter to be considered and a feature that must affect very seriously the economy of any road improvements. Good judgment, therefore, will often select a road material by the weight of such consideration that otherwise would not be chosen.

The abstract actual cost, use and maintenance cannot be applied rigidly in all cases. The economy of any road material cannot and must not be judged alone. It must be understood that it is affected by the manner and method by which that material is used in the construction of the road. But the reasonable maximum worth which is only reached by the manner and method of construction may be and should be assumed, for the reason that there is no possible excuse for constructing a road out of any material that is at all worthy of consideration in any way except that way which will render a service approaching a maximum of its possibilities. We cannot fairly approach the subject of economy of any road material except on such assumption. It will, therefore, be necessary to understand something of what is required in manner and method of construction in order to properly understand its cost.

Cost of construction and cost of repair and all else is not the full measure of economy. But the greatest element affecting the economy of any road is, strange to say, the very one that is least taken into account, and that is its out-of-repair condition. That road that calls for the most frequent repairs is the road that is most likely to be out of repair, and it is the road that in the sum of lapses of time in which it is out of repair, aggregates a total detraction from the road's worth which by the lesser load hauled, the broken spring, the injured horse, the extra wear and tear of the vehicle, if converted into dollars, would often equal in a short period of time, the entire original cost of the improvement.

When a road is out of repair, the road investment is bearing no interest. The road as a whole is only as good as its worst portion—even the rule of average will not apply. On the other hand, by inverse ratio the road approaches its maximum worth as repairs are eliminated. The road, therefore, from which repairs are practically eliminated, is the real economic road, provided only that the traffic passing over it meets in a reasonable toll charge, the interest on its cost.

This leads to the proper differentiation as to the choice of the road and the amount of its cost. The expenditure for any road is justified so long as the amount of tonnage passing over it will aggregate a toll equal to a reasonable interest charge thereon. To the extent that it exceeds such a sum, it represents a profit to the user. I may inject that in both Canada and the United States poor roads exact a larger toll than good ones should or will if we ever reach a time when our roads are intelligently built.

This continued cry for maintenance is all right, so long as it is made in good faith, but the trouble lies in the fact that behind much of it stands the father of the suggestion whose interest urges the building of a road that will need continued repair.

If we properly understand how a block stone road should be constructed, in order to attain its highest efficiency and best service, we must accord it a place, perhaps the first place, as affording the best economy for roads and streets, subject to heaviest and most severe traffic.

It is regrettable that the elements of economy that are combined in a properly constructed stone block road are known to too few road builders, and when you begin to enumerate them, many a man will regard your assertions with suspicion. The writer recalls the shock with which his assertion was received by a well-known engineer to the effect that the noise resulting from the use of a properly constructed block stone road was much less than that which was common to roads of certain other materials. The lack of appreciation in this respect was entirely due to the fact that the engineer in question had had no experience with a properly constructed block stone road.

The place here given to a block stone road will not be supported by assertions or any detail of testimony.

*Extracts from paper read at First Canadian and International Good Roads Congress, Montreal, May 18-23, 1914.

This should be done primarily by the people commercially and particularly interested in block stone pavements, and it is surprising that so far as the general public is concerned, they—the block stone people—do not understand, at least they do not advocate the best use of their own product. This concession puts the use of stone block within somewhat narrow limits, while the use of vitrified brick is properly placed within the larger limits of the excessively used highways and important thoroughfares of the country. Such roads are to be found from points where travel converges and terminates at large centres of distribution. It also includes such roads as connect up centres of trade and population—in other words, the main market roads and thoroughfares of the country.

The original cost of a brick road is not necessarily excessive. The cost of grading, drainage, bridging and the entire preparation for placing thereon the artificial foundation and wearing surface, should be alike for all types and is, therefore, no more expensive for a brick road than is required for the least expensive type of wearing surface. This necessary preparation in the case of a brick road bears a feature of economy that is well worth while to mention. It is not readily injured, either from wear or tear or from any character of climatic influences. It is likely to remain intact. With the brick wearing surface placed upon it, ample protection for the durability of all the work incident to such preparation is afforded.

A curb for a brick highway is not necessary. A small upper lug built on the extreme edge of the concrete foundation, the height of the depth of the sand cushion, is all that is necessary.

The concrete foundation, if used, must be made entirely smooth, conforming to the grade of the finished street. Even a concrete foundation is not essential in case the subgrade contains much sand and gravel, enabling a complete, ready and perfect drainage. The ideal condition is a dry subbase. A concrete foundation, however, is advisable in most instances throughout Canada where we naturally expect a considerable season of low temperature. Over this foundation, whether of natural soil or concrete, must be placed a cushion of sand to a uniform depth from 1½ to 2 inches, thoroughly and evenly compressed upon which to place the brick. The interstices of the brick must be filled from the sand cushion full and flush with the top, a mixture applied as a fluid, of the best quality of Portland cement and fine sharp sand in proportion of one to one, the setting of which shall be protected from use, uneven temperature and destructive weather elements, until completely set.

THE PROGRESS OF THE ELECTRIC FURNACE.

It has been generally supposed that British smelters and refiners have shown considerable reluctance to adopt the electric furnace, but statistics go to show that after all they have not lagged very much behind other countries. There are now 14 electric furnaces at work in England, 13 in France, 20 in Italy, 17 in the United States and 32 in Germany, besides a few in other countries, making a total for the world of something between 140 and 150. A remarkable fact is that in Germany 50 per cent. of the furnaces are of the induction type and 50 per cent. of the arc type. Out of the 20 Italian furnaces 19 are arc, as are 10 out of the total 13 French, and 13 out of the 14 English. The Heroult, the Girod, and the Stassano are the arc furnaces most numerously adopted, while the Kjellin and the Röchling-Rodenhäuser occur most frequently in the induction installations. The progress in Scandinavia is shown by the fact that Norway and Sweden employed only nine furnaces for the smelting of pig-iron in 1912, and had more than doubled the number by the end of the following year, when 20 furnaces were in full operation.

TAR TREATMENT OF ROADS.

The Road Board of Great Britain has issued a second edition of directions and specifications relating to the tar treatment of roads. In the specification for tar No. 1 (suitable for the surface tarring of roads), it is stated that the distillate between 170 deg. and 270 deg. C., or 338 deg. and 518 deg. F. (middle oils), shall remain clear and free from solid matter (crystals of naphthalene, etc.) when maintained at a temperature of 30 deg. C. for half an hour. It is, however, added that "this requirement may be waived in the case of tar supplied direct from gasworks; but tar from which the naphthalene has been extracted is preferable to tar containing much naphthalene." The tar must contain not less than 12 per cent. and not more than 21 per cent. by weight of free carbon. The free carbon is to be determined by complete extraction of the bituminous matter from a weighed portion of the tar by benzol and bisulphide of carbon. The residue left on treatment with these extractives is to be taken as "free carbon." Specification for tar No. 2 (suitable for making tar macadam, and for surface tarring in very hot weather, when the road crust is exceptionally dry) stipulates that the tar may contain not more than 25 per cent. of its volume of the tar (or distillates or pitch therefrom) produced in the manufacture of carburetted water gas. The free carbon limit, which was before put at 18 per cent. of the weight of the tar, has now been altered to not less than 12 per cent. and not more than 22 per cent. by weight. Prepared pitch from tar distilleries must contain not less than 16 per cent. and not more than 28 per cent. by weight of free carbon; and commercial soft pitch not less than 18 per cent. and not more than 31 per cent. In the latter case the pitch may contain not more than 25 per cent. of pitch derived from tar produced in the manufacture of carburetted water gas—in place of the 10 per cent. given previously. The last-named alteration has also been made in the case of tar oils.

TUNNEL THROUGH APENNINES NEAR COMPLETION.

The tunnel being constructed through the Apennines at a cost of $30,000,000 is nearing completion. When the Croce di Monaco tunnel through the Eastern Apennines is finished, the last engineering difficulty in the way of finishing the Puglian aqueduct will have been removed. The aqueduct was begun in October, 1899, and will, it is hoped, be completed next autumn. By diverting the River Sele, which flows into the Tyrrhenian Sea below the Gulf of Naples, its waters are carried through the main range of the Apennines to the Adriatic coast of Italy and delivered to the three arid provinces of Puglia. The aqueduct begins at Caposele, 1,358 feet above sea level, and the main waterway running to the eastern slope of the mountains at Venosa is 132⅗ miles long, of which 60 miles are cut through the rocky mountains. At Venosa the supply is divided into three conduits, one branch running to Foggia, another to Bari and the third to Lecee, in the very heel of Italy. These three main conduits have a total length of 1,000 miles; while the distribution among the principal towns and communes has necessitated the laying of 500 miles of piping.

It has been decided after exhaustive tests to use Pretoria cement in the extensive harbor works at Cape Town and Durban. The output of the Pretoria cement works is about 1,000,000 bags per annum, and the company hold contracts both with the government and municipalities. Great care is exercised in the manufacture of the cement and recent tests gave the following results in tensile strength, after seven days 786 pounds, and after 28 days 931 pounds. It is anticipated that the local cement will ere long entirely replace the imported article in South Africa.

DISCUSSION ON "PRESENT DAY WATER FILTRATION PRACTICE."*

By John H. Gregory,
Consulting Engineer and Sanitary Expert, New York City.

THE author has presented a paper which contains much of interest to waterworks engineers and superintendents interested in filtration, and there is much in the paper with which the speaker is in hearty accord. There are, however, some phases of the subject on which the speaker holds somewhat different views from those of the author, among which may be mentioned the questions of the cost and difficulty of securing sites for slow sand filters and those of the cost of both slow and rapid sand filters.

The author states: "It is true, on account of the much greater area required, the cost for land is far greater in the case of slow sand filtration systems than for rapid sand systems. Roughly, other things being equal, land will cost twenty times as much for a slow sand filter installation as for a rapid sand plant." There is but little question that, under ordinary conditions, the cost of land for slow sand filters will exceed that for rapid sand filters, owing to the larger area required, but that it will amount to as much as "twenty times" as that for slow sand filters is open to question. Those who have had experience in acquiring land for waterworks projects know that, even if only a small piece of land is required on which to locate the works, but that this piece of land is a portion of a much larger tract, the purchaser might often as well buy the whole tract of land as to buy only a small portion of it. Thus it may readily be that, in acquiring a site for rapid sand filters, much more land would be actually purchased than needed simply for the plant. It may be that the area required for the construction of a slow sand filter plant will be twenty times that required for a rapid sand filter plant, but that the land will cost twenty times as much does not necessarily follow.

In discussing further the question of site the author states: "Furthermore, in large projects, it is often difficult conveniently to locate a site for slow sand filters, while for a rapid sand filter plant it is a relatively easy matter as a rule. If it is necessary to go a long distance in locating an extensive and suitable area of land for a slow sand filter site there is incurred a large expense for a conduit to bring the filtered water to the city." The inference might be drawn from this that it has been exceedingly difficult to secure sites for large slow sand filter plants, but the history of many of the plants which have been built will hardly bear out this inference.

In commenting on some of the plants which the author mentions (*The Canadian Engineer*, April 30th, 1914, page 666), the speaker might say that he has been personally connected with seven out of the fifteen plants mentioned, and is familiar with the reasons which led to the selections of the sites on which these works were built. It is, of course, necessary to have land on which to build filters, whether of the slow or rapid sand type, but in the selection of a site local conditions are often a very important factor.

At Albany, N.Y., for example, practically the first ground available on which filters of either type could be built and which could be purchased at a reasonable price, was that on which the slow sand filters were actually built, just north of the city line. It happened that there was another tract of land a little nearer to the existing waterworks pumping station, to which the filtered water was to be delivered, where it would have been possible to build either slow or rapid sand filters. To have acquired land there, however, for either type of filters, would have been very expensive. The site on which the filters were built had another advantage in that the intake there would be further away from local sources of pollution. At Albany the Hudson River is tidal. The sewage from the city was and still is discharged into the river without treatment and on flood tides there is often an upstream current which carries some sewage with it. It will be seen then that other factors than simply area of land alone may have a bearing.

At Pittsburgh, Pa., as far as the speaker is aware, no difficulty was found in securing a site for the slow sand filters there, which plant is one of the largest in the world. The filter plant is located directly across the Allegheny River from the Brilliant Pumping Station, from which most of the water used in the city is pumped. It is true that it was necessary to build conduits under the river to bring the filtered water to the pumping station, but the case would have been the same if rapid filters had been built instead, for, if the speaker's memory is correct, the best site on which filters of either type could have been built was that on which the slow sand filters were constructed.

For the four slow sand filter plants in Philadelphia mentioned by the author, namely, Torresdale, Upper Roxborough, Lower Roxborough and Belmont, and of which the writer had charge of the design, no trouble was experienced in securing suitable sites.

As regards the Lower and Upper Roxborough filter plants, local conditions were of the greatest importance in that it was necessary to utilize existing reservoirs as settling basins, as well as existing pumping stations and pipe lines. Somewhat similar conditions existed with reference to the Belmont plant, although in this case there was no reservoir which could be utilized as a settling basin.

The Torresdale slow sand filter plant is the largest single plant in the world, and if difficulty had been experienced in securing suitable sites for such works it would naturally be expected to have occurred here. Such was not the case, however, and the plant was built inside the city limits. It is true that the plant was located some distance upstream from the closely built-up part of the city, and that a conduit about 2½ miles in length was constructed through which filtered water is delivered to the Lardner's Point pumping station, but it was good judgment on the part of the city authorities to locate the works where they did.

The Delaware River at Philadelphia is tidal and is polluted by the discharge of sewage from the city, and it was to avoid pollution as well as to secure a site that the plant was built as far upstream as it was. It might be added further that the city has already constructed a small sewage disposal works just below the Torresdale filter plant, where sewage is treated and the effluent disinfected before discharge into the river, in order to guard against raw sewage from the nearest point from reaching the intake of the Torresdale filters. Had rapid sand instead of slow sand filters been built at Torresdale there is no question in the speaker's mind but that such a plant

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* Mr. Johnson's paper, presented at the recent Convention of the American Waterworks Association in Philadelphia, was published in abstract form in *The Canadian Engineer* for April 30th, 1914. Mr. Gregory presented the discussion, given herewith, at the Convention on May 13th.

would have been built as far upstream as were the slow sand filters.

One might fancy possibly that trouble would be experienced by the City of New York in securing sites for filters. Such is not the case. Over ten years ago the Commission on Additional Water Supply, in its investigations for an additional water supply for New York City, looked into the question of filter sites not only for the additional supply, but also for the Croton supply. Sites were found where slow sand filters could be built in close proximity to the existing Croton Aqueduct, and sites for slow sand filters were also found and surveyed where the additional supply could be filtered along the line of the proposed new aqueduct. Some years later the Department of Water Supply actually prepared detailed plans for a slow sand filter plant for the Croton supply, on a site located in New York City, namely, in the east basin of Jerome Park Reservoir, the construction of which was suspended pending a decision as to the filtering of the supply. In the case of New York City it is not a question of going a long distance and building an expensive conduit to get a filter site, but rather a question of going a long distance and building an expensive conduit to get water.

At Cincinnati, Ohio, the rapid sand filter plant, which is the largest of its kind in operation in the world, was built well upstream above the city where plenty of land was available for either rapid or slow sand filters. The filtered water is discharged through a long conduit to a main pumping station from which it is pumped to the reservoirs in Eden Park. This plant was built for the future as well as for the present, and it was good judgment to locate the plant as far upstream as it was.

At Columbus, Ohio, the rapid sand filters were built at some little distance upstream above the city. It was a case here of going upstream to get out of the flood zone, although sufficient land for either rapid or slow sand filters was available nearer the city. At the point where the plant was finally built there was sufficient land for either rapid or slow sand filters. In acquiring the land for this particular plant it was found that it would be about as cheap to acquire the whole tract of land on which the works were built as to acquire only so much of the same as would be needed for the plant alone.

Perhaps enough has been said to point out that factors other than the area of land alone have to be taken into account, not only for slow as well as for rapid sand filters, in selecting a suitable site.

The author also considers, in the table on page 69, the cost of construction of different types of filters. It is exceedingly difficult to compare satisfactorily the costs of construction of different plants, even where the fullest information regarding the same is available. Those who are not well posted as to the history of some of the plants cited in the table may possibly be misled as to the cost of building both slow and rapid sand filters if they accept the figures of the author without full knowledge of local conditions.

One of the features which very materially affects the cost of such works is the total reservoir capacity provided, that is the combined capacity of the settling basins and of the clear water reservoirs. To illustrate: The rapid sand filter plant at Little Falls, N.J., which, in the author's table is the most expensive one cited, and which cost $15,000 per million gallons daily capacity, has a coagulating basin capacity of 1.3 hours and a filtered water reservoir capacity of 2.6 hours, or 3.9 hours total reservoir capacity. At Columbus, Ohio, the rapid sand filter plant there, which the author states cost $13,000 per million gallons daily capacity, the next to the highest in cost cited, has a settling basin capacity of 12 hours and a filtered water reservoir capacity of 8 hours, making a total reservoir capacity of 20 hours, or five times as much reservoir capacity as that of the Little Falls plant. If the reservoir capacity of the Little Falls plant had been approximately that of the Columbus plant the cost of construction of the Little Falls plant would have been materially increased over that given by the author. Again, the New Orleans rapid sand filter plant might be cited, which has 35.2 hours' total reservoir capacity, or practically nine times as much reservoir capacity as that of the Little Falls plant. Other factors which affect the cost of construction are the character of the raw water, the rate of filtration, the character of the construction of the works, etc.

In his reference to the Albany slow sand filter plant, the author gives its capacity as 20,000,000 gallons daily. The Albany plant as originally built before the pre-filters were added, had a capacity of 15,000,000 gallons daily. The addition of the pre-filters increased the capacity of the plant very materially so that at the present time the capacity is probably in the neighborhood of 28,000,000 gallons daily. If the capacity is taken at 28,000,000 instead of 20,000,000 gallons daily the cost of the plant would be about $14,300 instead of $20,000 per million gallons daily capacity, as given by the author.

The Philadelphia slow sand filter plants were expensive plants to build. They differ in one way from many of the other filters of the same type that have been built, in that underneath the filter floors and carried up all around the sides of the filters is a layer of puddle. This item alone materially increased the cost of construction. The Lower Roxborough and Upper Roxborough plants were built on high ground in an isolated section several miles from the nearest railroad, and the cost of delivering materials to such plants was higher than would ordinarily be the case.

In the cost of the Lower Roxborough plant the author did not include the cost of the Lower Roxborough reservoir, which was built many years before, and which supplies settled water to the filter plant. Again, a similar condition exists at the Upper Roxborough filter plant with regard to the settling basin. The New Roxborough reservoir was built some ten years earlier than the filter plant, and the author has not included its cost in the cost of the filter plant. Strictly speaking, the costs of the reservoirs should be included in the costs of these two plants so that the figures would be comparable with the costs of the other slow sand filters cited.

The Philadelphia plants were built during a regime of very high prices, and to use the costs of construction of these plants to indicate the reasonable cost of slow sand filters may be very misleading, except to those who are familiar with the early history of these works and who are aware that the costs were high and that the plants could be duplicated at less cost.

The largest slow sand filter plant under construction in America at the present time is at Montreal, and, when completed next year, will have a capacity of 60,000,000 U.S. gallons daily capacity. The total cost of the plant, on the basis of the lump sum contract prices, including the low lift pumping station, will be about $22,600 per million gallons daily capacity. Deducing the low lift pumping station, the cost will probably be about $21,000 per million gallons daily capacity.

It would have been interesting if the author had cited the cost of the slow sand filter plant which was completed at Toronto about two years ago. This plant has a capacity of 48,000,000 U.S. gallons daily, assuming one-sixth of the filter area to be held in reserve, and based on a rate of filtration of 6,000,000 U.S. gallons per acre daily, the rate for which the plant was designed. The cost of the plant, omitting the low lift pumping station, was only about $12,700 per million gallons daily capacity.

In considering the weighted average cost of slow sand filters given by the author, namely, $32,600 per million gallons daily capacity, it may be well to bear in mind that the Montreal plant will cost only about $21,000, that the Albany plant cost about $14,300 and the Toronto plant only $12,700 per million gallons daily capacity.

In referring to the cost of rapid sand filter plants the author cites the Columbus plant as costing $13,000 per million gallons daily capacity. This plant was designed and built under the writer's direction and is a water-softening as well as a rapid sand filter plant. The cost of this plant was given in great detail in a paper* read by the speaker some years ago. The speaker is not informed as to what items the author included in arriving at the cost of the Columbus plant, but in the speaker's judgment the Columbus plant, considered as a rapid sand filter plant alone, cost nearer $15,000 than $13,000 per million gallons daily capacity, the figure given by the author.

Another rapid sand filter plant which the author might have cited is that of Toledo, Ohio, the cost of which was published in the Engineering Record, November 26, 1910. Part of the plant was built for a capacity of 60,000,000 gallons daily, although the present capacity of the works is considerably less. Including only such items as are chargeable to the filter plant proper, the works cost about $14,500 per million gallons daily capacity.

Another rapid sand filter plant which might have been cited is that at Grand Rapids, Mich. The plant was completed inside of the last two years and has a capacity of 20,000,000 gallons daily. The cost of the plant, as given to the speaker by the Grand Rapids officials last year, including such items as are chargeable to the filter plant proper, was $16,300 per million gallons daily capacity.

In December, 1912, the City of New York received bids for a rapid sand filter plant to be located at Jerome Park reservoir and having a capacity of 320,000,000 gallons daily. The speaker is more or less familiar with the plans for the proposed Jerome Park filters as he served as one of a commission of engineers appointed by the Board of Estimate of New York City to report on the same. Taking the lowest bid received and adding to it the cost of the building and other necessary work, the Jerome Park filter plant, which would have been the largest rapid sand filter plant in the world, would have cost about $18,400 per million gallons daily capacity. When the plant is built, and it is greatly to be hoped it will be built soon, the actual cost will probably be in the neighborhood of $20,000 per million gallons daily capacity, as much of the excavation for the plant has already been completed.

The author gives the cost of the Cincinnati rapid sand filter plant, which has a daily capacity of 112,000,000 gallons, as $11,400 per million gallons daily capacity, and states that the cost of the large, plain sedimentation basins is not included. At Cincinnati there are two large settling basins to which the raw water from the Ohio River is pumped. The water is first settled in these two basins, and is then delivered to the coagulating basins at the filter plant. There is no question in the speaker's mind but that the settling basins are part of the filter plant at Cincinnati, but just how much of the cost of the same should be chargeable to the filter plant may be a question. Mr. J. W. Ellms, the superintendent in charge of the filters at Cincinnati, in a paper printed in the Journal of the Association of Engineering Societies in January, 1912, states:

"The settling reservoirs, which have a capacity of 330,000,000 gallons of available water, are in part a portion of the water purification plant, although they also serve the purpose of storage basins and were designed for such a use quite as much as they were for sedimentation purposes."

The two settling basins cost $1,521,000, or about $13,600 per million gallons daily capacity of filter plant. Adding this cost to that of the filter plant would give a total cost of $25,000 per million gallons daily capacity. As the settling basins serve as storage reservoirs also, it may be reasonable to charge the filter plant with perhaps only half their cost. On this assumption the cost of the settling reservoirs chargeable to the filter plant would be $6,800 per million gallons daily capacity, thus making the total cost of the filter plant $18,200 per million gallons daily capacity.

Still another plant which the author might have cited, and among the best in the country, is that at New Orleans, which has a capacity of 40,000,000 gallons daily. Including only such items as are chargeable to the filter plant proper, the cost of the New Orleans plant was about $30,200 per million gallons daily capacity.

The weighted average cost of the Columbus, Toledo, Grand Rapids, Cincinnati and New Orleans rapid sand filter plants, is $18,600 per million gallons daily capacity, while the author gives a weighted average cost for rapid sand filters as $12,100. In other words, the weighted average cost of the five plants just cited, all of which are in operation and which are among the best in the country, is over 50 per cent. higher than the weighted average cost given by the author.

The speaker has but little further to say on the subject of cost except that, in his judgment, the weighted average costs as given by the author, are too high for slow sand filters and are too low for rapid sand filters. Similarly the fixed charges on the costs of construction would respectively be too high for slow sand and too low for rapid sand filters.

The speaker is not presenting any brief for slow sand filters. The rapid sand filter is more flexible than the slow sand filter and in the majority of cases in the United States is better adapted to the purification of water than is the slow sand filter. The slow sand filter has done and is still doing good work in this country, and the present status of water purification is, to a large extent, due to the introduction of the slow sand filter.

*Trans. Am. Soc. C.E., Vol. LXVII., 1910.

The Board of Railway Commissioners has recently issued a general order respecting an application of one of the railway companies to cover Circular No. 133, dated May 5th, 1914, whereby the railways were required to submit monthly, in duplicate, reports on fires originating within 300 feet of the track and burning off an area of 100 square feet or more outside the right-of-way. The applicant petitioned that the circular be treated as privileged and not open to the inspection of the public generally. The Board complied with their request, ordering that such reports shall be made public or given out upon application, and, therefore, only by its own order.

BRIDGE OVER NORTH THOMPSON RIVER, BRITISH COLUMBIA.

A FEW months ago a deck girder bridge 1,209 ft. in length with a girder lift span 93 ft. long and a height of lift equal to 53 ft. was completed for the Canadian Northern Railway Company over the North Thompson River at Kamloops, B.C. Approaches of timber trestle construction at both ends of the bridge have a total length of 1,123 ft. The fixed spans, 12 in number, correspond in length to the lift span, giving the whole structure a very well proportioned and balanced appearance. The lift span is second from the centre span of the structure, as shown in Fig. 1.

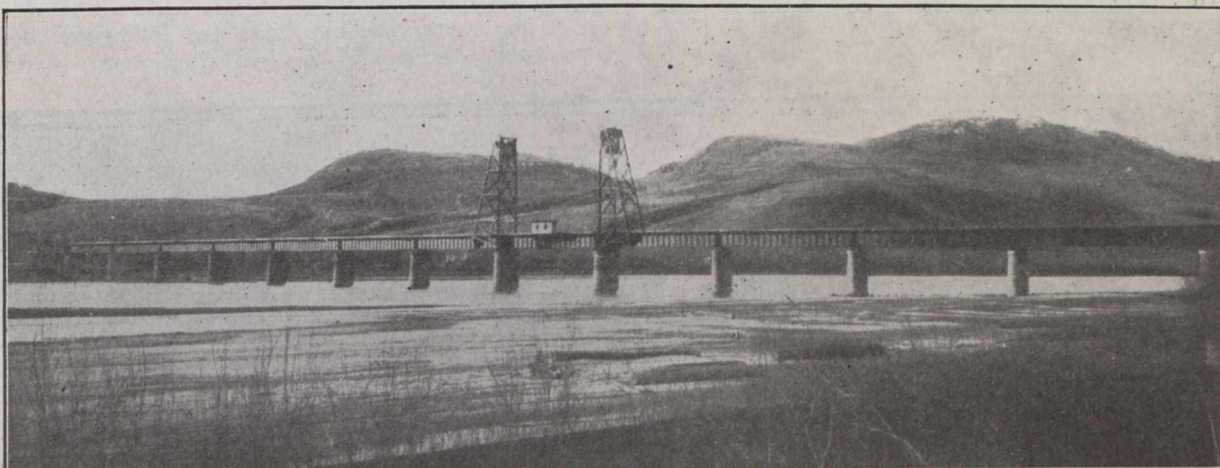


Fig. 1.—General View of the Thompson River Bridge.

The lift span weighs 118 tons and is operated by the assistance of counter weights attached to cables engaged in sheaves at the top of the towers, as shown in Fig. 2. The ends of the span ascend in guides so designed as to make due allowance for elongation due to changes of temperature and for changes in live loan. Cables, 1¼ in. in diameter, at each corner of the span pass over drums and are actuated through a system of gears by a gasoline engine, which, together with all the equipment, is located below the deck and between the girders in the centre of the span.

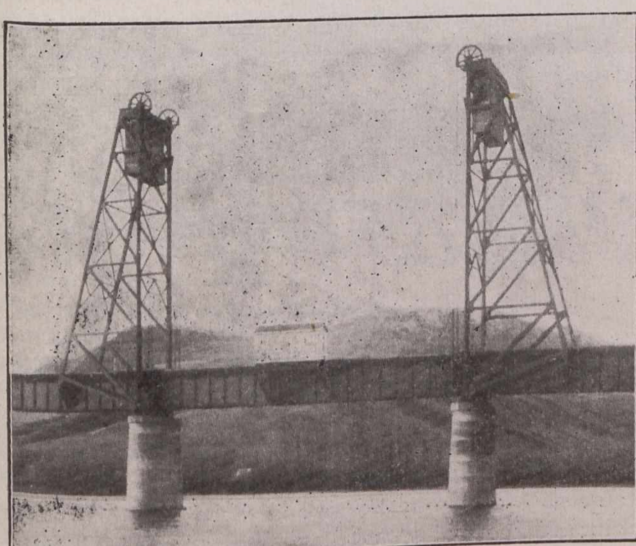


Fig. 2.—View of Lift Span, Showing Elevating Mechanism.

Centering castings provide for keeping the span in proper alignment when being seated. These castings also look after the longitudinal braking thrust. The track is equipped with the necessary special castings at the ends of the span to give continuity to the rails and with locks at each end of the bridge. Limit switches, coming into operation as the span is approaching its bearing, or its elevated position, control the igniter circuit of the engine which, under ordinary operating conditions, is capable of raising the span 53 ft. in 100 seconds, thus providing a clearance of 55 ft. above high water.

The bridge was designed by Messrs. Waddell and Harrington, consulting engineers, Kansas City, Mo. Mr. H. L. Johnston, divisional engineer for the C.N.R., represented the railway in its construction.

The approximate cost of the bridge was $250,000.

CANADIAN ELECTRICAL ASSOCIATION.

The twenty-fourth annual convention of the Canadian Electrical Association will be held in Montreal June 24, 25, 26 and 27, with headquarters at the Ritz Carlton Hotel. Local committees have been appointed and consist of the following:

General Committee—Major Hutcheson and Mr. J. S. Norris, joint chairmen; Messrs. L. D. McFarlane, E. F. Sise, G. H. Olney, R. S. Kelsch, R. J. Jones, J. M. Robertson and Dr. L. Herdt.

Ways and Means Committee—Mr. Julian C. Smith, chairman; Messrs. K. B. Thornton, J. A. Shaw, R. H. Balfour, W. F. Graves and R. F. Morkill.

Entertainment Committee—Mr. Lawford Grant, chairman; Alderman Boyd, Messrs. Paul Sise, R. G. Harris, W. C. Lancaster, W. H. Winter, H. C. Post, P. Roper, Powell and R. M. Wilson.

Publicity Committee—Mr. S. W. Smith, chairman; Messrs. W. J. Doherty and L. J. Belnap.

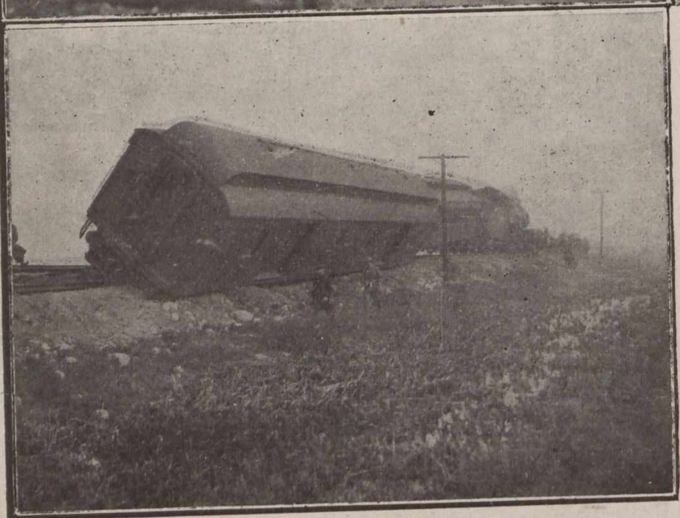
Finance Committee—Mr. J. W. Pilcher, chairman; C. F. Medbury, F. W. Smith, R. M. Wilson and L. B. Belnap.

P. T. Davies, honorary secretary.

A special programme has been prepared by the Entertainment Committee which is sure to appeal to all visitors. Special souvenirs have been provided for the ladies.

RECENT DERAILMENT NEAR TROUT CREEK, ONTARIO.

THE accompanying views give rise to some interesting conjectures in connection with train derailment. The accident which they illustrate occurred to the "Cobalt Special" at four-thirty in the morning. One of the Pullmans contained a party of railroad engineers, one of whom was looking out the window at the time, and it was stated positively that the speed at the moment of derailment did not exceed fifteen miles per hour. The extraordinary manner in which the rails, ties and ballast were torn out indicates the seriousness of such an accident occurring at this point at high or even moderate speed.



Views of Recent Derailment Near Trout Creek, Ont.

Apparently, one truck of one of the forward cars mounted the west rail, and after travelling along the ties for perhaps forty feet, commenced the process of tearing things loose. The following cars, on reaching the damaged roadbed, left the rails and completed the destruction. The point at which the rail was mounted was clearly indicated, though the gauge at this point and for some distance to the south was quite correct, and showed no reason for the derailment. When the train came to a stop, the tender and six out of the eight cars were off, some of which needed but little more to roll them completely over. One of the photos indicates three lengths of rail, detached from the ties and quite free from fish plates and bolts, apparently lying close to their original positions and not in any degree twisted or otherwise damaged.

We are indebted to Mr. K. L. Aitken, consulting engineer, Toronto, for the photos illustrating the mishap.

CONCRETE ARCH BRIDGES.

The following conclusions drawn in a paper, "Concrete Bridges; Some Important Features of Their Design," by Walter M. Smith, Sr., and Walter M. Smith, Jr., in Vol. 39, p. 1193, Proceedings of the American Society of Civil Engineers, are of interest. This paper deals with the advantages of an arch of two ribs over the solid sofflt arch, with narrow ribs rather than wide ribs and with deep ribs of I-section rather than rectangular section; it also deals with the advantages of the three-hinged arch over the fixed and two-hinged types.

The writers believe that the following conclusions are amply justified by the investigations:

(1) An arch span consisting of two separate ribs is more economical than one with a solid sofflt, if the span is greater than 100 ft.

(2) Narrow, deep ribs are more economical than thin, wide ones.

(3) The three-hinged arch is more economical and reliable than fixed or two-hinged arches for spans greater than 100 ft.

(4) For spans of 200 ft. or more the rib of I-section is more economical than the rectangular rib.

(5) Piers of any considerable height are much more economical if built of two separate legs thoroughly braced, thickening rapidly in the direction of the axis of the bridge as they go down.

On June 2 the steel mills of the American Steel and Tinplate Company, which have been idle for many weeks, were ordered into service again; and nine of the eleven mills began running. The other two are being repaired.

A plan is under way and is being furthered by the Baden government, Germany, to dredge and widen the Rhine River from Strassburg to Constanz; and the project is declared to be a perfectly feasible one. The dredging and widening of the river portion from Strassburg to Basle, would, it is considered, be an integral part of the main waterway from Strassburg to Constanz; and the Rhine should be made navigable to Constanz or not at all. For Baden, the undertaking is one of great importance as it would eventually open up a waterway for the largest steamers from the North Sea to the Baden Sea.

Coast to Coast

Woodstock, Ont.—Estimates for the year 1914, totalling $83,982.81, have been approved by the London city council.

Sarnia, Ont.—The Dominion Government has commenced dredging along the docks of the Northern Navigation Company at Point Edward.

Windsor, Ont.—Niagara power will be delivered in Windsor by August 1. All the towers are placed, and installing of equipment is progressing rapidly.

Hamilton, Ont.—Another offer has been made to the city of Hamilton of property to be purchased for a civic stone quarry. The firm of Teeter & Kemp offer 110 acres in the township of Saltfleet for $30,000.

Ottawa, Ont.—The city council of Ottawa has adopted a motion calling for the appointment of a committee to inquire into the existing organization regarding the construction and maintenance of roads, and to bring in a report.

Swift Current, Sask.—No further drilling will be done at the Swift Current gas well until October 1. Collarless pipe must be secured from Germany before the contractors can carry the depth of the drill to 3,000 feet, as recently decided upon by the city.

Oil Springs, Ont.—It is stated that the new Oil Springs oil and gas strike on the Wallen property is now estimated at a capacity of 12,000,000 feet per day, and this in consideration of the fact that drilling has only been carried a couple of inches into gas rock.

Weyburn, Sask.—A recent discovery was made a few miles south of Weyburn of an extensive quarry of what is claimed to be excellent sandstone. The deposit is located one mile from the C.P.R. station at Ralph, and shows a seam about 8 feet thick and 50 feet wide.

Toronto, Ont.—City Surveyor Le May has outlined a scheme for the remodelling of North Toronto, which is now being considered by civic authorities. The project calls for the extension of many streets and the opening of others, which will reach an expenditure of about $1,000,000.

Vancouver, B.C.—Paving work at Vancouver, recently contracted for by the Canadian Mineral Rubber Company, is progressing rapidly. Within a few weeks, a total yardage of approximately 16,000 square yards has been completed, and the company is now busy at the resurfacing of Vancouver street.

Winnipeg, Man.—Work is reported as showing satisfactory progress on the power plant of the Winnipeg Electric Railway Company being built at Grand Bonnet Falls. In April a private railway along the company's right-of-way was commenced, and is being rapidly built. It will extend 12 miles from Lac du Bonnet to the power site.

Sudbury, Ont.—The construction of the Sudbury-Copper Cliff Suburban Electric Railway has been commenced, and it is the intention of the company to have the line completed this year from Sudbury to Copper Cliff. Three lines are contemplated at present, e.g., Copper Cliff route, 5.1 miles; Ramsay Lake route, 1.2 miles; and Frood Mine route, 1.2 miles.

Toronto, Ont.—The works committee of Toronto has recommended to council submission of money by-laws amounting to $1,734,465, as follows: roadway section, asphalt plant, $125,000; sewer section, $121,400; Dundas street bridges, $148,000; North Toronto water supply mains, $525,000; extension of high-pressure system, $500,000; other mains, $315,000.

Vancouver, B.C.—City officials of Vancouver observed recently tests of pressure made at the First Narrows on the water main recently connected between the north and south shores, which have been reported as very satisfactory. It is stated, also, that the work of hauling across the second 18-inch main, which is to form one of the connections for the Point Grey partnership pipe line, will commence at once.

Ottawa, Ont.—The compromise reached in connection with the question of the liability of the government in guaranteeing the bonds necessary to complete the construction of the G.T.P. mountain line, provides that the government shall guarantee bonds for three-quarters of the additional cost required for completion. It is understood that the amount of the guarantees, including interest, is $16,000,000.

Edmonton, Alta.—It is claimed by experts who have spent years north of Edmonton that oil fields will be developed to the north of the province which will prove to be of much greater moment than those in south-western Alberta now attracting world-wide attention. The country is said, by geologists, to show both surface and geological indications of the greatest oil development.

Ottawa, Ont.—The city auditor of Ottawa has reported to the city council that the total cost so far of the work on the old intake pipe is $153,849.37, as given in a statement prepared by the city engineer's office. Of that amount, already there has been passed $122,708.45, of which $82,636.63 has been for extras. The city engineer's estimate for the entire work was only $57,000, and the contract was let to Loomis, McBean and Williams for $40,000.

Victoria, B.C.—An inspection was made recently by D. O. Lewis, divisional superintendent of the C.N.P. railroad, particular attention being made to Section D, which lies between mileage 100 and 140. The grade from mileage 124 to 135, which runs through heavy rock work, has been practically completed. It is said that this section of the road is in splendid condition, requiring but little more attention at the hands of the contractors. Nothing has been done, of course, between mileage 136 and 140, where there are alternative routes between which a choice has yet to be made.

London, Ont.—Actual construction work undertaken this year by the city engineer's department under by-laws passed by the council now totals $525,000, a small amount of this having been authorized last year. The road work being carried out in the city is well under way. The concrete work on Horton street from Ridout street bridge has been completed, and the work of laying vitrified brick surface can now be undertaken. Work on the Wharncliffe road sewer has been commenced and will be completed, it is expected, within two weeks; after which the laying of pavements will proceed.

Victoria, B.C.—The laying of concrete flow line along the route between Humpback reservoir and Cooper's Cove in connection with the Sooke Lake water supply works, is reported to commence shortly. Enough pipe is ready to proceed with work on this section as well as on the line from Sooke Lake to Cooper's Cove, where work is in progress. Also for the section of the pressure line between the reservoir and the city, the fabricating of steel pipe will soon be commenced by the Burrard Engineering Company. Preparations are being made for procedure on excavation for the line, continuing on from the point where excavation now stops.

Fort William, Ont.—Owing to the fact that, upon breaking through many of the pavements in Fort William, it is found that the earth has sunken below them, leaving no support whatever, a new system of street paving is being advanced by M. Ferguson and J. H. Walker, of west Fort William. Their plan is to construct a line of concrete piers under the crown of a pavement and to run a reinforced concrete beam over the top of these as a support to the pavement. If, as in the case of some of the city roads, the sewer is laid in the centre of the street, they propose that two rows of piers be constructed, one row on each side of the sewer. With such a system, it is said, the pavement would carry the greatest loads even when the supporting earth sinks away beneath it.

Brandon, Man.—In an address made to the Brandon Trades and Labor council upon the power question, Mayor Hughes advocates as the most feasible and profitable way of getting power for Brandon the hydro-electric scheme from the Winnipeg river. In support of his contention, Mr. Hughes gave the following figures for the cost of power from Winnipeg: cost of line from Portage to Brandon, $297,903, this to include transformers, patrol and upkeep of the line, $5,500 per annum; one-half cost of line from Portage to Winnipeg, $12,630; 2,500 h.p. at $20, $50,000, making a total of $91,386 for power and upkeep of line. Speaking of the probable income, the speaker said that from the waterworks $20,000 would be realized; from the street railway, $12,000; and from the street lighting, $18,000. These sums were in addition to revenue from two flour mills, the C.P.R., C.N.R., and numerous smaller plants.

Vancouver, B.C.—A recent report on the construction of C.P.R. bridges over the Pitt and Harrison rivers in British Columbia says that structural operations are now well advanced on the double-track bridge being erected by the C.P.R. over the Pitt River. The huge swing span, 276 feet in length, and weighing 650 tons, is being erected; and girders are being placed from the eastern end of the structure. Nearly one-third of the upper portion of the bridge has been erected; and the work is expected to be completed in November. The structure is 1,750 feet in length, and will be the largest of its kind on the British Columbia division of the C.P.R. Also rapid progress is being made on the Harrison River bridge, a structure of a similar type to the Pitt River bridge, and 950 feet long. The superstructure is nearing completion, the swing span having been installed and work well advanced from both ends. It will be ready for service, it is anticipated, by the end of July.

Brantford, Ont.—The Board of Water Commissioners has awarded contracts for a new waterworks pumping plant. Two De Laval 12-inch, multi-stage, centrifugal pumps, two De Laval single-stage, double suction type booster pumps, and two high-speed turbines for driving the booster pumps, will be supplied by the Turbine Equipment Company, Toronto. The contract for the 250 h.p. synchronous motors for driving the domestic pumps has been awarded to the Canadian Westinghouse Company, Hamilton. The output of each of the domestic units will be 4,000,000 imperial gallons per day, against 200 feet head. The output of each of the booster units will be 4,000,000 gallons, against 100 feet head. In case of the electrical power being out of commission, the two booster pumps can be arranged to run in series, the output being 4,000,000 gallons against approximately 90 pounds pressure. In case of fire, either booster pump can run in series with either electrically-driven domestic pump.

Ottawa, Ont.—The city council of Ottawa has passed the first reading of by-laws authorizing the issue of debentures totalling about $1,000,000, which include the following amounts for local improvements: $44,239.33 for sewers; $164,846.84 for asphalt pavements; $10,206.23 for opening of Murray street; $14,385.41 for opening of Heney street; $93,530.53 for asphalt pavements; $14,008 for tarvia pavements; $98,571.91 for concrete sidewalks; $159.50 for plank sidewalks. Other items of expenditure are: $5,000 to complete main drain system; $5,000 to pay city's share of cost of subway on Bank street; $8,000 to pay for cost of alterations and additions to Howick hall; $50,000 for construction of horticultural and agricultural hall; $30,000 for completion of main drainage system along certain streets; $25,000 for trunk sewer in Rideau ward; $80,000 for bridge over canal; $60,000 for cost of intercepting sewer through Broad street yard of C.P.R.; $40,000 for new hydrants and water meters; $80,000 for water mains and extensions.

Sault Ste. Marie, Ont.—According to a judgment made public at Ottawa on June 4 by the International Joint Commission in the case of the Michigan Northern Power Company and the Algoma Steel Corporation, these companies are to be allowed to divert 30,000 cubic feet of water per second from the river; and this means the development by Sault Ste. Marie of 106,000 continuous electrical h.p. The capital cost of the development will be $13,250,000. Throughout the consideration of the case the paramount rights of navigation interests have been kept in mind; and the powers given the companies are contingent upon the construction of a dyke so operated under Government supervision as to ensure the maintenance of the level of Lake Superior. Under the lease by the United States Government to the Michigan Power Company the dyke and sluice-gates on the American side will eventually be acquired by the United States Government, and similar action will probably be taken by the Canadian Government in respect to the works on its side of the river.

Toronto, Ont.—The plans for the Don section of the Bloor Street viaduct, as designed by Engineers Thomas Taylor and C. W. Power, of the Civic Works Department, show a straight stretch of construction from Castle Frank road east to the present western terminus of Danforth avenue, with a high bridge of 4-arch span crossing the Don Valley and river, the longest span to be 282 feet from pier to pier. The deck of the viaduct is divided longitudinally into three sections, the two outward sections being devised for street traffic, the central section for rail. A ballasted roadbed is planned to deaden the noise customary in connection with traffic bridges. Moreover, provision is made in the plans for providing a lower deck to the viaduct in future to accomodate rapid transit railways; and whenever the growth of street traffic warrants, it will be possible with little alteration and expense to remove all the cars from the upper deck and to provide a clear roadway from one side of the viaduct to the other. Preparation of plans for the Rosedale section of the viaduct are almost completed. This section comprises two diagonal stretches from Sherbourne and Bloor Street south-east to the head of Parliament Street produced, and thence north-east to Castle Frank road.

Vancouver, B.C.—Besides the Central Park section of the trunk sewer to be constructed by the Greater Vancouver joint sewerage commission, and for which tenders are to be advertised shortly, there are many other portions of work, some of which are also included in the 1914 program outlined by the commission. Sections which are in a fair way to being realized are the Clark drive interceptor, which will take all the sewage from China Creek to Burrard Inlet; extensions to the present Bridge street sewer, the construction of that along Balaclava street, and the laying of a trunk line east of Hastings Park, extending from the inlet some distance south of Hastings street; the Stanley Park interceptor, which will do away with the outfall at English Bay and will carry all sewage from the West End into the First narrows; and the deepening of the Brunette river, which will lower Burnaby lake and allow of better drainage of the surface water in the section of Burnaby municipality in this vicinity. The China Creek trunk sewer and its tributary, the Canoe Creek extension, are now in progress; and the city is preparing to lay lateral sewers draining into the trunks, which will serve D.L. 301, hitherto without sewers of any kind. Up to the present, at least $200,000 has been expended on the work.

OIL ENGINES FOR FISHERIES.

The attention of Canadian manufacturers of oil engines suitable for fishing craft, is drawn to the increasing demand in Great Britain, by the report of Mr. J. E. Ray, Canadian trade commissioner at Birmingham. There seems to be a very keen competition in the supplying of oil engines for this purpose as all types of British fishing boats are being equipped with motors as auxiliary power. The leading British manufacturers of heavy type paraffin and hot-bulb engines are said to be extremely busy. A well-known firm in England secured in one week recently fourteen orders for paraffin motors of 55 and 75 b.h.p. to be installed in boats on the coast of Scotland.

The outfitting of these boats with motor power has had a remarkable growth during the last few years. Nearly all the new intermediate boats and yawls on the east coast of England have motors. Fishing craft, large and small, along the Irish coast and at the Isle of Man ports are also being fitted. The same applies to the south of England, to the Shetlands and to the west of Scotland. Scarcely a new boat is being turned out in which a motor is not installed.

PERSONALS.

WM. FORBES has been appointed road superintendent for the County of Oxford, Ont.

A. M. JACKSON, of Brantford, has recently been appointed engineer to the County of Brant.

GEO. B. TAYLOR was recently appointed superintendent of the power and water departments of the city of Medicine Hat, Alta.

E. R. SMITHRIM, B.A.Sc., has been engaged by the Public Utilities Commission of Strathroy, Ont., to superintend the construction of its distribution system for Hydro-electric power.

C. G. DAVEY, a 3rd year student in mechanical engineering at the University of Toronto, has been awarded the scholarship of the Boiler Inspection and Insurance Company of Canada.

CHAS. W. POWER, assistant engineer, City of Toronto, in charge of the Department of Railways and Bridges has resigned and on July 1st, will become associated with the Canadian Stewart Company, Toronto, as engineer in charge of harbor work.

CARL WEBER, the inventor of the Weber reinforced concrete chimney, has become president of the Gun-Crete Company of Chicago. The firm specializes in cement-gun work for engineering, mining and industrial structures, and is also introducing the Weber system of hollow concrete floor construction. These floors are erected without forms and are said to be sound, fire and water proof and of light construction.

At the University of Toronto commencement exercises held on June 5th, the professional degree of civil engineer of the University of Toronto was conferred upon Messrs. P. Gillespie, associate professor of applied mechanics; C. R. Young, assistant professor in structural engineering; T. H. Hogg, assistant hydraulic engineer, Ontario Hydro-Electric Power Commission, and S. N. Hill, Topographical Surveys Branch, Department of the Interior, Ottawa.

The degree of electrical engineer was conferred upon R. A. Sara, sales manager, Winnipeg Light and Power Department.

OBITUARY.

On June 1st, Mr. Chas. C. Nugent, of Toronto, was fatally injured in a motorcycle accident. Mr. Nugent was 35 years of age and a native of Ireland. Since his arrival in Canada seven years ago he has been engaged in civil engineering work, during which time he has been connected with the Toronto staff of the Canadian Pacific Railway.

The death was announced on June 2nd, of Mr. Wm. R. Perrin of Chicago, architect, engineer and contractor for the Toronto civic abattoir. Mr. Perrin was 54 years of age and was head of the firm of W. R. Perrin and Company, Chicago and Toronto.

In the list of those who met death in the disaster which befell the Empress of Ireland is included the name of Mr. A. E. Barlow whose activities in mining and geological work throughout the Dominion are widely known. Mr. Barlow was for many years connected with the Geological Survey of Canada. During another period of his career he held a professorship in McGill University, Montreal. For some years prior to his death he has been engaged in private practice as consulting engineer and geologist. Only recently Mr. Barlow made some extensive investigations in British Columbia in connection with which he took passage to England on the ill-fated liner.

On June 5th death came accidentally to Mr. Robt. H. Jupp, engineer for Simcoe County, Ont. Mr. Jupp was inspecting the construction of a bridge at Nicolston when he fell a considerable distance as a result of a misstep.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown. Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21885—May 27—Approving location C.N.R. proposed third-class station at Marvin, Saskatchewan.

21886—May 27—Approving location C.N.O.R. station grounds at Clemow, Tp. Barron, Dist. Nipissing, Ont., mileage, 133.26 from Ottawa.

21887—May 20—Rescinding Order No. 21217, dated Jan. 16th, 1914. And directing that Can. Nor. Que. Ry. fence portion of its right-of-way between mileage 26 and 27, on south side of track, on or before June 1st, 1914.

21888—May 26—Authorizing, temporarily, pending installation of interlocking plant to be called at crossing, Toronto and Eastern Ry. Co., to operate trains over crossing of G.T.R. Port Perry Branch at Town of Whitby, Ont., for construction purposes only; interlocking plant to be installed on or before July 20th, 1914. All movements of Applicant's trains be flagged over crossing by an employee of Applicant Company.

21889—May 27—Dismissing complaint of Mrs. Kate S. Massiah, Lachute, Que., alleging discrimination by C.P.R. against Lachute, in issuing commutation tickets to St. Agathe, Vaudreuil, Hudson, and other points.

21890—May 27—Authorizing C.P.R. to construct road diversion in S. W. ¼ Sec. 3-8-29, W. 2 M., Sask., and construct, by grade crossing, its Weyburn-Stirling Branch Line across said road allowance between S. W. ¼ Sec. 3 and S. E. ¼ Sec. 4-8-29, W. 2 M., mileage 105.23, on said Branch Line.

General Order No. 125—May 30—Directing that terms of Judgment, which is hereby made part of this Order, and tariff changes therein directed to be made, be complied with and become effective not later than Sept 1st, 1914; and that, for period of two years from date of this Order, no rates at present in effect west of Port Arthur, Ont., be increased without approval of Board.

21891—May 27—Authorizing C.P.R. to construct siding for I. L. Lafleur, town of Notre Dame de Grace, from point on southerly limit of right-of-way of main line, Eastern Div., mileage 2.54, Windsor Street, to Montreal Jct., in Lot Cadastral Nos. 181-23, 24 and 25, (Civic) Notre Dame de Grace Ward, city of Montreal, Mun. of Parish of Montreal, Co. Hochelaga, Que.

21892—May 27—Authorizing C.N.R. to construct across and divert highway between Secs. 15 and 16-11-22, W. 2 M., at Traux, Sask.

21893—May 26—Authorizing C.N.O.R. to construct, by means of a separation of grades, across G.T. and C.P.R. Cos., in city of Toronto, Ont.

21894—May 27—Amending Order No. 21508, dated March 14th, 1914, to allow G.T.P. Ry. to make certain changes in highway crossings in Tp. 34, Rgs. 1 and 2, W. 3 M., Sask.; and extending for period of 30 days from 31st May, 1914, time within which said work required under Order No. 21508 was to be completed.

21895—May 27—Authorizing G.T.P. Ry. to construct spur for Inland Lumber and Building Co., Ltd., Edmonton, Dist. North Alta., Alberta.

21896—May 26—Authorizing G.T.P. Ry. to construct highway crossing over its main line in N.W. ¼ Sec. 7-53-4, W. 5 M., mileage 44.9, Sunset Ave., Whitewood Sands, Alta.

21897—May 27—Authorizing G.T.R. to construct siding and spurs therefrom, into premises of Elias Rogers Co., Limited, leased from G.T.R., city of Toronto, Ont.

21898—May 27—Authorizing G.T.R. to construct siding into premises of United Drug Co., Limited, city of Toronto, Ontario.

21899—May 26—Authorizing G.T.R. to use and occupy branch line authorized to be constructed by T., H. & B. Ry. to lands of National Steel Car Co., Limited, under Order No. 17562, with full right and power to run trains over and upon said spur, subject to any Orders or directions Board may hereafter make as to exercise, enjoyment, or restrictions of powers and privileges herein granted, and subject to and upon certain conditions.

21900—May 27—Directing that Dominion Atlantic Ry. employ flagman to protect crossing of highway west of Port William Station, N.S., when trains are passing Port William Station without stopping.

21901—May 28—Amending Order No. 21243, dated Jan. 21st, 1914, by striking out word and figures "Fifty ($50.00)" in last line of Order and substituting therefor "Ten ($10.00)."

21902—May 29—Approving agreement entered into between Bell Telephone Co. and Byron Telephone Co., and dated May 14th, 1914.

21903—May 29—Approving agreement entered into between Bell Telephone Co. and Alnwick Rural Telephone Co., Limited, dated May 15th, 1914.

21904—May 29—Directing C.P.R. construct subway under tracks crossing highway between lots 5 and 6, Con, 5, Tp. Toronto, Ont., proposed subway be constructed in line with highway so there will be clear view through it from highway at each end; headway, 14 ft.; clear span of 20 ft. over crown of highway. Cost of construction, 20 per cent., not exceeding $5,000, by railway. Grade-Crossing Fund, 5 per cent., remainder by village of Streetsville, 15 per cent. Tp. Toronto, and 80 per cent. by Ry. Co. Surface of road be maintained by Municipal authorities responsible for highway; all other cost of maintenance be borne and paid by Railway Company.

21905—May 28—Dismissing application Town Aylmer, Que., for reduction in fare between Ottawa and Aylmer on Hull Electric Railway.

21906—May 29—Refusing application St. Mary's Horse Shoe Quarry, St. Mary's, Ont., for Order relieving it from expense of maintenance and interest charged upon G.T.R. spur into their property.

21907—May 28—Directing Lake Erie and Northern Ry.; at own expense, to construct level crossing over railway where it crosses farm of Bradford Bowlby in Lot 5, Con. 2, Tp. Woodhouse, Ontario.

General Order No. 126—May 28—Declaring that report or reports submitted by Railway Companies in accordance with Circular No. 133, are privileged, and shall only be made public or given out upon application therefor by Order of the Board.

21908—June 1—Amending Order No. 21837, May 18th, 1914, by adding after figures "589" in 3rd line of recital to Order words and figures, "and No. 1186, certified copies," and striking out words "a certified copy"; and striking out word "condition" and word "Order" in 1st and 2nd lines of operative part of Order and substituting word "conditions" and word "Orders."

21909—June 1—Extending, until August 15th, 1914, time within which G.T.R. complete work of lighting Victoria Bridge, Montreal.

21910—June 1—Relieving G.T.R. from providing further protection at crossing of railway immediately west of Lorne Park Station, Ontario.

21911—June 1—Amending Order No. 21725, April 29th, 1914, by striking out following words and figures: "the said crossing to be constructed in accordance with Standard Regulations of Board Affecting Highway Crossings as amended May 4th, 1910," in last three lines of operative part of Order.

21912—May 27—Authorizing C.P.R. to construct diversion of Graham Ave., town of Stonewall, Man.; authorizing Co. to construct, by grade crossing, its main line, Man. Div. Arborg Sub. Div. across Lilly St., said town of Stonewall.