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Volume 23 Toronto, August 1, 1912

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The Canadian Engineer

An Engineering Weekly

THE HIGH TENSION TRANSMISSION SYSTEM OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

SECOND ARTICLE.

Insulators.—Suspension-type insulators are employed exclusively on the high-tension system. The specifications called for an insulator capable of withstanding an electric strain of 330,000 volts (three times normal) dry, 220,000 volts (twice normal) under a precipitation of ½ inch of water a minute at an angle of 45 degrees and a mechanical longitudinal stress of 8,000 pounds. The strain insulators employed to take up the horizontal strain on the cable were required to withstand a tensile load of 10,000 pounds without injury.

A number of insulator factories were visited before these specifications were prepared. Data was collected regarding methods of manufacture, and the facilities of the various manufacturers were investigated for producing insulators of the required quality in sufficient quantities. The data secured from the insulator tests carried out at the different factories was so varied that the commission decided to make independent comparative tests under similar conditions on the various types and three complete sample insulators called for with each tender. The insulator tests were made in the transformer station of the Ontario Power Company at Niagara Falls, Ontario. This company courteously offered the commission the use of all necessary apparatus, machinery and power, and during the tests assisted the engineers of the commission. The 330,000-volt dry test (Fig. 12) was performed in all cases. However, the 220,000-volt rain test constituted the real test of efficiency. The water was applied through a series of spray nozzles directed toward the insulators at an angle of 45 degrees. The flow was adjusted to give a precipitation of at least ½ inch a minute, which was called for in the specifications. The nozzles were arranged to subject all insulators to exactly the same conditions.

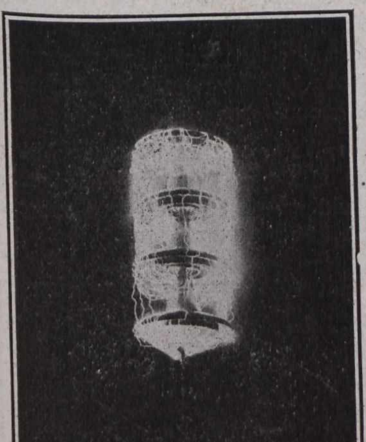

Fig. 12.—Insulators Under Test.

These tests were performed in absolute darkness, and a large number of photographs were taken to compare the more or less vivid luminous display due to leakage and flashover. The mechanical strength of the sample insulators was also investigated and a large number of tests were performed to ascertain the ultimate breaking loads.

All tests were made entirely independent of the prices submitted in the various tenders, and the question of cost was not considered until after the final selection had been made, based on the above tests. As an evidence of the thoroughness of the tests and inspection of quality of manufacture, it may be mentioned that during the year and a half that the system has been in operation no interruptions have occurred through mechanical or electrical insulator trouble. An insulator of American manufacture was finally chosen after a few alterations in design had been made at the recommendation of the commission's engineers. The suspension type of insulator consisted of eight sections with a ball and socket connection, as shown in Fig. 13. The strain type consisted of ten reinforced sections with similar connections. These insulators were shipped assembled in crates to various railway sidings, and from there transported by team to the railway sites. The eight-section suspension-type insulators were used on standard towers. The ten-section strain type insulators were used on the line anchor, corner and long-span towers, and all special towers at railway, transmission line and navigable water-way crossings.

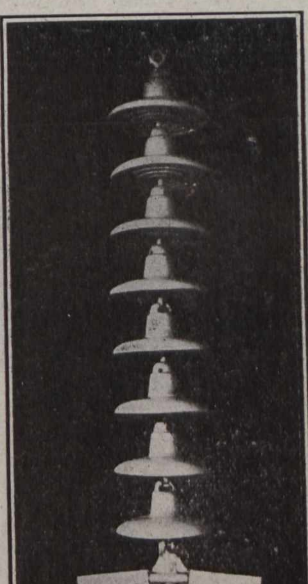

Fig. 13.—Standard High Tension Suspension Insulator.

The suspension type insulators weigh, assembled, about 100 pounds, and have an over-all length of 5 feet 2 inches, including the clamp. They are attached to the tower drossarm by means of an eye-bolt, which is suspended from the tower arm by a galvanized U-bolt supplied by the tower contractor and placed in position by this assembling gang. The suspension insulators were hung by a gang of three men and a foreman, the insulator being raised to the arm by a line and pulley, the eye-bolt slipped into the socket in the cap of the top section and then keyed in place with a small cotter-pin. The greater portion of this work was performed in the winter and the rate of progress varied considerably, but under favorable working conditions, the gang could cover forty towers a day on single-circuit sections, three insulators to a tower. The strain insulators were not hung by this gang, but were delivered where required, and later erected by the cable gang.

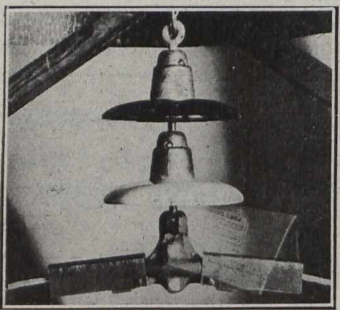

Fig. 14.—Standard High Tension Suspension Insulator Clamp.

The cable clamp employed with the standard suspension-type insulator is shown in Fig. 14. It was specially designed for this insulator and consists of a malleable-iron casting with supporting grooves and a bolted cast clip for clamping the cable. An aluminum sleeve of 1/16 inch plate surrounds the cable and serves to protect it from abrasion. The clamp for the suspension insulator is also provided with two galvanized sheet-iron shields, projecting over the cable at either end of the clamp and preventing burning of the cable by short-circuits occurring from the flash-over or failure of an insulator. All clamps and iron and steel parts are galvanized.

The strain insulator clamp, illustrated by Fig. 15, consists of two ¼ inch galvanized pressed-steel plates bolted together and provided with grooves to receive the cable. Aluminum sleeves and iron shields are also employed with these clamps to protect the cable from abrasion and burning. During the course of construction it was found advisable to place an order for a portion of the insulators with an European manufacturer, who furnished insulators of the same design and quality as those supplied by the American company. The total order for insulators was 11,000 of the suspension type and 3,000 of the complete strain type, together with the necessary clamps, sleeves and shields.

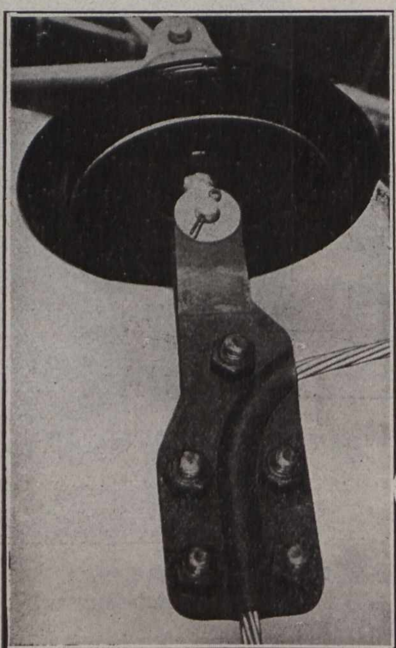

Fig. 15.—Standard High Tension Strain Insulator Clamp.

Cable.—With the exception of about three miles of copper circuit within the city limits of Toronto, aluminum cable was used throughout the system. Two sizes were employed, No. 4/0 B &S gauge being used on the double-circuit line from Niagara Falls to Dundas, and No. 3/0 throughout the rest of the system. The cable was delivered on the field in reel lengths of 4,000 feet, and has the dimensions and characteristics specified in Table IV.

The cable gang consisted of twenty-five men, one foreman, one sub-foreman and two teams. The reels were mounted on portable frames and the cables run out three at a time by a team. As each tower was reached the cable was raised to the cross-arms and placed on wooden pulleys, suspended at the same height and adjacent to the cable clamps. When the cable on the three reels had been run out one span on each line was adjusted for sag by the commission's inspector, the sags on the other spans were allowed to adjust themselves over the pulleys.

The cables were then snubbed and men working on swings suspended from the arms removed them from the pulleys and clamped them to the insulators. While this was being done part of the gang with the sub-foreman and the other team worked in advance erecting ground cable. The ground cable is 5/16 inch, seven-strand galvanized steel, and was pulled up to the proper sag and clamped directly on the towers. On the double-circuit towers three ground cables are employed with two power circuits (Fig. 16) and two ground cables with one power circuit. The single-circuit towers are provided with a single ground cable.

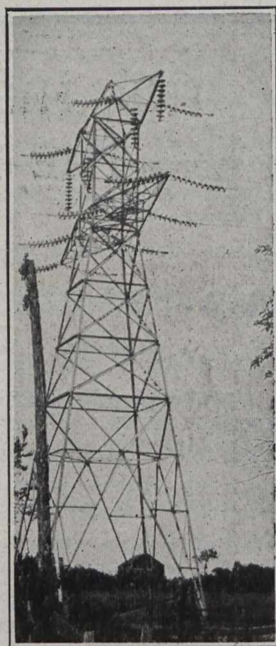

Fig. 16.—Standard Double-Circuit Anchor Tower.

Cable splicings (Fig. 17) were made by means of 18-inch and 22-inch aluminum McIntyre sleeves, the specifications called for sleeves providing for two and one-half complete turns. The ground cable splices were made by means of a specially designed connector. Cable sags were adjusted in the field according to sag tables which were compiled with reference to temperature and length of span. Calcula-

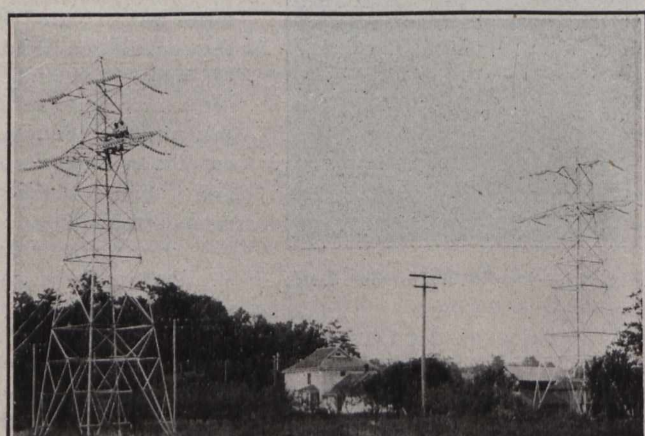

Fig. 17.—Cable Splicing on Heavy Anchor Tower.

tions were based on the assumption that the cables would be stressed to the elastic limit at 32 degrees Fahrenheit with a 3/8 inch coating of ice and a 65-mile gale. The minimum ground clearance allowed was 20 feet.

The rate of cable erection varied greatly, depending not only on weather conditions and topography, but upon the number of railways and transmission lines encountered. (Fig. 18). The erection of strain insulators and the forming and adjusting of loops on anchor and crossing towers seriously

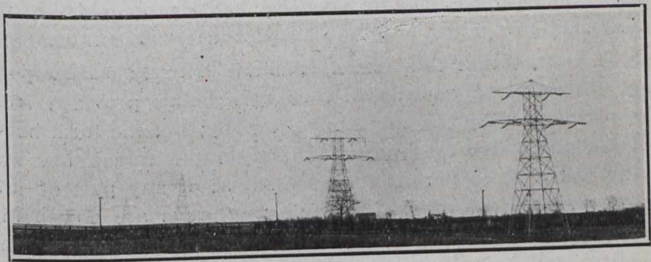

Fig. 18.—Typical Double-Circuit Transmission Line Railway Crossing.

affected the progress of the work on some sections of the line. On double-circuit sections, where six power cables and three ground cables were erected, the average rate of erection was from ½ mile to 6/10 mile of the completed line a day. The labor cost varied from $110 to $215 a mile, the average being $130 for a mile of completed line. The rate of erection for three power cables and the ground cables was from ½ mile to ¾ mile of line a day, and the labor cost averaged about $80 for a mile.

Special Construction.—The most important special construction is located within the corporate limits of Toronto, where the high-tension line (Fig. 19) is carried to the Strachan Avenue station. This section of line is supported on towers giving 70-foot minimum ground clearance, and for a distance of about a mile the towers are located in Lake Ontario, 200 feet from the shore. Reinforced-concrete piers, cross-braced with steel girders 15-feet above water-level and protected at their bases by heavy hand-laid rip-rap support the tower bases.

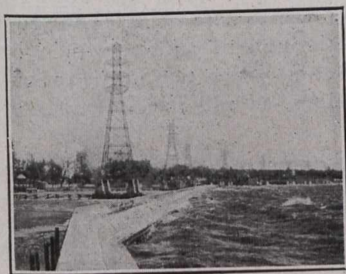

Fig. 19.—High Tension Transmission Line in Humber Bay, Toronto Entrance.

Table IV.—Cable Diminsions and Characteristics.

	No. 0000.	No. 000.
Over-all diameter	.530 in.	.470 in.
Number of strands	7	7
Diameter of strands, average	.1756 in.	.1559 in.
Elastic limit, lbs. per sq. in.	14,000-15,000	14,000-15,000
Ultimate strength, lbs. per sq. in.	24,000-27,000	24,000-27,000
Conductivity	61	61
Weight per mile	1050 lb.	816 lb.
Total miles single aluminum cable erected	312.2	673.8
Total weight of aluminum cable erected	164 tons	275 tons

HOW CITY PLANNING BILLS ARE TO BE PAID.*

By Nelson P. Lewis.†

In discussing city planning there is frequently a disposition to ignore such practical questions as that which is the subject of this paper. The writer recalls one occasion at a public dinner when a gentleman of distinguished reputation in the world of art expressed his sense of humiliation that one of the speakers, who was the chief financial officer of the city, should have introduced such sordid considerations as those of cost when the discussion up to that time had been confined to things of beauty. He assured his hearers that when, a few centuries ago, the men of Sienna or Florence wanted to do something to adorn their cities, they did not stop to consider the cost but went ahead and did it and thought about the expense afterward.

In contrast with this a prominent officer of a real estate holding company recently expressed his strong disapproval of any widening of streets or readjustment of street lines which was calculated to facilitate traffic, whether vehicular or pedestrian. He admitted that such changes might be advantageous to the city at large and would stimulate the development of outlying sections, but as his company owned a large amount of business property in the older part of the city, he believed that the rental value of that particular property for retail shops would be greater if the movement of the people were so obstructed that they would be compelled to loiter, to look into the shop windows and go in and buy.

We may have less patience with the latter than with the former point of view, yet both are inimical to real progress in city planning. He who scorns any consideration of cost may by his enthusiasm succeed in committing the city to projects which will seriously cripple its finances for years to come and render the public suspicious of any improvement, while he who openly avows his supreme selfishness may possibly arouse a feeling of indignation which will result in bringing about the very things he would like to prevent.

The question of how the bills are to be paid is not only a pertinent but a necessary one and cannot be avoided. To provide for a city of 100,000, with no apparent reason for exceptional growth, an ambitious scheme suited to a metropolis of several millions is to invite disaster; while to limit the plan of a large and rapidly growing city occupying a strategic position to one suited to its present size will seriously retard its future orderly development and may prevent it from realizing the growth and importance of which its natural advantages appear to give promise.

The feeling is common and not unnatural that if we are planning more for the future than the present, future generations which will reap the benefit should bear the greater part of the burden. It seems easy to pay with borrowed money, particularly when the money can be borrowed for fifty years or the span of two generations. The habit of paying in this way is easily acquired and is broken with difficulty. When anything is paid for with money borrowed for a period longer than the possible or even probable life of the article purchased, the city's credit is improperly used. A corporation which pays for its betterments from earnings is on a sound basis. When large earnings are used to pay excessive dividends and betterments and renewals are paid from borrowed money representing additional obligations, there is danger. When interest on existing debt is paid

*Paper presented at the Fourth National Conference on City Planning, Boston, Mass., May 27-29, 1912.

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from funds raised by incurring more debt, disaster is imminent.

The only source of revenue of the American city is its power to tax. Its credit is due to this same power plus the value of its own property. The larger the city's debt which has been incurred for projects which are not self-sustaining, the greater will be the demands upon its taxing power to meet interest and sinking fund charges due to such debt, and the less will be its ability to undertake new improvements and at the same time meet the enormous running expenses of the modern city. It might not be a forced comparison to say that the ordinary service which the city renders to the public through its administrative departments, the expenses of which are met by the regular tax levy, are the dividends which it pays to its stockholders, while for its betterments it must issue bonds or levy special assessments. Every bond issue requires an increase in the tax levy for a term of years in order to meet interest and amortization charges, curtailing by just so much the amount which can be expended upon municipal housekeeping expenses. In order to keep the tax rate within reasonable limits, expenses which should properly be met from the tax levy are often paid with borrowed money. Is not the city which adopts this policy actually doing the same thing as the business corporation which incurs additional debt in order to pay dividends?

The class of improvements which are commonly considered city planning projects are not self-sustaining. They consist for the most part in the correction of defects due to lack of proper planning. The property affected by them has presumably been already assessed for the acquisition and improvements of streets which were at the time considered adequate for its local needs. The widening and rearrangement of streets in built-up sections will, however, improve conditions and increase values, and a part of the expense should, therefore, be placed upon the property benefited.

In the more fundamental work of city planning, where unoccupied territory is being developed, the property will not have been assessed for improvements, and consequently the cost of the acquisition and construction of new streets can properly be assessed upon the adjoining property according to benefit, such benefit representing the entire cost in the case of local streets and a portion of the cost in the case of thoroughfares of metropolitan importance.

One principle should be invariably recognized, namely, where there is local benefit there should be local assessment. There can be no improvement which has been intelligently planned and executed without some local benefit, and it follows that there should always be some local assessment. No improvement, however small or however large, will be of equal benefit to the entire city and to distribute the burden of paying for it over the whole city according to taxable values is unfair in that it is not placed according to the benefit. The owners of property in the immediate vicinity are frequently enriched at the expense of those whose holdings are entirely outside the district directly affected.

Perhaps this statement should be so qualified as to exclude certain great improvements, such as public buildings, bridges, docks and rapid transit lines, and yet there is doubtless a local benefit resulting from these. It may be urged that such things are not included in what is commonly called city planning. If so, the definition of city planning needs revision, for they are certainly most essential parts of any city plan.

The City Club of New York several years ago showed that as a result of the building of the first rapid transit subway in New York the actual land values in those portions of upper Manhattan and the Bronx which were most directly affected were within seven years increased $80,500,000 above the normal increase for that period. The cost of that part of the subway passing through the districts where this rise in values took place was about $13,000,000, while the cost of the entire subway from the Battery north was $43,000,000. It is quite evident that if the $13,000,000 which was spent upon that part of the subway traversing the district so notably benefited had been assessed directly upon property, its owners would still have netted a neat profit of some $67,000,000, while had the cost of the entire subway been assessed upon the same limited district, the net profit to the land owners would have been $37,500,000. Was it quite fair that property in distant parts of the city, entirely unaffected by this great project, should bear the same proportion of the burden as that which was so conspicuously advantaged?

It is true that this improvement is entirely self-supporting, interest and amortization charges being provided from the rental paid by the operating company, but the local benefit was so clearly established that the rapid transit law was so amended as to permit the assessment of any part of the cost of future subways. Many new subways are now being planned, and some are being built, but it is doubtful if any of them will be self-supporting for years, the route furnishing the most intensive traffic having been followed by the line first built. The property owners along the present operating line having secured their benefit without direct tax, those along the proposed lines are not enthusiastic about being assessed for theirs, and there seems little prospect that the right to assess will be availed of.

To take another illustration from New York: Two new court houses are about to be built, one in New York County, the other in Kings County. In the former case a site has been selected to include a large area which will provide sites for still other public buildings and result in the creation of a real civic centre. What will be the effect upon the neighboring property of the expenditure of the millions required for this site and buildings? There is abundant evidence to justify the prediction that its value will be doubled, if not trebled, by the time the first building has been completed. Is is fair or just that the owners of this contiguous property should be enriched through no action of their own and that they should bear the same proportion of the expense, according to their taxable values, as will those owning property ten miles distant?

It needs no extended argument to prove the equity and wisdom of local assessment wherever there is local benefit. That it has been done to such a limited extent in the past is no reason why it should not be more generally done in the future. That certain property owners have heretofore been treated with such prodigal liberality is no good reason why others should fatten through a continuation of an irrational and essentially unfair policy. To the degree that the assessment plan is adopted, to that same degree will the city place itself upon a cash rather than upon a credit basis.

It may be urged that the adoption of such a policy would discourage the agitation for and execution of many desirable city planning projects, that American cities have been slow to appreciate the advantages of intelligent city planning, and now that there has been a marked awakening it would be unwise to suggest the adoption of a policy which might dampen this new born enthusiasm. A desire for something which involves no direct cost is not a sign of intelligent interest. We are learning that the improvement of our cities pays. That is a hopeful sign. If we have simply reached the stage where we want better conditions only if someone else is to pay the bills, the hope has not a very substantial basis. If we want them badly enough to pay for them ourselves in proportion to the benefit we feel sure will follow, we are making real progress.

Assuming that a case has been made in favor of assessing the cost of all improvements in accordance with prospective benefit, we are still confronted with a very difficult problem. The direct and indirect benefit must be estimated in advance. We cannot first carry out our city planning schemes and afterwards determine how the cost is to be met. Furthermore, we must determine to what extent the benefit will be strictly local, in what degree it will extend to a larger tributary area, and, again, how much it will mean to the entire city or metropolitan district.

In the case of residential streets, the purpose of which is to give light, air and access to the dwellings located upon them, the benefit will be entirely local, and the entire cost can properly be imposed upon the abutting property. When a highway is given a more generous width in the expectation that it will be called upon to accommodate a certain amount of through traffic, the benefit is more extended, and the assessment in such a case may be prolonged to a line midway between it and the next street of more than residential width. The major part of the cost should, however, be confined to the abutting property, so that the cost to it shall be somewhat more than that of the narrower street. In the case of arterial thoroughfares, or in that of the first street to be opened through an undeveloped territory the effect of which will be to give access to and stimulate the development of a large area, the district of benefit will be correspondingly enlarged. Again, in the case of thoroughfare of exceptional width, which it is proposed to treat as boulevards, the entire city or metropolitan district will be substantially benefited and should bear a portion of the expense. In fact, the state itself may derive an advantage which would justify its assumption of a portion of the cost, but the disposition to recognize such an obligation on the part of the commonwealth is exceedingly rare, even though a great city within its limits may, through its large taxable values, contribute the larger part of the state's revenues by which its rural highways are maintained.

In the case of parks this same principle might be applied. Some small parks are of strictly local benefit, and their cost could properly be placed upon the district in which they are located. Every park, whether small or large, is of some local benefit, even if such benefit were deemed to consist solely in unobstructed light and air to the property on the surrounding streets.

In the case of street widenings or the cutting through of new streets, the local advantage is less marked, though it will always follow. The mere fact that a widening or extension is required to accommodate traffic is conclusive evidence that the street has assumed more than local importance. The width of the roadway as widened is not an index of its local or general importance. There may be cases where the opening up of a new street of a width commonly given to local streets and extending for a very short distance would, on account of its strategic position, be of very great general and of little local benefit.

It is quite apparent that the relative local, district or general benefit of any street or other improvement can be determined neither by its dimensions nor its cost. An improvement involving an expenditure of $1,000,000 in one part of the city may be more distinctly local in its beneficial effect than one costing $5,000 in another section. No fixed rule can be established to govern the distribution of the expense. It must be determined in each case after a painstaking investigation. Such investigation should not be entrusted to a different individual, board or commission in each case. There should be a permanent body which should act in all cases. This body should not be large, and it should be so constituted that its entire personnel could not be changed at once, thus insuring continuity and consistency of policy. They should be broad men whose training should have fitted them for their difficult and delicate duties. The misleading evidence commonly called expert testimony as to existing and prospective values will be of little value to them. They should be capable by experience and intelligence of forming their own conclusions.

While no definite rule can be adopted to govern the distribution of assessments representing the district and general benefit, it should be possible to prescribe a method of determining the amount and extent of local benefit, particularly in the case of new streets, boulevards and parks. Let us assume that 60 ft. is the normal width required for a local street; then the entire cost of acquiring and improving all streets 60 ft. or less in width may properly be placed upon the property within half a block on either side of the street. In the case of wider streets that proportion of the cost represented by the ratio which 60 ft. plus 25 per cent. of the excess over 60 ft. bears to the width of the street would probably be an equitable proportion to assess upon the local district.

Inasmuch as property fronting a wide street is more valuable, it would be manifestly unfair to adopt a rule which would result in making the cost of a 70 or 80-ft. street less to the abutting owner than would have been the cost of a street 60 ft. wide. On the other hand, after a street reaches certain proportions, additional width will not involve additional benefit. It may be assumed that a share of the expense which would be equivalent to paving for a street 80 ft. wide should represent the limit of local assessment. This limit would be reached under the rule proposed when the street becomes 140 ft. wide. The percentage of cost which would be locally assessed would, therefore, be as follows for various street widths: 60 ft., 100 per cent.; 70 ft., 89.3 per cent.; 80 ft., 81.25 per cent., 90 ft., 75 per cent.; 100 ft., 70 per cent.; 120 ft., 62.5 per cent.; 140 ft., 57.1 per cent.; 150 ft., 53.3 per cent.; 200 ft., 40 per cent.

In the case of parks the problem is more difficult, the amount of local assessment and the extent of the area of local benefit being determined by the size and shape of the park and facility of access to it from other parts of the city. In any case, no rule should be adopted until it has been carefully tested and it has been demonstrated that the assessments levied in accordance with it will constantly decrease with the distance from the improvement. This decrease should not be directly in proportion to the distance, but in geometrical ratio.

A curve to determine the distribution of the assessments after the limits of the district have been decided has been proposed by Mr. Arthur S. Tuttle, Assistant Chief Engineer of the Board of Estimate and Apportionment of New York City, in accordance with which about 32.5 per cent. of the assessment would be placed upon the first 10 per cent. of the distance to the outer limit of the area of benefit, 55 per cent. upon the first 25 per cent. and 80 per cent. upon the district extending half way to the boundary of the assessment area.

In the case of street widening involving the destruction of buildings, it is suggested that the same general principles be adopted as in the case of new streets, but that they be applied to the land values only. If the street were less than 60 ft. wide, the proportion of the expense for additional land in order to make it 60 ft. would be assessed upon the half block on each side, while for all excess over 60 ft. the same rule already proposed could be adopted.

For instance, if a street 50 ft. wide were to be widened to 80 ft., involving the acquisition of 30 ft. of additional property, the first 10 ft. required to make it 60 ft. and 25 per cent. of the 20 ft. over 60 ft., a total of 15 ft. or one-half of the cost of the additional land to be taken, might be assessed locally, the expense involved in damage to buildings included in the district assessment, or in the general assessment if the improvement were of sufficient importance to involve general benefit. If the same street were to be widened to 100 ft., the local assessment under the same rule would be for 20 of the 50 ft. to be acquired, or 40 per cent. of the total land damage, the damage to buildings, as before, being included in the district or general assessment.

Special cases would undoubtedly arise which would require special treatment, but it is probable that in the great majority of improvements the method proposed would result in an equitable distribution of the burden. Those who are to pay the bills have a right to know in advance how the costs are to be apportioned, and the formulation of a policy which can be consistently followed is not only desirable but necessary.

The problem of determining whether or not there is general benefit and the proportion of the cost representing such benefit will be difficult. A typical case is that of a new boulevard recently laid out in the city of New York and now being acquired. It has been given a width of 200 ft. and extends from one of the great bridges over the East River directly across the Borough of Queens to Jamaica, and it is expected that it will ultimately be carried to the ocean front. It will afford ready access not only to the highway system of the Borough of Queens, but to all of Long Island. It includes within its lines an existing highway about 80 ft. in width.

Owing to its strategic position, this boulevard will be of more than local benefit. It was thought proper in this case to assess upon an area extending 800 ft. on each side that proportion of the cost of acquiring title represented by increasing the existing highway from 80 to 100 ft. Of the remaining 100 ft. it was decided to impose three-eighths upon the Borough of Queens and five-eighths upon the city at large. This division would have placed upon the local area, the borough and the city 16.7 per cent., 31.2 per cent. and 52.1 per cent., respectively, but these were rounded off to 20 per cent., 30 per cent. and 50 per cent.

In the improvement of this highway it is proposed to construct one central driveway 44 ft. wide, with parking spaces 30 ft. wide on each side, and outside of these side roadways 28 ft. and sidewalks 20 ft. in width, the side roadways and walks to be treated strictly as local improvements and assessed directly upon the abutting property, and the central driveway and parking spaces to be treated as a part of the park system and to be built at the expense of the entire city. It is believed that such a distribution of the expense is just, but there has been a disposition to consider it a precedent for similar treatment in the case of other streets where the general public benefit would be far less, while in some places there would be none.

Demands for the apportionment of the expense of local streets as though they were thoroughfares of metropolitan importance must be consistently denied, however powerful may be the influences exerted to induce special treatment in certain cases. A policy which is manifestly just will ultimately win popular favor. To hastily adopt a plan for the distribution of costs which afterwards proves unworkable, and which must, therefore, be modified, will involve some injustice as between those who may have been assessed by one plan and those whose burdens may be determind by a revised plan. The policy should, therefore, be carefully studied and thoroughly tested before its adoption, after which it should be consistently adhered to. It follows that such a policy should be confined to principles rather than be expressed in percentages, for special cases will inevitably occur where a principle can be applied, while a rigid rule involving fixed percentages would entail serious hardship.

There is one other method by which the expense of city planning projects could be met, at least in part, namely, through recoupment by the exercise of the right of excess condemnation where this right exists, but this subject is to be treated in another paper, and is simply referred to in this connection.

Where the financial condition of the city will permit, the burdens of the property owner can be considerably lightened by the recognition of deferred benefit and a correspondingly deferred assessment. In this case the city would carry the amount until the benefit resulting from the improvement should have been fully realized, or, in other words, should have been reflected in actual increase in values. Similar relief could be given by permitting the payment of assessments in installments carrying a moderate rate of interest. Either plan would require larger capital to finance such improvements, and would to that extent impair the city's borrowing capacity for other purposes. These however, are matters of detail and have to do with the matter of collection of the assessments, rather than the distribution of the expense.

The general principles which should, in the writer's opinion, govern the distribution of the cost of city improvements, may be briefly summarized as follows:—

1. Where there is local benefit, there should always be local assessment.

2. The entire city or the metropolitan district should bear no part of the expense unless the improvement is in some degree of metropolitan importance and benefit.

3. Assessments should not be confined to the cost of acquiring and improving streets, but should extend to any improvement which will increase the value of the neighboring property, and should be apportioned as nearly as possible according to the probable benefit.

4. A workable policy once adopted should be consistently adhered to.

5. The determination of a policy and its application to each case should be entrusted to a board composed of men especially qualified, whose terms of office should so overlap as to insure continuity of policy and purpose.

A LARGE REINFORCED CONCRETE BOAT.

A very large reinforced-concrete boat has recently been built for the use of the Manchester Ship Canal Company in England. This boat is described in the June 14, 1912, issue of London "Engineering." From that account we have made the following abstract:—

The boat in question is known as a sludge pumping pontoon. It has been built for the purpose of enabling dredged material to be deposited on low-lying land anywhere along either bank of the ship canal. The pontoon will be towed by steam tugs to selected points and there moored. The hopper barges will then be towed from the dredges as they are filled and moored alongside the pontoon. The suction pipe of the pontoon will be lowered into the barge to be discharged and the delivery pipe will deliver material upon the area selected for its reception. The pontoon is equipped with its own boilers and engine for the pumping operation described. It is 100 ft. long by 28 ft. wide, and 8 ft. 6 in. deep from the keels to the main deck, drawing about 6 ft. 6 in. of water when fully loaded. Its entire construction, including four water-tight bulk-heads and settings for the boilers and engine, is of reinforced concrete. The pontoon was built according to the Hennibique system by the English agents of that system, Messrs. L. G. Mouchel & Partners.

A LARGE RETAINING WALL FOR THE CANADIAN PACIFIC RAILWAY IN TORONTO.

The Canadian Pacific Railway some time ago purchased from the Ontario Provincial Government the Government House property, located at the corner of King and Simcoe

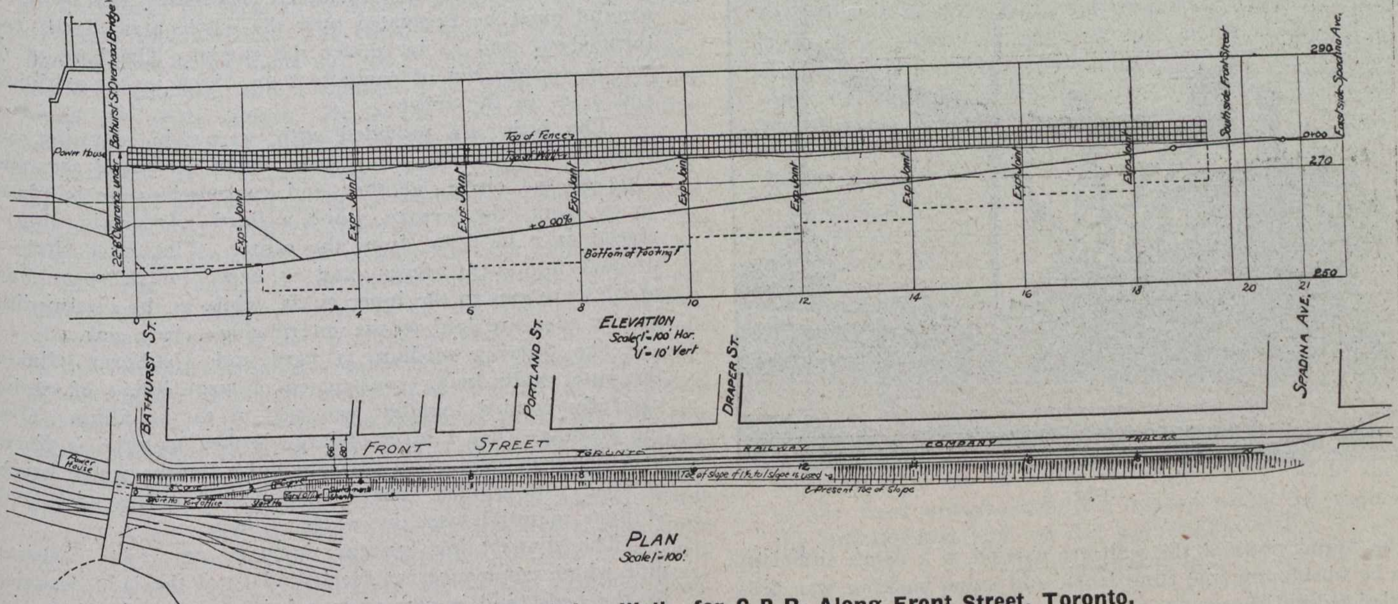

Fig. 1.—Location of New Retaining Wall for C.P.R. Along Front Street, Toronto.

Streets, Toronto. This land is to be used for freight terminals and, therefore, had to be connected by track with the rest of the system lying south of Front Street. Two tracks of the Toronto Street Railway Company run along Front Street at an elevation of about twenty

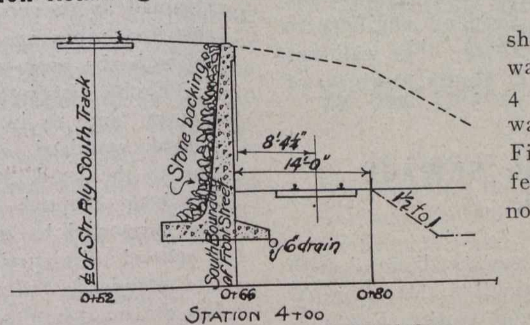

Fig. 3.—Typical Section of Retaining Wall at Station, 4 + 00.

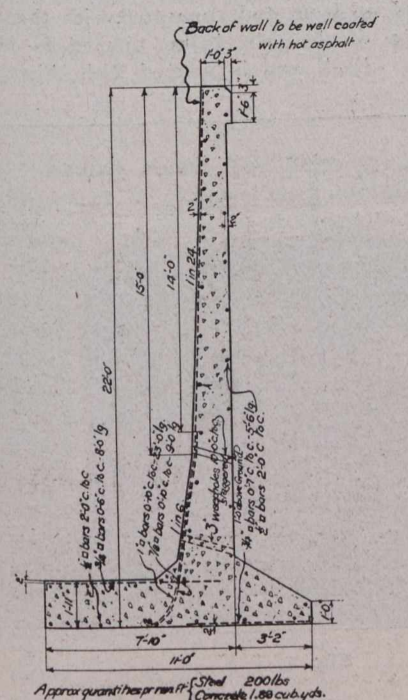

Fig. 2—Typical Section of Retaining Wall at Deepest Point.

feet above the level of the tracks of the Grand Trunk Railway. It was, therefore, necessary, in order to connect the tracks at the lower level with the Government House property, to run along the south side of the street railway tracks on Front Street, and to protect these tracks by means of a retaining wall. Fig. 1 shows the location of the retaining wall along Front Street and an elevation of the wall itself. The wall at Bathurst Street is the highest section and at Spadina Avenue, about 2,100 feet east, the wall vanishes. Fig. 2 shows a typical section of the retaining wall at its greatest depth. Figs. 3 and 4 show the wall at different points. The wall is surmounted by an iron fence. Fig. 5 illustrates a typical detail of the fence posts used. The contractors were not allowed to interfere with the traffic

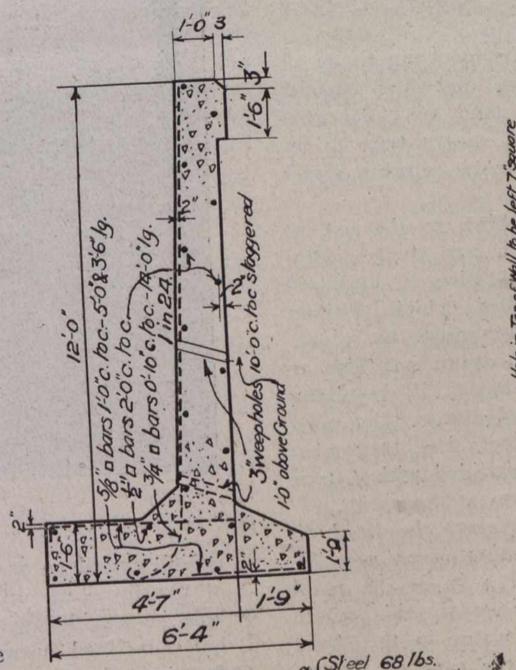

Fig. 4.—Typical Section of Retaining Wall at Intermediate Point.

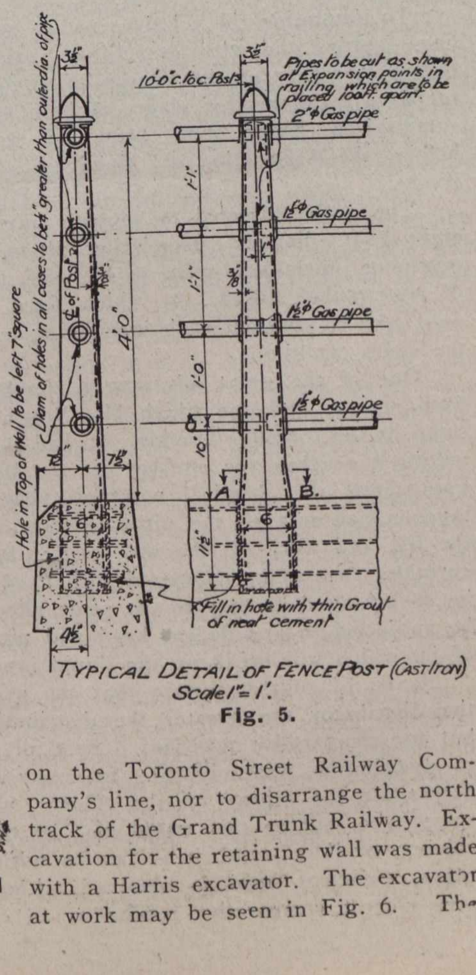

Fig. 5.

on the Toronto Street Railway Company's line, nor to disarrange the north track of the Grand Trunk Railway. Excavation for the retaining wall was made with a Harris excavator. The excavator at work may be seen in Fig. 6. The forms were located, steel and concrete put in, and the back-fill placed before the excavation was made on the south side, next the Grand Trunk track. Fig. 7 gives a general view of the location, showing the street railway tracks on the left.

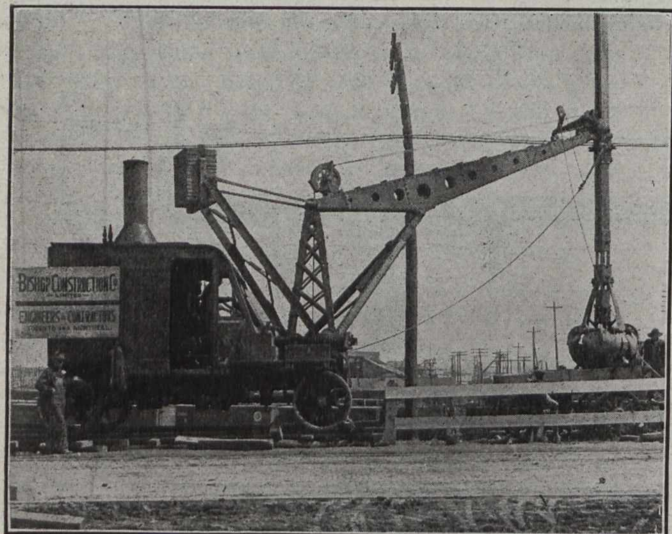

Fig. 6.

The foundations of the wall are carried to a depth sufficient to be absolutely free from frost, and stone backing was provided behind the wall. The contractors for the work are the Bishop Construction Company; the resident engineer in charge for the C.P.R. is Mr. C. S. Hertzberg. The wall was designed under the direction of Mr. P. B. Motler, engineer of bridges for the C.P.R.

FIXED AND TRAVELLING SEWAGE DISTRIBUTORS.

To determine the relative cost of sewage disposal with fixed sprays and with travelling sprinklers, Mr. Reginal Brown, engineer of the Southall-Norwood Works, England, prepared estimates for plants of both types. His findings, summarized below, were presented recently in a paper before the Association of Managers of Sewage Disposal Works.

The author decided to adopt a unit for comparison of eight 80-ft. diameter percolating filters, on which special revolving sprinklers were to be used, and an equal area of rectangular filters, on which fixed sprays were to be used, and to consider each installation to be working under the same conditions.

One of the great advantages attaching to the use of fixed sprays, and one which Mr. Brown has always advocated, is the complete breaking up and aëration of the liquid before it reaches the surface of the bed, which, without going into the chemical point of view, must be advantageous not only to the ultimate purification, but also to the life and work of the bed itself; hence, if revolving sprinklers are to be compared with fixed sprays they must be so arranged as to give the same effect; i.e., they must be subjected to a sufficient head and provided with a type of jet which will break up the liquid into a fine spray.

It is, of course, certain that the greater the head on the distributor the greater the distribution area per jet, but for comparative purposes a head of 4 ft. at the point of distribution was adopted. In many cases this would necessitate the lifting of the effluent water in the fixed spray type, but as this would also be the case in the revolving-sprinkler type, it is fair to assume that, in both cases, sufficient head is obtained without pumping. To give correct comparative results as to cost, each system of distribution should be provided with means of control into the same number of units; for the case under review this number would be eight.

Revolving Sprinklers.—The unit under discussion is eight 80-ft. circular beds. The ground is assumed to be level with the top of the carrier surrounding the beds. It has, therefore, been considered necessary that 6 in. of ground must be excavated over the whole area of the beds themselves, and 12 in. under the carrier. The base of the bed is constructed of concrete 6 in. thick at the periphery and 9 in. in the centre.

The beds are provided with 12 x 12-in. aërating and drainage tile. A ring of tiles is placed all round the outer edge of the circle, another and concentric ring is placed 20 ft. from the centre, while a third concentric ring is placed at 2 ft. 6 in. from the centre. The outer circle is divided into 3-ft. spaces, and at every fourth space lines of tiles are run to the inner circle, while at the intermediate spaces tiles are laid to the intermediate circle only.

The filtering medium is hard and well-burnt clinker, the outer walls being constructed of large lumps of clinker carefully bonded together and tied in to the filling. Over the drainage tiles a layer of large broken material is placed to a depth of 6 in., and the remainder for the whole height is filled with graded clinker and finished with a 3-in. layer of finer material over the whole surface.

The distributing system includes an 18-in. cast-iron pipe which commences at the boundary of the land occupied by the beds, and is carried to a brick control chamber constructed at the centre of the area. From this point 6-in. cast-iron pipes are carried under the beds and brought up through the concrete base by means of easy bends.

Each distributor is bolted to a concrete block 2 ft. square and 12 in. thick. The distributor consists of a central standard, a sealed top to utilize the full pressure due to the head, and to prevent overflow the mercury seal has been adopted. The distributing arms, four in number, are supported by means of strained guy ropes attached to a central tube carried up from and connected with the central standard, the top of the tube being pierced to allow for the escape of air. Each arm is pierced with thirty-five

Fig. 7.

holes, spaced so as to give equal distribution and to permit of the breaking up of the liquid into a fine spray. Each hole is provided with a screw plug, pierced with two small holes inclined outwardly toward each other, so that two fine jets of water are discharged from each hole, and which meet at a short distance, thus creating a fine spray.

The cost of the sprinkler beds was $20,500. The area of land required is 6,535 sq. yds., which at $605 per acre is $815. The actual area covered by the eight beds is 5,044 sq. yds. The total external area of walls exposed to the air is 1,118 sq. yds.

Fixed Sprays.—To give a fair comparison, the area of the rectangular bed should be exactly similar to that of the eight circular beds; and, further, the means of distribution should be such as to control one-eighth of the whole area as a separate unit. The clinker area of the eight 80-ft. circular beds being 4,464 sq. yds., a square of 200-ft. sides has been selected, and a channel 3 ft. wide is constructed round the whole square. As in the case of the circular beds, the ground is assumed to be level with the top of the carrier. It has, therefore, been considered necessary that 6 in. of ground must be excavated over the whole area of the bed, and, to give about the same cross-fall to the concrete, the thickness of concrete at the centre will be 12 in. The carrier is, as before mentioned, 3 ft. wide inside, and its highest point is on the side opposite the outlet; this length is 400 ft., and to give the same fall as in the circular channels, commencing at a depth of 3 in. at the highest point, the depth of the carrier at the outlet will be, say, 12 in. Thus the depth of excavation for the carrier will be 1 ft. 6 in. The carrier has walls and bottom of concrete. The bed is covered with drainage tiles, arranged with a complete course round the exterior edge of the square, and straight lines of tiles are taken from this outer course towards the diagonals, drawn from each corner of the bed. The filtering media and external walls are similar to those described.

The following is a description of the distributing system. An 18-in. cast-iron pipe commences at the boundary area, and at the centre of one of the sides of the square a brick control chamber is constructed, as for the circular beds; 6-in. cast-iron pipes are taken from this control chamber to a point opposite to the centre of each unit, into which the whole bed is divided, and are continued upwards and over the drainage carriage, on to the edge of the bed. The bed is divided into eight units—seven being 24 ft. wide and one being 32 ft. wide.

The cost of the fixed spray system was $20,300 The area of land required is 4,922 sq. yds., which, at $605 per acre is $615. The total external area of walls exposed to the air is 445 sq. yds.

Annual Cost.—The total annual cost is made up of repayment of principal and interest on land and constructional work, and cost of labor and maintenance. For the land, in both cases it may be assumed that a loan would be granted for sixty years, and for the constructional works thirty years, but for the revolving sprinklers—as machinery—the loan would be for fifteen years only. For calculation these periods are taken, and the interest to be paid is 3½ per cent.

For the revolving sprinklers the capital cost is $21,330 and the annual cost $1,560. For the fixed sprays the capital cost is $20,900 and the cost per annum $1,440.

Effect of Spray.—In an 80-ft. revolving sprinkler Mr. Brown has found that with a head of 4 ft. there is a travel —at the periphery of the circle—of 8.4 ft. per second; there is, therefore, an intervening period of 7½ sec. before any part of the circumference of the circle receives a second dose of liquid. With the fixed sprays, however, the whole area of the bed is not, theoretically, covered by the spray, which takes a circular form. The area covered, however, depends upon whether the jets are spaced 8 ft. apart, vertically and horizontally (on plan), or whether they are spaced with the centres in the form of an equilateral triangle, each side of the triangle being 8 ft. In both cases, with a head of 4 ft. at the nozzle, the maximum diameter of the circle covered by the spray may be taken to be 8 ft., and the area of such a circle would be 5.58 sq. yds. If the sprays were spaced 8-ft. centres horizontally and vertically on plan, the total area per nozzle would be 7.11 sq. yds.; hence, an area of 1.53 sq. yd. is not covered. If spaced in the form of a triangle, the total area per nozzle would be 6.15 sq. yds.; hence, an area of .57 yd. would not be covered. Assuming the number of nozzles to be 625—arranged on the latter principle—the actual area covered by the nozzle would be 3,487½ yds., and, as the area of the bed is 4,464 yds, the area not actually covered is 976½ yds. super., or about 22 per cent. If spaced in triangular form, the actual number of sprays which could be fixed on the bed is 726, and the area not covered by the spray would be reduced to 10 per cent. of the whole area, but the cost of construction would be increased by $60 for nozzles only.

From Mr. Brown's figures it will be seen that a difference only of $120 per annum is in favor of the fixed-spray principle, but it must be borne in mind that this is obtained by the sacrifice of 22 per cent. area of bed not covered by sprays, no rest being given to the actual space covered by jet, if continually at work, and a very large reduction in area exposed to the air.

The chief reason for the excess of cost, although slight, of the revolving sprinklers over the cost of fixed sprays is due to the loan for the former being granted for fifteen years only. If the loan was for thirty years—as in the case of the fixed sprays—then the excess would be reduced to the infinitesimal sum of $25 per annum.

THE USE OF COPPER-SULPHATE IN PURIFYING WATER SUPPLIES.*

By Geo. Embrey, F.I.C., County Analyst, Gloucestershire.

In the year 1870 the author had frequent opportunities for observing the evil effects of plant growth in the artificial lakes of Sutton-Coldfield, Warwickshire. These were used as fishponds and for pleasure boats, but the growth of weeds was so extensive as to render them almost useless. Attempts were made to destroy the weeds by fixing scythes to the bottom of a punt and dragging this through the water, afterwards removing the weeds by means of rakes. This method was very costly, and not very effective, but in 1872, in the construction of a railway between Sutton-Coldfield and Walsall, an embankment which passed over the end of one of the lakes was constructed with ferruginous sand, and this, washing into the lake, effected in one season what the cutting method had failed to accomplish in seven; the vegetation was entirely destroyed, and this particular pool (Blackroot Pool) was effectually cleared of weeds.

On coming to reside in Gloucester in 1873, the author observed the bad odour and color of the drinking water, and on enquiry was informed that this was due to plants growing in the reservoir. He at once suggested the use of ferrous-sulphate to the city surveyor, Mr. R. Read, and an experiment was made on one of the reservoirs. About this time some trouble arose at a tannery due to oxide of iron from rusty pipes staining the skins red; this being wrongly attributed to the iron used in the reservoir, the experiment was discontinued, and for many years the weeds were removed by rakes at considerable expense without any satisfactory result.

The establishment of Bell's filters in 1901 to a considerable extent overcame the difficulty, but the author's attention was at that time directed to the reports of experiments made by the United States Department of Agriculture with copper-sulphate, which seemed to be an effective remedy. In the course of that year some watercress beds

* Paper read before Institution of Water Engineers of Great Britain.

were treated with copper-sulphate, which was found to destroy the algæ, especially spirogyra, without injuring the watercress. In 1904 and 1905 numerous investigations were made to determine the amount which could be used for the destruction of the lower forms of plant life without destroying the fish or rendering the water toxic to human beings. It was found that quantities of 1 to 1,000,000 fulfilled these conditions, but quantities of 1 to 3,000,000 were sufficient to destroy the algæ, which were believed to cause the trouble.

In 1908 permission was given by the Sanitary Committee to carry out an experiment at Witcombe reservoirs, which were at the time choked with Chara Vulgaris. This plant is propagated by means of spores contained in an archegonium, and, fertilized by antheridia from an antheridium, the bursting of the archegonium sets free myriads of minute greenish cells, which, with the countless anthrozoids, give the water a distinct color and a fishy odour. In consequence of this odour it has been suggested that the particular chara was a new species named Chara Fœtida, but the author does not find that the plant differs in any material respect from the well-known Chara Vulgaris, except in regard to the odour. This, however, was removed by washing the plants, and an examination of the washing water revealed the presence of numerous Spongilla fluviatalis, which gave out a distinctly fishy odour. A portion of these was used to inoculate a nutrient agar medium, which, on incubation, yielded Proteus Vulgaris, a microbe well known to evolve a "fishy" odour, and the author, therefore, believes that this, and not the much-maligned chara, is the cause of the odour.

Method of Application.—The author's method of applying the copper-sulphate differs from that usually adopted, which is to place the crystals in a canvas bag and trail this at the stern of a moving boat. The defect of this method is that the copper-sulphate solution is very much diluted before reaching the bottom of the reservoir. This, however, is overcome by scattering the fine crystals over the surface of the water, as in sowing seed, the crystals falling rapidly to the bottom before dissolving. The sulphate is used in the form of a fine powder containing 98 per cent. of the salt, the present price of this being 28s. per cwt.

The three reservoirs have capacities, when filled, of 60,000,000 gallons (No. 1) and 30,000,000 gallons each (Nos. 2 and 3), and for these 4 cwt. of sulphate is used, giving approximately a proportion of 1 to 3,000,000. Each reservoir is allowed to stand at least three days, and, if convenient, a week, at the end of which period not a trace of sulphate of copper can be found in the water.

The water should be treated in the early spring (about February), when the bottom is usually covered with diatoms only; in March and April the confervæ make their appearance, and later the chara begins to grow. It has been found that if the treatment is applied in the early stages the diatoms are destroyed, and neither the confervæ nor the chara appear.

The Gloucester reservoirs are stocked with trout, and it has been important not to destroy these. In the author's opinion the roach disappeared, not by their having been poisoned, but owing to the removal of the vegetable food on which they live, and this view is supported by the result of an experiment made at the end of last summer, when, No. 3 Reservoir being nearly empty, the rest of the water was, with the sanction of the city surveyor, drawn off, and, the trout having been removed to No. 2 Reservoir, only a few starved roach were found remaining.

As regards the question, What becomes of the copper-sulphate? it has been suggested that it unites with CO_2, and becomes carbonate, but the author has been unable to find this salt. He has, however, noticed that the stones with which the reservoirs are partly lined become coated with the two oxides of copper, bands of red cuprous oxide being traced, which, after exposure, becomes black by oxidation to cupric oxide. After four years' experience the author can confidently say that the odour and color so frequently met with in reservoirs containing water collected from the upper lias and inferior oolite can be perfectly removed by the use of sulphate of copper, and that no danger need be feared if the operation be performed with care and under proper supervision.

SOME NOTES ON BAND CONVEYORS.

By F. Tissington.

(THIRD ARTICLE.)

Belt Conveyors Capacities.—It is hardly possible to give any definite information as to the relative capacities of conveyors, as the figures are liable to change, even when considering the same class of material. This variation is due to a large extent to the feed, and also somewhat to the size of the material and the speed at which it is carried. Something has been said about these points before, and if the general practice laid down in Table I. is adopted so far as the two latter conditions are concerned good results should be obtained. Table II. has been compiled to give a general idea of the capacities of these belts for various classes of material and in a general way these figures should be obtained if a continuous feed can be arranged, as the estimate is by no means excessive. If, however, the material is being dumped in parcels with intervals between, an allowance must be made for this and a corresponding percentage of the values in the table taken.

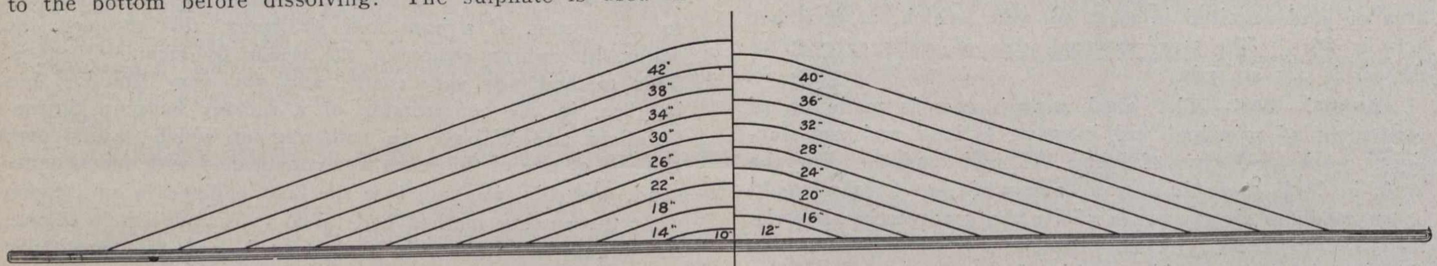

Fig. 16.—Cross Section of Belt Showing Approximate Carrying Capacities.

This table has been calculated on the assumption that the material loaded on the belt takes the form of a broad wedge in cross section with the two sloping sides at an angle of about twenty to twenty-five degrees with the horizontal. This will correspond roughly to the natural slope of the material, but naturally this varies with the different products carried. However, a clear edge distance of about three inches has been allowed for on each side of the belt which would prevent any spilling. The diagram given in Fig. 16 illustrates this, and in order to avoid confusion it has been laid out on a flat belt with a percentage added to allow for troughing.

Some further useful information is given in Table III., consisting of the weight in pounds per cubic foot and cubic inch, and also the amount of space occupied in cubic feet of one ton of material, and the number of cubic inches required to contain one pound weight of the same substance.

If any serious difficulty is experienced in obtaining the required capacity of a given belt it will be found that the addition of a special feeding apparatus suitable for the particular class will be necessary to increase same. In the case of large lumps, particularly if delivered onto a comparatively narrow band, some such arrangement will be necessary.

Horse-Power Required for Driving Band Conveyors.—It is a somewhat difficult matter to foretell exactly what will actually take place in any particular case, and why the only definite figures that can be obtained are those taken from an ammeter if the belt is driven by electric motor, and it therefore becomes a question for the designing engineer to estimate what power will be required from previous results.

A certain amount of power will be absorbed by the gearing and the belt itself when running light, and, as every engineer knows, the work on erection in setting all the parts up correctly and in alignment will have a great deal to do with the efficiency of the conveyor. In addition to this reverse bends in the band, such as are caused by the use of throw-off carriages, snub pulleys, etc., all require increased power over and above that necessary to drive a simple band of the same width and length, even if carrying the same material.

There are a number of different formulas, all claiming some particular advantage, some simple and some complex, and it appears to the writer that the only rational way of treating this problem is to select a set of rules that appear to be as near ordinary practice as possible and then make small allowances where necessary for special conditions.

The theoretical horse-power required to lift a given weight is H.P. $= \frac{WN}{33{,}000}$ where W = weight in pounds carried per minute and N = height in feet material is elevated.

Table IV. gives a series of values for this equation, the capacity ranging from 20 tons to 550 tons and the vertical life from 5 to 80 feet. These figures do not, of course, take into account any other factors, but simply represent the power necessary to elevate the load minus friction, efficiency of gearing, width of belt, etc.

For horizontal traction the force required must be some percentage of the figures given in Table IV. and the proportion will be regulated by the amount of friction to be overcome, both for the weight of the belt and for the full carrying capacity of same, the friction in the rollers and end gearing, etc.

Good average practice will be obtained if the percentage is taken at 20 per cent. on the maximum amount of the material which can be carried by the belt per minute. This allows for all losses for the moving parts of the conveyor itself except in the case of the smaller capacities, say from 150 tons per hour downwards, and for these an additional table giving values of the horse-power necessary for horizontal traction has been prepared. (See Table V.).

With the help of these two tables, it is now quite easy to estimate the power required to drive a belt conveyor of any ordinary type. If it is a horizontal one the figure can be taken at once from the table. Should there be any inclination in same all that is necessary is to add the figure for the latter to the former value and the sum is the total horse-power required. Note that the allowance for friction was made for horizontal traction and, therefore, in the case of an inclined conveyor no extra allowance for friction requires to be added to the figures in Table IV. for horse-power necessary to elevate the material.

TABLE II.—Table of Maximum Capacities for Troughed Band Conveyors.

Width of Band.	Cubic inches capacity per foot run.	Cubic feet capacity per foot run.	Number of Cubic Feet Capacity at a speed of				NUMBER OF TONS (2000 LBS.) PER HOUR FOR MATERIAL WEIGHING. 25 lbs. per cubic ft.				50 lbs. per cubic ft.				100 lbs. per cubic ft.				125 lbs. per cubic ft.	
			100	200	400	600	100	200	400	600	100	200	400	600	100	200	400	600	200	400
			feet per minute.				AT A SPEED IN FEET PER MINUTE OF													
10"	26	.015	1.5	3.0	6.1	9.2	1.1	2.2	4.4	6.6	2.3	4.6	9.2	13	4.6	9.2	18	27	11	22
12"	39	.023	2.3	4.6	9.2	13.8	1.7	3.4	6.8	10	3.4	6.8	13	20	6.8	13	27	40	16	33
14"	66	.038	3.8	7.7	15.4	23.1	2.8	5.6	11	16	5.7	11	22	34	11.4	22	45	68	27	56
16"	105	.060	6.0	12.1	24.2	36.3	4.5	9.0	18	27	9.0	18	36	54	18.0	36	72	108	45	90
18"	158	.091	9.1	18.2	36.5	54.7	6.8	13	27	40	13.6	27	54	81	27.2	54	108	163	67	135
20"	184	.110	11.0	22.0	44.0	66.0	8.3	16	33	49	16.5	33	66	99	33.0	66	132	198	82	165
22"	264	.154	15.4	30.8	61.6	92.4	11.5	23	46	69	23.0	46	92	138	46.0	92	184	276	115	230
24"	316	.182	18.2	36.5	73.0	109.5	13.8	27	55	82	27.5	55	110	165	55.0	110	220	330	137	275
26"	396	.222	22.2	44.4	88.8	133.2	16.5	33	66	99	33.0	66	132	198	66.0	132	264	396	165	330
28"	475	.27	27.5	55.0	110.0	165.0	20.5	41	82	123	41.0	82	164	246	82.0	164	328	492	205	410
30"	554	.33	33.0	66.0	132.0	198.0	24.5	49	98	147	49.0	98	196	294	98	196	392	588	245	490
32"	686	.39	39.6	79.2	158.0	237.0	29.5	59	118	177	59.0	118	236	354	118	236	472	708	295	590
34"	831	.47	47.3	94.6	189.0	283.0	35.0	70	140	210	70.0	140	280	420	140	280	560	840	350	700
36"	924	.10	55.0	110.0	220.0	330.0	41.0	82	164	246	82.0	164	328	492	164	328	656	984	410	820
38"	1056	.60	60.5	121.0	242.0	363.0	45.0	90	180	270	90	180	360	540	180	360	720	1080	450	900
40"	1120	.12	66.0	132.0	264.0	396.0	50	100	200	300	99	198	396	594	198	396	792	1188	496	992
42"	1416	.82	82.5	165.0	330.0	495.0	56	112	224	336	112	224	448	672	224	448	896	1344	560	1120

TABLE III.—Weight in pounds and measure in cubic feet, and inches for various materials.

MATERIAL	Weight in Lbs. per Cubic feet.	Weight in Lbs. per Cubic inches.	Cubic Measure. Feet per ton.	Cubic Measure. Inches per lbs.
Ashes (coal)	45	.026	43	39
Ashes, pot and pearl	55	.032	34	31
Asphalte	140	.08	14	12.5
Ballast	103	.06	19	17
Bones	50	.029	39	34.5
Bones (calcined)	22	.013	85	76.5
Cement clinker	102	.06	19	17
Cement, Portland	79	.046	23	21.5
Chalk (solid)	122	.071	16	14
Clay	122	.071	16	14
Coal (slack)	52	.03	36	33
Coal (nuts)	43	.025	44	40
Coke	31	.018	60	54
Copralites	103	.06	19	17
Concrete	122	.071	16	14
Cock dust	7	.004	254	230
Earth	79	.046	23	21.5
Earth (mould)	69	.04	28	25
Firewood	78	.004	247	221
Freestones	140	.08	14	125
Gravel (coarse)	97	.056	20	17.7
Gypsum	122	.071	16	14
Hay, compressed	21	.012	90	80.8
Hay, uncompressed	16	.009	120	10.78
Ice	58	.34	33	29.5
Limestone, broken	96	.053	21	19
Lime (quick)	53	.03	36	32.5
Logwood (dust)	17	.01	106	96
Marl	79	.046	24	21.5
Mortar	86	.05	22	20
Manure (artificial)	55	.032	34	30.5
Mud	104	.06	19	16.5
Ore (pulverized)	236	.133	8	7.5
Oxide of iron	58	.034	32	29
Phosphates	103	.06	19	17
Plaster of Paris	103	.06	18	16.5
Pitch	50	.029	38	34.5
Plumbago	143	.083	13	12
Sand	124	.072	15	13.8
Sand (river)	112	.066	16	15
Sand (moulding)	77	.045	24	22.5
Sand (pit)	103	.06	19	17
Sawdust	7	.004	254	216
Shale	165	.096	12	10.47
Shuigle	88	.051	21	19.5
Slag	86	.05	22	20.5
Slate	176	.102	11	9.75
Salt cake	69	.04	27	24.5
Salt	55	.032	34	30.5
Sugar (brown)	55	.032	34	30.5
Sugar (in bags)	57	.033	34	30
Sulphate of ammonia	55	.032	34	31
Trap	175	.101	11	9.85
Quartz	173	.1	11	10
Wood pulp (damp)	29.4	.017	64	57.5
Grain Seeds, Etc.				
Barley	38	.022	50	44
Barley (dried)	28	.016	69	61.5
Beans	50	.029	38	34.5
Bread (in bulk)	18	.01	106	95.5
Buckwheat	37	.021	52	47
Clover	47	.027	41	37
Coffee (in bag)	37	.021	52	47
Cotton (compressed)	45	.026	43	38.5
Cotton (seed)	23	.013	86	77
Flax	26	.014	75	67.7
Flour	43	.025	44	40
Flour (in barrels)	45	.026	43	38.5
Ginger	28	.016	70	61.6
Hemp	35	.02	55	49.3
Hemp (seed)	29.4	.017	63	57.5
Hides (well packed)	35	.02	55	49.3
Hides (loosely)	26	.015	72	64.7
Indian corn	45	.026	42	38*
Indian meal	42	.024	47	42
Indigo (in cases)	34	.02	57	50.8
Linseed	42	.024	47	42
Locust	22	.013	85	76.5
Malt	29.4	.017	64	58
Malt (green)	17	.009	112	101
Massecuite	93	.055	21	18.0
Molasses	37.5	.022	31	46.2
Oats	31	.018	61	55
Oats (in bulk)	37	.021	52	47
Oatmeal	38	.022	50	44
Peas	50	.029	38	34.5
Rape (seed)	37.5	.022	51	46
Rice (in bags)	50	.029	38	34.6
Rum (in casks)	37.5	.022	51	46.2
Rye	42	.024	46	42
Saltpetre	62.4	.036	31	27.7
Tea (in boxes)	16	.009	123	111
Wheat	47	.027	41	37

TABLE IV.—Table of Horse Powers for Inclined and Horizontal Conveyors.

Capacity Tons per Hour.	Capacity Pounds per Minute.	Horse Power Required to Lift to a Height of 5 ft.	10 ft.	15 ft.	20 ft.	30 ft.	40 ft.	50 ft.	60 ft.	70 ft.	80 ft.
20	660	.10	.20	.30	.40	.6	.8	1.0	1.2	1.4	1.6
30	1000	.15	.30	.45	.60	.9	1.2	1.5	1.8	2.1	2.4
40	1320	.20	.40	.60	.80	1.2	1.6	2.0	2.4	2.8	3.2
50	1660	.25	.50	.75	1.00	1.5	2.0	2.5	3.0	3.5	4.0
60	2000	.30	.60	.90	1.20	1.8	2.4	3.0	3.6	4.2	4.8
70	2320	.35	.70	1.05	1.40	2.1	2.8	3.5	4.2	4.9	5.6
80	2660	.40	.80	1.20	1.60	2.4	3.2	4.0	4.8	5.6	6.4
90	3000	.45	.90	1.35	1.80	2.7	3.6	4.5	5.4	6.3	7.2
100	3320	.50	1.00	1.50	2.00	3.0	4.0	5.0	6.0	7.0	8.0
110	3660	.55	1.10	1.65	2.20	3.3	4.4	5.5	6.6	7.7	8.8
120	4000	.60	1.20	1.8	2.40	3.6	4.8	6.0	7.2	8.4	9.6
130	4320	.65	1.30	1.95	2.60	3.9	5.2	6.5	7.8	9.1	10.4
140	4660	.70	1.40	2.10	2.80	4.2	5.6	7.0	8.4	9.8	11.2

Horse-Power Required for Horizontal Belts.

Length or height		25 ft. 5 ft.	50 ft. 10 ft.	75 ft. 15 ft.	100 ft. 20 ft.	150 ft. 30 ft.	200 ft. 40 ft.	250 ft. 50 ft.	300 ft 60 ft.	350 ft. 70 ft.	400 ft. 80 ft.
150	5000	.77	1.54	2.31	3.10	4.62	6.25	7.70	9.24	10.78	12.50
160	5320	.80	1.60	2.40	3.20	4.80	6.4	8.0	9.6	11.2	12.8
170	5660	.86	1.72	2.58	3.44	5.16	6.88	8.5	10.3	12.0	13.7
180	6000	.91	1.82	2.73	3.64	5.46	7.28	9.1	10.9	12.7	14.6
190	6320	.96	1.92	2.88	3.84	5.76	7.68	9.6	11.5	13.4	15.3
200	6660	1.01	2.02	3.03	4.04	6.06	8.08	10.1	12.1	14.1	16.1
220	7320	1.11	2.22	3.33	4.44	6.66	8.88	11.1	13.3	15.5	17.7
240	8000	1.21	2.42	3.63	4.84	7.26	9.68	12.1	14.5	16.9	19.4
260	8660	1.31	2.62	3.93	5.24	7.86	10.48	13.1	15.7	18.3	20.9
280	9320	1.41	2.82	4.23	5.64	8.46	11.28	14.1	16.9	19.7	22.5
300	10000	1.51	3.02	4.53	6.04	9.06	12.08	15.1	18.1	21.1	24.1
320	10660	1.61	3.22	4.83	6.44	9.66	12.88	16.1	19.3	22.5	25.7
340	11320	1.71	3.42	5.13	6.84	10.26	13.68	17.1	20.5	23.9	27.3
360	12000	1.81	3.62	5.43	7.24	10.86	14.48	18.1	21.7	25.3	28.9
380	12660	1.91	3.82	5.73	7.64	11.46	15.28	19.1	22.9	26.7	30.5
400	13320	2.01	4.02	6.03	8.04	12.06	16.08	20.1	24.1	28.1	32.1
420	14000	2.11	4.22	6.33	8.44	12.66	16.88	21.1	25.3	29.5	33.7
440	14660	2.21	4.42	6.63	8.84	13.26	17.68	22.1	26.5	30.9	35.3
460	15320	2.31	4.62	6.93	9.24	13.86	18.48	23.1	27.7	32.3	36.9
480	16000	2.41	4.82	7.23	9.64	14.46	19.28	24.1	28.9	33.7	38.5
500	16660	2.51	5.02	7.53	10.04	15.06	20.08	25.1	30.1	35.1	40.1
525	17500	2.65	5.30	7.95	10.60	15.90	21.20	26.5	31.8	37.1	42.4
550	18320	2.78	5.56	8.34	11.12	16.68	22.24	27.8	33.3	38.9	44.5

TABLE V.—Table of Horse Powers for Horizontal Conveyors.

Capacity Tons per Hour.	Capacity Pounds per Minute.	Horse-Power Required for Horizontal Conveyors of Various Lengths. 25 ft.	50 ft.	75 ft.	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.
20	660	.40	.80	1.20	1.60	2.40	3.2	4.0	4.8	5.6	6.4
30	1000	.43	.86	1.26	1.72	2.52	3.44	4.30	5.04	6.02	6.88
40	1320	.46	.92	1.38	1.84	2.76	3.68	4.60	5.52	6.44	7.36
50	1660	.49	.98	1.47	1.96	2.94	3.92	4.90	5.88	6.86	7.84
60	2000	.51	1.02	1.53	2.04	3.06	4.08	5.10	6.12	7.14	8.16
70	2320	.54	1.08	1.62	2.16	3.24	4.32	5.40	6.48	7.56	8.64
80	2660	.57	1.14	1.71	2.24	3.42	4.48	5.70	6.84	7.98	8.96
90	3000	.60	1.20	1.80	2.40	3.60	4.80	6.00	7.12	8.40	9.60
100	3320	.63	1.20	1.89	2.52	3.78	5.04	6.30	7.56	8.82	10.08
110	3660	.66	1.32	1.98	2.64	3.96	5.28	6.60	7.92	9.24	10.56
120	4000	.69	1.38	2.07	2.76	4.14	5.52	6.90	8.28	9.66	11.04
130	4320	.72	1.44	2.16	2.88	4.32	5.76	7.20	8.64	10.08	11.52
140	4660	.75	1.50	2.25	3.00	4.50	6.00	7.50	9.00	10.50	12.00

NEW SPECIFICATIONS FOR CREOSOTE WOOD BLOCK PAVEMENT.

The Board of Local Improvements of Chicago, Ill., has lately gotten out new specifications for the construction of creosoted wood block pavements in that city. The new specifications differ from the old ones in a number of the requirements. The method of treating the timber is specified more fully and provision is made for the use of oil which shall be a distillate obtained wholly from coal tar. In addition the new specifications provide that an asphaltic filler may be used. The following is an extract of the specifications as far as they relate to the creosoted wood block wearing surface:

Blocks.—The blocks shall be cut from southern............yellow pine, tamarack or southern black gum timber. Only one kind of wood, however, shall be used on the work. The blocks shall be not less than 5 ins. in length, nor more than 10 ins. in length, but shall average 6 ins. in length. The depth shall be............ins., and the width shall be 3¾ ins.

All blocks shall be made of sound timber and shall be free from any defects which will be detrimental to the life of the block or interfere with the proper laying of the same. Each block shall have at least 66 per cent. of heart wood.

The blocks shall be carefully protected from the effect of the sun and weather before and after treatment and until laid.

Timber.—The timber shall be that known to the trade as "prime" timber and of a texture permitting satisfactory treatment as hereinafter specified, and shall be subject to inspection at the works in the stick or at any time during the process of preparation or thereafter. The timber shall be sound, square-edged, free from bark, shakes, large or loose or rotten knots, red heart, worm or knot holes, or any other defects which will be detrimental to its strength or durability. No second growth timber or loblolly pine will be accepted.

With southern...........yellow pine timber, the annual rings in the 3 ins. measured radially from the centre of the heart shall average not less than 8 to the inch.

When the timber for the blocks is only partially seasoned, the Board of Local Improvements may require the same to be piled in such a manner and for such a length of time as will prepare it for the treatment herein specified.

The Board of Local Improvements may at any time reject in bulk all timber that does not fulfill the above requirements, and order same removed and properly culled before being returned to the mill.

Treatment.—The blocks shall be placed in an air-tight cylinder, where, by means of steam and the vacuum pump, the sap in the blocks will be vaporized and the moisture in them removed. During the process of steaming a vent shall be kept open in the cylinder to permit the escape of water, air and condensed steam in the cylinder. After the heating or steaming period, the drain or vent in the bottom of the cylinder shall be opened and all moisture removed from the cylinder. During the vacuum period the temperature in the cylinder must be above the boiling point of water under existing vacuum.

When the cylinder is thoroughly drained a vacuum of not less than 20 ins. (Hg.) shall be maintained.

When the blocks are thoroughly dry the cylinder shall be filled with oil, destroying a vacuum of not less than 20 ins. (Hg.), and pressure shall then be applied and increased gradually to not more than 200 lbs. per sq. in. and maintained until............pounds of oil have been forced into, and retained in each cubic foot of timber and until the oil has impregnated the blocks to the satisfaction of the Board of Local Improvements. The pressure period on the oil shall be continuous and of a duration of not less than three hours. After the surrounding oil has been removed, the blocks shall remain in the closed cylinder for a period of 30 minutes to allow the excess oil on the surface of the blocks to drain off. The oil thus drained off shall be forced back into the treating tank in order to determine the amount of impregnation. In the process of treating the blocks, a correction must be made for any water contained in the cylinder. Compensation shall also be made for leaks and other wastes of oil that may occur during treatment.

If, in the treatment of the blocks, more oil is injected per cubic foot of timber than is called for in the specifications, such excess oil must not be removed. The temperature of the oil after entering the cylinder shall not be lower than 165° F. The cylinder shall be provided with sufficient steam coils to fully maintain this temperature throughout injection.

The oil tanks and cylinder in which the blocks are treated shall be equipped with the necessary gauges, thermometers and draw-cocks in order to facilitate a thorough inspection of the materials and treatments. The cylinder shall be equipped with the proper connections and apparatus for artificially seasoning timber before the impregnation with the creosote oil.

The plant shall be provided with proper means for obtaining the absolute measurement and weight of all oils entering the cylinder and the amount of oil absorbed by the blocks.

Oil.—1 The oil shall be distillate obtained wholly from coal tar.

2. It is required by this specification that the oil used shall be wholly a distillate oil obtained only by distillation from coal tar. No other material, of any kind, shall be mixed with it.

3. The oil shall contain not more than 1 per cent. of matter insoluble in hot benzol and chloroform.

4. Its specific gravity at 25° C. shall be not less than 1.08 and not more than 1.12.

5. The oil shall be subject to a distilling test as follows:—

The apparatus for distilling the creosote must consist of a stoppered glass retort having a capacity, as nearly as can be obtained, of 8 ozs. up to the bend of the neck, when the bottom of the retort and the mouth of the off-take are in the same plane. The bulb of the thermometer shall be placed ½ in. above the liquid in the retort at the beginning of the distillation, and this position must be maintained throughout the operation. The condensing tube shall be attached to the retort by a tight cork joint. The distance between the thermometer and the end of the condensing tube shall be 22 ins., and during the process of the distillation the tube may be heated to prevent the congealing of the distillates. The bulb of the retort and at least 2 ins. of the neck must be covered with a shield of heavy asbestos paper during the entire process of distillation, so as to prevent heat radiation, and between the bottom of the retort and the flame of the lamp or burner two sheets of wire gauze, each 20 mesh fine and at least 6 ins. square must be placed. The flame must be protected against air currents.

The distillation shall be continuous and uniform, the heat being applied gradually. It shall be at a rate approximately one drop per second, and shall take from 30 to 40 minutes after the first drop of distillate passes into the receiving vessel. The distillates shall be collected in weighed bottles, and all percentages determined by weight in comparison with dry oil. When 100 grams of the oil are placed in the retort and subjected to the above test, the amount of distillate shall not exceed the following:—

Up to 150° S., 2 per cent.
Up to 210° C., 10 per cent.
Op to 235° C., 20 per cent.
Up to 315° C., 40 per cent.

The distillation of the oil shall be carried to 355° C. The residue thus obtained when cooled to 15° C. shall not be brittle but shall be of a soft, waxylike nature, so that it can be readily indented with the finger. When a small portion of this residue is placed on white filter paper and warmed, the oil spot produced, when viewed by transmitted light, shall appear of an amber color.

The contractor shall deliver to the Board of Local Improvements an affidavit from the individual manufacturing the blocks (if manufactured by an individual), from the managing officer of the corporation manufacturing the blocks (if manufactured by a corporation) and by an active member of the firm manufacturing the blocks (if manufactured by a firm), setting forth that all oil used for treating the blocks for this contract is a distillate oil obtained wholly and entirely by distillation from coal tar, and that it is free from any adulteration.

Oil.—The oil shall be a pure coal tar product, free from any adulteration. It must not contain any petroleum oil or any product obtained from petroleum, and shall contain not more than 5 per cent. of matter insoluble in hot benzol and chloroform. No oil obtained wholly or in part from water gas tar or oil tar will be accepted.

The specific gravity of the oil shall not be less than 1.10 nor more than 1.13 at 25° C.

[This oil is subjected to a distilling test similar to that for the first mentioned oil.—Editors.]

Laying.—The blocks shall be laid in parallel courses across the roadway at an angle of approximately.......... degrees from the centre line thereof, except at the intersections of all alleys, where they shall be laid at right angles with the centre lines thereof. On intersections and junctions of lateral streets, the blocks shall be laid at an angle of 45° with the line of the street, unless otherwise ordered by the engineer. The blocks shall be laid with the fibre of the wood running in the direction of the depth. Gutters shall be constructed as directed by the engineer. The courses shall break joints alternately by a lap of not less than 2 ins., and the blocks shall be driven together except where joints for expansion are constructed as follows: On each side of the roadway a longitudinal joint shall be formed by placing a 1½ in. board on edge against the curb. The blocks shall be firmly laid against said boards. The boards shall remain in place until the blocks are rolled, and immediately preceding the application of the filler as hereinafter specified, they shall be carefully removed without disturbing the adjacent blocks.

The blocks, when set, shall be rolled with a steam roller weighing not less than five tons, until firmly bedded and brought to a uniformly even surface. After rolling, all imperfect blocks shall be removed and replaced by perfect blocks. Broken blocks shall not be used except to break joints in starting courses and in making closures. If the blocks that have been laid should become wet before the filler is applied, they must be taken up and reset at the contractor's expense, if the engineer so directs. In no case will teams be allowed on the work before the wearing surface is completed.

Asphaltic Filler.—After rolling, the surface of the pavement shall be swept clean and the joints between the blocks and expansion joints shall be filled with an asphaltic filler which shall be free from water, coal tar pitch, or any product of coal or water gas tar. It shall adhere firmly to the blocks, be pliable at all climatic conditions to which it will be subjected, and conform to the following requirements:—

It shall have a specific gravity of not less than 0.965 at 77° F.

It shall have a melting point of not less than 110 and not more than 160° F.

It shall have a penetration of not less than 20 nor more than 50.

The bitumen of the asphaltic filler shall be soluble in carbon tetra chloride to the extent of at least 98½ per cent.

The asphaltic filler shall be heated to a temperature of not less than 280° nor more than 350° F., and shall be applied in such a manner that all spaces between the blocks will be completely filled, the temperature of heating to be varied within these limits according to the nature of the asphaltic filler used and at the discretion of the Board of Local Improvements. In applying the asphaltic filler care must be taken to use the least amount necessary to properly fill the joints and hold the top dressing. The blocks must be dry at the time of the application of the filler.

The contractor shall provide the Board of Local Improvements with a duplicate delivery ticket for each and every consignment of asphaltic filler delivered on the work. This ticket must be signed by the consignor, and be of a form approved by the Board of Local Improvements.

Pitch Filler.—After rolling, the surface of the pavement shall be cleaned and the joints between the blocks and expansion joints shall be filled with a "straight run" paving pitch obtained from gas house tar. No pitch from coke oven tar shall be used. It shall be of such quality and consistency as will be approved by the Board of Local Improvements. The pitch shall contain not less than 28 per cent. nor more than 35 per cent. of free carbon, and shall have a melting point at a temperature of not less than 145° and not more than 155° F. The pitch must be used at a temperature of not less than 300° and not more than 350° F. In applying the pitch, care must be taken to use the least amount necessary to properly fill the joints and hold the top dressing.

The contractor shall provide the Board of Local Improvements with a duplicate delivery ticket for each and every load or tank of paving pitch delivered on the work. This ticket must be signed by the consignor and be of a form approved by the Board of Local Improvements.

Cement Grout Filler.—After rolling, the surface of the pavement shall be swept clean, and the joints, except as hereinafter provided, between the blocks shall be filled with a cement grout filler composed of equal parts by volume of clean, sharp, dry sand and Portland cement, the same to be thoroughly mixed dry, after which water shall be added, forming a liquid of the consistency of thin cream. From the time the water is added until the grout is floated into the joints of the pavement, the mixture must be kept in constant motion, and immediately after applying to the pavement it shall be thoroughly swept into all the joints. The grout or filler shall be applied in two or more courses. The first course shall fill the interstices between the blocks to within 2½ ins. of the top, the same to be left undisturbed and sufficient time allowed to elapse for the first application to stiffen. The following courses or applications shall be mixed in like manner, except that the mixture shall be slightly thicker than that of the first course. To avoid a possibility of the grout thickening at any point, water shall be applied ahead of the sweeping by spraying.

The expansion joints and points between the blocks in a space of 2 ft in width adjacent to the gutters and around all covers to sub-surface improvements shall be filled with a "straight run" paving pitch obtained from gas house tar. No pitch from coke oven tar shall be used. It shall be of such quality and consistency as will be approved by the Board of Local Improvements. The pitch must be used at a temperature of not less than 300° and not more than 350° F. The pitch shall contain not less than 28 per cent.

nor more than 35 per cent. of free carbon, and shall have a melting point at a temperature of not less than 145° and not more than 155° F.

Sand Filler.—After rolling, the surface of the pavement shall be swept clean and the joints, except as hereinafter provided, between the blocks shall be filled with clean, warm fine sand, which shall be swept into the joints until the same are completely filled.

The expansion joints and the joints between the blocks in a space 4 ft. wide in the middle of the roadway shall be filled with a "straight run" paving pitch obtained from gas house tar. No pitch from coke oven tar shall be used. It shall be of such quality and consistency as will be approved by the Board of Local Improvements. The pitch must be used at a temperature of not less than 300° and not more than 350° F. The pitch shall contain not less than 28 per cent. nor more than 35 per cent. of free carbon, and shall have a melting point at a temperature of not less than 145° and not more than 155° F.

Top Dressing.—Immediately after the filling of the joints, the surface of the pavement shall be covered to a depth of ¼ in. with screened, hot, torpedo sand.

THE DESIGN OF REINFORCED CONCRETE GRAIN ELEVATORS.

Certain of the problems that enter into the design of reinforced concrete grain elevators were discussed by Mr. E. Lee Heidenreich, in a paper read before the eighth annual convention of the National Association of Cement Users, from which the following notes are taken:—

Mr. Heidenreich states that the design of such structures is dependent entirely upon the nature and value of the pressure exerted by grain while at rest and in motion. Experiments and calculations to determine these values have been made by a number of well-known engineers, among whom are Mr. Janssen, Mr. Wilford Airy, Mr. Tolz, Mr. Prante, Mr. Jameson, of Canada, and Professor Milo B. Ketchum.

The last named states that the flow of grain is more like that of a semi-liquid than a liquid, with the pressure line forming a curve. According to calculations of Mr. Janssen and Mr. Jameson the lateral pressure may be expressed as:—

$$L = \frac{w\,R}{u}\left(I - e^{-Cuh/R}\right)$$

and the vertical pressure by:—

$$V = \frac{w\,R}{C\,u}\left(I - e\frac{Cuh/R}{}\right)$$

where w is the weight per cubic foot of grain or 50 lbs. for wheat, R is the bin area divided by its perimeter (hydraulic radius), u is the coefficient of friction of grain against the bin surface, h is the height of the bin, and C is the ratio between the lateral and the vertical pressures, e being the base of the Naperian logarithm, or 2.71828. According to Mr. Jameson, for wheat $C = 0.6$ and for grain on concrete $u = 0.4$ to 0.425. For quick and easy calculation L may be taken as equal to $q\,w\,h$, where q is the ratio of grain pressure to liquid pressure, and $V = 1.667\,q\,w\,h$. Values of q for different ratios of height divided by the diameter or width $= h/b$ may be determined graphically. The maximum bottom pressure occurs when $h/b = 3.5$. The value for L in a circular bin of a series at a depth h is equal to $q\,w\,h$, and the tension in the reinforcing steel required for 1 ft. in height is $T = L\,D/2$.

If the circular bin is empty and the two opposite interstices A and B are filled, we have a condition which necessitates reinforcement both at the intrados and extrados of the ring.

Compression in the direction $A\,B$ causes tension at the extrados at C and D and at the intrados at A and B. From experiments in loading culvert pipe firmly supported at the two lower quarter points, corresponding to E and F, the maximum moment at the section may appropriately be written

$$M = (D / \sqrt{2} - 6)\; L'\,D'/64.$$

Computing the resisting moment in the customary fashion, the stress in the concrete and in the steel may be determined from the expressions:—

$$f_c = \frac{M}{K / 2\,(I - K/3)\,b\,d^2}$$

and

$$f_s = \frac{M}{p\,(I - K/3)\,b\,d^2}$$

By adding 1 in. to d_1 or d_2, the ring thickness is found.

A calculation of the external pressure shows that the stresses from the filled interstices are greater than those resulting from the filled circular bins. To provide for this some contractors using single reinforcement in the centre bins have rodded the interstices, while others increase the thickness of the bin walls and the connection between contiguous circular bins.

According to Mr. Heidenreich, the logical method seems to be to use double reinforcement.

The calculation of square bins, he states, is a simple matter, after the lateral pressure L has been found. The bending moment will be in inch pounds $M = 12\,L\,l^2/10$ where l = width of bin in feet.

Mr. Heidenreich states that interior bin walls having alternately pressure on either side should be reinforced on both sides. The connection of the reinforcements at the intersections and the corners of the bin walls in such cases becomes of the greatest importance. Where possible he recommends employing a strong wire fabric as a part of the reinforcement for the outer walls, running this reinforcement horizontally around the building.

SERIOUS OUTBREAK OF TYPHOID FEVER OCCURS AGAIN IN OTTAWA.

The alarming increase in the number of typhoid cases in the city of Ottawa has called for the immediate action of the authorities and other business has been temporarily thrust to one side in order to give all concentrated energy to this pressing matter.

Dr. J. W. MacCullough, chief health officer of the Province of Ontario, has made a personal investigation of the district including an inspection of conditions along the water front.

The cause of this contamination is due to a leak in a concrete well through which the polluted water entered.

The Provincial Medical Health Officer has ordered the City Council to have plans prepared for a new system of water supply, to consist of a mechanical sand filtration plant on Lemieux Island in the Ottawa River, to be connected with the pumping station in the city by a tunnel under the bed of the river to carry the intake pipe and keep it free from contamination. The estimated cost of the tunnel is $300,000, while the plant will cost about $750,000.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

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

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

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Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 23 TORONTO, CANADA, AUGUST 1, 1912. No. 5

CONTENTS OF THIS ISSUE.

RAILWAY BUSINESS FOR MAY.

For the month of May the net operating revenue of the railways of the United States declined five and five-tenths per cent. per mile of line as compared with May, 1911, and that for May, 1911, was four and eight-tenths per cent. less than for May, 1910. This is the salient fact of the monthly summary of the Bureau of Railway Economics, compiled from the reports of the railways to the Interstate Commerce Commission, and embracing ninety per cent. of the steam railway mileage of the country.

The total operating revenues were $226,109,262, an increase of $7 per mile of line over May, 1911. The operating expenses were $161,368,677, an increase of $24.29 per mile of line, while the net operating revenue was $64,740,585, a decrease of $17.23 per mile of line. Taxes amounted for the month to $9,897,301, or $45 per mile, an increase of nine and two-tenths per cent.

The decrease in net operating revenue was most severe for the Eastern group of railways, amounting to eleven and nine-tenths per cent. For the Southern group it increased four-tenths of one per cent., and for the Western group less than one-tenth of one per cent. The aggregate of the net operating revenue for the eleven months of the fiscal year, and also for the five months of the calendar year, when measured per mile of line, shows a decrease in comparison with the corresponding periods of the previous year.

OTTAWA WATER SUPPLY.

The water supply of the city of Ottawa has again been the subject of discussion, as a result of another outbreak of typhoid. The Provincial Medical Health Officer in no uncertain manner has impressed on the city council the necessity for immediate action with regard to improvements in the supply. For some time the city engineer has been preparing plans for a slow sand filtration plant. The council had decided on this method of purification, although the experts who were called to report on the method, and the source of supply, had decided against it. The city engineer himself had objected to slow sand filtration, but his objections were brushed aside by the council. The Provincial Health Officer, however, refused to sanction slow sand filtration, and demanded that immediate action be taken towards installing a mechanical filtration plant.

In the seventeenth annual report of the Board of Health of the Province of Quebec, Mr. James O. Meadows, the sanitary engineer for the board, gives a report on a sanitary survey of the Ottawa River. His report presents many matters of interest, and has been published in a pamphlet form recently by the Provincial Government for general distribution. This report of the sanitary condition of the Ottawa River was undertaken to study the river as a source of domestic water supply and its relations to public health, and the information contained is based upon results secured from analytical data recently completed and by analytical data which was available from previous local studies. These studies relate to the potability of the domestic water supplies in regard to their relation to sewage, refuse, and industrial wastes discharged into the river at points above those from which such water supplies are obtained. These questions have been further studied by the aid of vital statistics and typhoid fever data so as to obtain their relations to the public health. The work has been confined to a study of the main river from a point above Pembroke to Montreal, and the main object has been to determine to what extent the Ottawa River is used as a source of public water supply.

This study has shown that the Ottawa River above the city of Ottawa is in a very satisfactory condition as regards bacterial purity, except where polluted for a short distance by municipal sewers. It is not probable that the amount of pollution for this district will increase perceptibly for a considerable period of time. The report states that because of the high color content of the Ottawa River water, mechanical filtration will be found to be the most satisfactory method to be adopted to secure a purified water of satisfactory physical appearance and bacterial purity.

In the face of their experts' report and the above investigation, conducted by the Quebec Board of Health, the council showed poor taste, to put it mildly, to order plans prepared for slow sand filtration, and the rebuke administered by Dr. McCullough was well deserved. On last Friday night the Ottawa Council decided in favor of a mechanical filtration plant, to be established on Lemieux Island, in line with Dr. McCullough's recommendations. Ottawa's experience is one more instance of the result of interference on the part of the city council in matters of which they know nothing, and which should be decided by engineers.

CANADIAN PACIFIC STOCK.

Accumulating money at a rapid pace, making continued increases in earnings, always enlarging its programme of construction and improvement, the discussion of another issue of stock for the Canadian Pacific Railroad will not be silenced. A member of a New York banking house with London connections is the latest to re-echo the belief that when Parliament meets again at Ottawa, the railway will apply for authority to increase the amount of its authorized common stock capitalization.

The authorized common stock of the company is $200,000,000, it having been increased from $150,000,000 at the stockholders' meeting in October, 1908. Outstanding on June 30th, 1911, was $180,000,000. Shareholders of record of January 2nd, 1912, were privileged to subscribe at 150 for $18,000,000 of new common (ordinary) stock to the extent of 10 per cent. of their holdings. This is now being paid for, and will have yielded $27,000,000 by the time of the last payment, viz., October 18th.

In some quarters it is asserted that the next bonus to stockholders will take the form of an increase in the regular dividend rate to 12 per cent., which rate, in view of the rapidly expanding earnings, could be easily enough sustained. Others still seem to hold to the belief that a plan will be formulated whereby the large extraneous assets of the company will be segregated from the railroad assets proper and new securities created to represent them. But the majority is anticipating a new issue of common stock at 150 or 165, with accompanying valuable "rights" accruing to shareholders.

"The circumstances giving rise to this expectation of new financing," says the New York banker, "are the extraordinary expansion of earnings and the fast-rising values of land. It is apparent to those who have a reasonably good acquaintance with the vast scale upon which Canadian Pacific operates, that in a comparatively short time $100,000,000 or more of new cash capital must be provided. When the time comes, some of this will be raised, no doubt, through the issuance and sale of new 4 per cent. debenture stock and perhaps 4 per cent. preferred stock, but the greater part of the requirement will be obtained by issuing additional common stock."

The earnings of the Canadian Pacific for several years have consistently made new records, and it looks as though the current year will make still another. While no official decision respecting the double-tracking of the system from coast to coast has been announced, observers see that such an enterprise will become necessary in a comparatively short time.

If another offering of stock is made, say, $40,000,000, at 150, which was the price of the $18,000,000 issue of last January, it would yield $60,000,000, but, as there is a likelihood of the next block being offered at a higher price, probably 165, an issue of $40,000,000 would bring $66,000,000. Such an amount would serve to carry the company's programme forward on an increased scale for another year. The company usually has on hand a working cash balance of $45,000,000 to $50,000,000, and this amount, coupled with the newly raised capital—$27,000,000 through sale of common stock and about £1,000,000 of preferred stock in London at the close of last year—the company could put about $80,000,000 into the construction work it has under way without issuing any new stock. Ample amounts, however, must be provided from time to time for the proper operation of the company's system, not only to-day, but in years to come.

EDITORIAL COMMENT.

We have had occasion several times of late to refer to the request of the Chicago Drainage Canal Sanitary District for permission to divert more water. We are glad to note that the United States Secretary of War has decided against allowing any increased diversion. The Canadian Commission of Conservation, and its able secretary, are to be congratulated on the able manner in which the objections of Canada were presented. It was largely due to this energetic protest that the increased amount was not granted.

* * * *

The judgment of the Privy Council, just delivered, awarding a decision in favor of the Niagara Falls Queen Victoria Park Commission against the Niagara power companies, in the matter of power rentals, means much to the Commission and its policy of beautifying the Niagara Peninsula. The question was whether the companies should pay rental on a peak basis or on the average load, and the decision of the Privy Council reverses the previous judgment of the Canadian courts. It is of interest to note that the opinion voiced by Dean Galbraith, of the University of Toronto, some years ago, when called as an expert by the Park Commission, has been sustained by the Privy Council.

LETTER TO THE EDITOR.

Sir,—In your leading editorial in your issue of July 25th you refer to a recent article of mine which you entitle "Mining and the University." The article referred to was one of a series being published in the Canadian Mining Journal, and in Applied Science, and the title was "The Mineral Industry and the University of Toronto." In this particular case, this is a distinction with a difference. The choice of terminology happens to be exceedingly vital.

H. E. T. HAULTAIN,
306 Stair Building, Toronto.

THE PRODUCTION OF CHLORINE FOR WATER AND SEWAGE STERILIZATION.

By Joseph Race, F.I.C., (Toronto Filtration Plant.)

Chlorine is being so largely used at the present time for the treatment of drinking water and sewage that a review of the different methods used in its production will be of general interest. Almost the entire quantity used at present is made either from bleach or by the electrolysis of brine solutions, and as the latter are becoming more prominent, they will be described first.

Electrolytic Methods.—When electricity is passed through a solution of common salt, the sodium chloride molecule is dissociated and the components liberated. If these are not separated, the chlorine combines with the sodium hydrate formed by the action of the sodium on the water present, to form sodium hypochlorite, a strong germicidal agent. There are two types of electrolysers used for the process. In one, the cathodic and anodic products are allowed to recombine in the main body of the electrolyte; and the other, the diaphragm process, the products are removed separately from the cell as produced. For the production of sodium hypochlorite, the non-diaphragm process has usually been adopted because it dispenses with the destructive diaphragms and the loss of energy that such diaphragms cause. Dr. Rideal of London, (England), has recently developed a cell of this type with an energy efficiency of 68 per cent., but as complete data are not available, the non-diaphragm process only will be dealt with.

The theoretical voltage required for the decomposition of sodium chloride is 2.3, but when the products recombine in the electrolyte, side reactions occur which raise the minimum voltage to 3.54. On this basis one kilowatt gives 272 amps., and as one amp. hour is theoretically capable of producing 1.28 grams of chlorine, 1.26 kilowatt hours are necessary for the production of 1lb. of chlorine by the decomposition of 1.65 lbs. of salt; this represents an energy efficient of 100 per cent.

Charles Watt (1851) was the first to patent this process and to recognize the necessary conditions, which are: (1) Insoluble electrodes; (2) Low temperature of electrolyte; (3) Rapid circulation of electrolyte from cathode towards anode. The temperature is very important, for, if it reaches over [illegible]° C, oxidation takes place, and the efficiency is lowered. The following types of electrolytic cells are now in use in various places:—

The Haas and Oettel Electrolyser.—The latest form of this electrolyser makes use of carbon as electrode material and of the liberation of hydrogen at the cathode to effect automatic circulation and mixing of the liquid in the cell. The inner or working cell is a rectangular stone-ware tank divided by the carbons into 30 narrow compartments or cells, each of which has one hole at the bottom and two others at the sides about two inches from the top. The first and last carbons of the set form the main electrodes of the cell; the intervening carbons act as secondary electrodes, i.e., as anodes on the one face and cathodes on the other. This inner cell is supported on a brick foundation within a stone-ware tank measuring 72 inches by 36 inches deep and is filled with a 15 per cent. solution of brine to within four inches of the top. The carbons are protected at their top and bottom edges with slips of glass of the same width as the carbons, which prevent short circuiting due to dirt and sludge, and also prolonging the life of the carbons. A continuous current of 80 amperes at 100 volts is employed to work the electrolyser, and as soon as the electrical connection is made the evolution of hydrogen at the negative or cathode surface of the electrodes causes the level of the liquid within the cells to rise above the overflow pipes, and a rapid circulation of the brine occurs, fresh liquid flowing in at the bottom of the cells. The liquid passing away at the top of the cells flows over cooling plate, and when necessary the heat produced by electrolysis is further dispersed by aid of cooling pipes placed in the layer containing tank.

The following figures give the yields of the industrial type TE/3 of this particular electrolyser:—

- Capacity—165 gallons of brine. Strength 15 per cent. Salt required (112 kilos) 247.5 pounds.
- Current—75 to 80 amperes at 110 volts for 10 hours equivalent to 88 B.T. units.
- Yield—165 gallons hypochlorite solution containing 14 grms. of free chlorine per litre (1.4 per cent.) equivalent to (10.5 kilos) 23.1 pounds of chlorine.

The carbon electrodes are reported to have a life of 18 months for a 10-hour working day, and to cost for renewal £3-10c.-0 per set. The labor required for operating this type of electrolyser is about one hour per day, as when once charged with fresh brine is can be left for 10 hours but with slight attention. The current efficiency falls from 95 per cent. to 52.8 per cent. during the 10 hours required to produce a solution containing 14.0 grms. of chlorine per litre (1.4 per cent.) the highest efficiency being obtained with a concentration of 2.5 grms. of chlorine per litre (0.25 per cent).

The Kellner Electrolyser consists of a shallow stone-ware tank divided into a large number of narrow cells by means of vertical glass plates so arranged that the electrolyte is obliged to take a zig-zag course in its passage through the electrolyser. The electrodes are formed of platinum-iridium gauze, and are arranged horizontally with anodes below the cathodes, so that the chlorine liberated at the former may be absorbed by the supernatant liquid. This electrolyser has only two terminal electrodes, and all the intervening electrodes function as secondary electrodes as in the Haas and Oettel apparatus. The electrolyser is constructed usually to take a current of 110 volts. Brine is passed continually through the apparatus until the desired concentration is obtained, a small centrifugal pump being employed to circulate the brine through the electrolyser and an external cooling vessel being used to keep down the temperature below 25° C. Using a 10 per cent. solution of salt, the current efficiency falls from 87.5 per cent. to 45.8 per cent. in 10 hours, the free chlorine rising from 0.309 to 1.295 per cent. during this period. The following figures give the yield of the industrial type (2 Esn. 60/9) of this apparatus.

- Capacity—820 litres (180 gallons) of brine. Strength 15 per cent. Salt required 123 kilos (270 ibs.).
- Current—90 amperes at 110 volts for 10 hours, equivalent to 99 B. T. Units.
- Yield—820 litres (180 gallons) of hypochlorite solution, containing 20 grams free chlorine per litre (2 per cent.), equivalent to 16.4 kilos (36 lbs.) of chlorine.

The life of the platinum-iridium electrodes is, of course, much longer than that of the carbon electrodes employed in the Haas and Oettel electrolyser, and their scrap value is considerable; but, on the other hand, they are not indestructible, and if the brine contains magnesium salts, the deposit of these cause trouble.

The Hermite Electrolyser.—The distinctive features of this cell and process are the uses of a mixture of sodium and magnesium chloride as electrolyte, of magnesium hydrate as a preservative, and of zinc as negative element in the cells. The electrolyte is prepared in an elevated tank, and is allowed to flow by gravity through a series of four double troughs. These troughs were formerly made of slate, but are now constructed of glazed earthenware, and each is divided by a partition which causes the electrolyte to pass twice along the length. Each division of the trough contains five sets of electrodes, two negative electrodes of zinc, enclosing one positive electrode formed by winding thin platinum wire upon a perforated porcelain slab of the required shape. There are thus six separate cells containing 40 pairs of electrodes in the one unit of plant, and a current of 15 amperes at 230 volts is employed, the electrodes and cells all being connected electrically in series. The electrolyte passes between each of the electrodes in its passage from the inlet to the exit, the flow from one trough to the next being controlled by glass syphons and funnels. A small addition of sodium hydroxide solution is made to the liquid as it flows from the last trough, glass carboys being employed to receive the mixed solution of calcium and magnesium hypochlorites. The capacity of each unit of plant is 185-200 gallons of solution at a strength of 4 to 6 grams. of chlorine per litre (0.4 to 0.6 per cent.) per eight-hour day, the rate of flow of electrolyte being 3 1-3 pints per minute. The first unit of plant was erected at Poplar in 1906, and cost with all the necessary accessories £583 ($2,915), the second unit erected at the beginning of 1910 cost £501 ($2,505). The running cost—electricity, water, chemicals, supervision and testing—for the half-year ending September 30th, 1910, amounted to $500 (£100), but this total does not contain any allowance for interest, depreciation, rent, or distribution charges. The net cost of one electrolyser is $1,625, (£325).

The Vogelsand Electrolyser.—The original form of Vogelsand electrolyser resembled in its main construction features of Hermite and Kellner electrolysers, the electrolyte being made to take a zig-zag (vertical) course through a trough filled with a large number of electrodes (secondary). Lead plates faced with platinum on the anode side were used as the intermediate electrodes, and by varying the number of these the electrolyser could be made to take a current of 85 amperes at 65 to 110 volts. An electrolyser of this type was said to have produced 20 kilos (44 lbs.) of active chlorine in a 10-hours working day, equivalent to a yield of 1 kilo of active chlorine (2.2 lbs.) per 6.6 E.H.P. hours, or an energy efficiency of 35.8 per cent. The use of lead for electrodes did not, however, prove satisfactory, and the Vogelsand cell has been considerably modified. The electrolyser now worked at Nottingham and other places abroad is constructed with composite electrodes. Narrow bars of slate extending the full width of the cell are wrapped with a sheet of platinum-iridium foil in zig-zag fashion, the result being an electrode of great strength, which can carry high current densities, and presents opposing surfaces of foil where required. The sectional area allowed for carrying the current through the electrode (from one face to the other) should be proportioned to the superficial electrode surface in contact with the electrode.

The Mather and Platt Electrolyser.—This resembles that of Kellner, and is constructed with 39 electrodes made of a platinum-iridium alloy, and with two terminal electrodes for connection to the current mains. The 40 cells into which the electrolyser is divided by plate-glass strips and so arranged that the electrolyte takes a zig-zag course, and attains a strength of 7 grms. of chlorine per litre (0.7 per cent.) at the exit of the electrolyser. A current of 19⅓ amperes at 2.2 volts for 10 hours is stated to yield 7 kilos (15.4 lbs.) of active chlorine, equivalent to 6 K.W. hours per kilo, or 2.7 K.W. hours per pound of active chlorine. The strength of salt solution used is 6 per cent., and cooling tanks are employed both for the brine and the electrolysed liquor.

The Dayton Cell.—Consists of a shallow earthenware tank, containing two carbon electrodes and a number of baffle plates to direct the course of the continuous flow of brine solution. The glazed stone-ware tank is practically indestructible and the renewal of the electrodes, which have a life of from 12 to 18 months, is but a trifle.

Rickard's quarterly bulletin, Ohio State Board of Health, Oct.-December, 1909, states that with this cell one pound of available chlorine could be produced by the consumption of 2.65 K.W. hours and 6.9 pounds of sodium chloride. This result was obtained by cooling with ice. Without the cooling process, 3.62 K.W. hours and 7.2 pounds of salt were necessary. Other results with this cell are to the effect that one pound of available chlorine can be produced by the consumption of 3.38 K.W. hours and 7.7 pounds of salt. The cell (model T N) using 20 gallons of 5 per cent. salt solution per hour gave a liquor containing 0.65 per cent. of available chlorine by the consumption of 40 amperes at 110 volts.

Taking the results given in the above descriptions of the various forms of electrolytic hypochlorite cells, we obtain the following figures for the relative yields:—

Type of Cell.	Salt used. lbs.	K.W. hours.	Active chlorine. lbs.
Haas and Oetell	247.5	$\frac{80 \times 110 \times 10}{88}$	23.1
Kellner	270.0	$\frac{90 \times 110 \times 10}{99}$	36.0
Hermite	78.5	$\frac{15 \times 230 \times 8}{27.6}$	9.57
Mather and Platt	.....	$\frac{19.33 \times 220 \times 10}{42.52}$	7.0
Dayton	100	40 x 110 x 10	13.0
Theoretical	1.65	1.26	1.0

Efficiency.

	Salt used. lbs.	Salt used. per cent.	Power used. K.W. hrs.	Power used. Efficiency.
Haas and Oettel	10.7	15.4	3.80	33.2
Kellner	7.5	22.0	2.75	45.8
Hermite	11.2	14.5	2.87	43.9
Mather and Platt	....	....	2.75	45.8
Dayton	7.7	21.4	3.38	37.3
Theory demands	1.65	100	1.26	100

The cost of production will depend upon local circumstances. If alternating current is available at $30 per horsepower per annum, the price per K.W. hour of direct current, assuming the efficiency of a motor generator set to be 88 per cent., will be 0.52 cent. With low-grade salt at $5 per ton, the cost of one pound of available chlorine would be as follows:—

Cost of Pound of Available Chlorine.

Type of cell.	Salt.	Current.	Total.
Haas and Oettel	2.67	1.97	4.64
Kellner	1.87	1.43	3.30
Hermite	2.80	1.49	4.29
Dayton	1.92	1.76	3.68

From these results it is evident that the most efficient cells are the Kellner and the Dayton, but as the former involves a much larger capital outlay owing to the high cost of the platinum-iridium electrodes, the latter is the most economical cell available. Low-grade salt is often unsuitable for use in the Kellner cell owing to the magnesium salts depositing on the electrodes and reducing the efficiency.

Chemical Methods.—

(a)—Bleaching powder.
(b)—Sodium hypochlorite.
(c)—Liquid chlorine.

Bleaching Powder.—Bleaching powder (commercial calcium hypochlorite) on addition to water yields chlorine in an active condition, and this constitutes one of the simplest and most economical methods of producing chlorine for sterilization purposes. Bleach usually contains 37-38 per cent. of available chlorine, and of this about 33 per cent. is easily obtained by solution in water. The product of the new plant at Windsor, the only bleach plant in operation in this country, is sold at $25 per ton, so that each pound of available chlorine costs 3.75 cents.

Sodium Hypochlorite.—This compound is sold by Brunner Mond & Co., Northwich, England, under the trade name of "Chloros." In this country it costs 25 cents per gallon, and as the solution contains about 12 per cent. of available chlorine, each pound of chlorine costs approximately 20 cents.

Liquid Chlorine.—Anhydrous liquid chlorine has recently come into use for sterilization purposes, and its introduction in 1910 was due to Major Darnall, M.D., of the Medical Corps of the United States Army. The method is very simple, being the addition of dry chlorine gas, evolved by releasing the pressure on the liquid chlorine, to the water to be treated. Chlorine is obtained as a by-product in the manufacture of caustic soda, and a portion of it is purified, dried, liquefied by pressure, and put on the market in steel drums or cylinders holding 100 to 140 lbs. each. The chlorine thus obtained is almost chemically pure, the impurities being traces of oxygen, carbon dioxide, and nitrogen. The pressure of the liquefied chlorine on the walls of the drum varies from 54 pounds per square inch at 32° F. to 216 pounds pressure at 122° F. The price is approximately 12 cents per pound, but there is doubt that this will be very materially reduced if the consumption materially increases.

Relative Sterilization Efficiencies of Chemical and Electrolytic Chlorine.—The claims made for the superior bleaching efficiency of chlorine produced by electrolytic methods have been modified by the results of recent independent research, and it is now generally accepted that there is but slight difference (not exceeding 5 per cent.) between the bleaching effects obtained, if the chlorine be present in the same form of combination and in the same degree of concentration in the various bleaching liquors. The disinfection and bleaching properties of chlorine are both due to the nascent oxygen liberated on solution, so that the above remarks apply equally well to chlorine for disinfection purposes. It is probable that the carbonic acid content of the water to be treated is a much more important factor than the form of combination of the chlorine, as this is the constituent of water that is mainly responsible for the decomposition of the hypochlorite into hypochlorous acid and free chlorine which in turn produce nascent oxygen.

Capital Outlay.—The capital outlay required for chlorine treatment depends so largely upon individual requirements that generalizations on this phase of the subject are practically of no value. Whilst chemical chlorine is undoubtedly the best in an emergency or for temporary use, the electrolytic method is deserving of full consideration, where chlorination is decided upon as a permanent measure. At Baltimore and Cincinnati the electrolytic process was probably installed on account of the extremely low cost of electrical current, and where even the same conditions obtain, this method is undoubtedly the most economical.

Resume of Costs.

Electrolytic—				
Haas and Oettel	4.64	cents per pound	of available	chlorine
Kellner	3.30	”	”	”
Hermite	4.29	”	”	”
Dayton	3.68	”	”	”
Chemical—				
Bleach	3.75	”	”	”
Sodium Hypochlorite	20.0	”	”	”
Liquid Chlorine	12.0	”	”	”

CONCRETE SUBSTRUCTURAL WATER-PROOFING.*

By J. R. Wickle.

The cost of the proper waterproofing of a building bears but a slight percentage of the total cost of the completed structure, and architects and engineers have recognized the fact that the use of good materials, giving permanent results, are the only ones which they can afford to employ, if only as a matter of good economy. The use of pitch and kindred products is gradually being abandoned for the reason that such materials disintegrate when in contact with moisture and are affected by alkalies and other substances in the soil which rapidly destroy them. Therefore, it must be apparent that such materials should be used which are unaffected by the conditions peculiar to the foundation.

Two methods are open to the architect preparing his waterproofing scheme. The first is the membraneous or seal method, which consists in surrounding the entire foundation with an impenetrable envelope interposed between the structure and the water or moisture to be kept out. The "integral" method is that by which the waterproof agent becomes absorbed into and integrated throughout the concrete mass, or through the cement plaster, or concrete so completely as to render the mass, or plaster, impregnable to the attacks or penetration of water or dampness.

For your consideration we will first take up the membraneous system. Where the term "foundation" is used, it is understood to be that of concrete in accordance with the general practice. The matter of heads pressure, and so forth, will be referred to only in a general way, as the object of this paper is not to dwell upon the engineering features of the substructure, but to discuss the waterproofing systems used and employed in this connection. The conditions under which the work is to be done will, to a large extent, determine the method to be used. In considering the membraneous treatment let us assume that our footing course has been placed. The next step is to lay the waterproofing over the footings, using no less than three ply of good felt bonded by means of a good bitumen. Bitumens which require heating are the ones used most advantageously in this connection. Binders of the sort will remain relatively tacky, and will not crack or break, due to any subsequent settling of the foundation. Having laid this damp course, the waterproofing will be carried up the outside of the foundation wall to six inches above the grade line. Where only ordinary seepage exists, the use of a heavy asphaltum damp-proof paint applied on such walls will be sufficient, but should the walls be left in very rough shape, a bituminous plastic which is applied with a trowel should be substituted for the liquid damp-proof paint as suggested above. This last treatment dispenses with the safety coat of cement mortar which is necessary as a protection to the waterproofing in back-filling on completion of the work. In placing the waterproofing over footings the felt should project at least six inches on either side of same in order to make connection with the waterproofing to be carried over floors and the exterior side of the wall. The floor waterproofing is laid between upper and lower beds of concrete, the concrete being laid in such a manner that the top bed of same will resist any hydrostatic pressure which may develop from below. To illustrate: Supposing the total thickness of concrete to be placed for floors is seven inches, a three-inch bed would first be placed on which will be laid the waterproofing, the same number of plies being used as laid over footings. Upon this three inches of concrete will be put, as an upper bed, and a one-inch top dressing of cement and sand, say 1 to 2 mix, to

* Paper read before a meeting of Architects in Winnipeg.

provide a wearing surface for the floor. This floor waterproofing is made continuous by joining the felt with six inches of same projecting from the footings and up the walls. The method is simple, but is not always permanent, except that you employ such materials as will be unaffected by the expansion and contraction of the foundation. The architect or the contractor will see that the connections are properly made as between the wall waterproofing and the floor waterproofing, for it is at this point that trouble usually develops. Irish felt is considered one of the best reinforcing agents for substructural waterproofing, and, to-day, materials of this kind which are on the market compare very favorably in price with the domestic paper, in fact I believe a number of imported felts to be cheaper. Where considerable pressure is to be met with at least six ply of felt should be installed. In many cases automatic pumps or ejectors are erected in connection with a sump pit in order to keep the water around the foundation below the floor level. This installation, however, is optional, for waterproofing done in a careful manner as I have outlined, with an eye to the selection of proper materials on the part of the architect, will be reliable in the most acute cases. Where ordnary seepage occurs, a stratum of a plastic bitumen can be substituted for the felt. If the foundation adjoins that of another structure it is evident that the felt cannot be placed on the outside of the foundation walls, without first laying up a brick wall on the outside of the bearing wall to sustain the waterproofing. In instances of this kind, it depends upon the conditions whether this scheme should be preferred to the integral method.

Coming to the integral method, it is perhaps, well to touch upon the character of materials now largely in use. In the laboratory or in very careful practice, it is possible to obtain a voidless concrete by using properly graded aggregates with the cement. A concrete thus obtained is waterproof, but in every-day work, taking into consideration the human equation, the probabilities of securing an absolutely dense concrete, are too utopian for consideration in this paper. Owing to the porous nature of concrete, many tests have been conducted with the object of securing a medium to overcome this porosity with an absolutely voidless concrete at the ultimate. Some materials on the market are liquid in form, and we are advised they do not act as void fillers, but simply increase the cementative properties of the cement without affecting the volume of concrete and have for their object a closer relation between the cement and the aggregate. This is explained as bringing into service the full colloidal possibilities of the cement. Frequently hydrate of lime is used for the purpose of waterproofing concrete. It is my opinion that this is not a successful agent, unless the lime can absorb oxygen or slack. In plastering, for instance, the object of using three coats of lime mortar is to give the lime sufficient surface to take up oxygen and fulfil its purpose. Take a sixteen-inch wall, for instance, waterproofed by the use of lime; it will only be waterproof on or near the surface where the lime has the opportunity of becoming active. In the interior of such wall we find this agent in an unslacked state, having absolutely no chance to assist the cement, and is a loafer on the job. It will be seen that unless all parts of the mass can receive the full advantage of the active lime, that the purpose of the agent cannot be fulfilled.

Experiments have been conducted in the laboratories in some of the large universities of the United States, which bear out my contention. Other materials now in use act as void fillers, the products of themselves being inert and water-repelling. As to affecting the strength of the concrete, they are for the most part neutral. Materials of this kind are simple in their application and are extensively used. A concrete mass so waterproofed will lose its capillary value for attracting water. Having selected the material, the next question to decide is, shall we incorporate it throughout the entire concrete body, or use it in an interior plaster coating? If we decide the former, all that is necessary is to put in the waterproofing when mixing the concrete, and the other details of construction can be carried on without further regard to the waterproofing except to observe the manufacturer's directions as to mixing and so forth, and leaving no part of the substructure untreated. The question is often brought up as to what assurance we have that the material be properly mixed. If the workman is not careful in mixing his concrete he will not secure a good concrete, and by the same token he will not secure a waterproof concrete. On the other hand, a careful workman will be as careful in adding his waterproof compound as he will in mixing his concrete. The fact that many perfect jobs executed by following manufacturer's directions and without his supervision, is a test to the merit of these waterproofing factors. The advantages of the integral method are quite apparent. No need to build a retaining wall to receive the waterproofing when building against an adjoining wall. Another service, and a great one, which the integral method performs is exemplified when trouble develops in a foundation. Excavating around the outside of foundation walls, and applying asphaltum, serves only to keep the water from the structure at that point, while it is a natural course for the water to find its way through the footings and floors. The best that we can expect from such a treatment is a waterproof wall down to the footings, and water will come up through the footings and floors. In other words, we must secure continuity of the waterproof course. The solution of the problem and the only practical way of obtaining such a continuous surface is an interior application whereby the waterproofing can be placed over all walls and floors, and thus successfully resist the penetration of water at all points.

In discussing the membraneous method I mentioned that the waterproofing would need to be placed between the water to be combatted and the structure, but in the application of the integral method as a plaster coating, this is not necessary. For the purpose of explanation, let us consider a concrete foundation with seepage occurring at different points. It is not possible to apply the waterproof coating as described, on a surface continuously wet and by water under pressure, so as in all problems in waterproofing, the first step will be to keep the water below the floor level during the process of waterproofing. One of the methods commonly employed for this purpose is known as "bleeding the wall"—that is, inserting iron pipes in the wall at points where the entrance of water is most apparent, these bleeders being placed so as to permit the pumping of the water from the outside wall to a point below the level of the surface to be waterproofed. Having done this, the next step is to make all surfaces to be treated sufficiently rough to receive the plaster coating. This can be done by hacking, followed by an acid wash, which, in turn, is washed off with clean water after the effervescence ceases. The use of acid (common muriatic acid) or acids in powder form used for this purpose act upon the lime in the cement and expose the silicate particles of the concrete. Then we apply our waterproof plaster coating, which is a coat of either 1 to 2 or 1 to 3 mixture of cement and sand, having the waterproof agent mixed in. This applied on the walls in a three-quarter inch coating and on the floors in a coating at least one inch in thickness, will accomplish the result after the waterproofing is set up; then it is possible to seal the bleeders. As to the adhesion between the waterproof coating and the concrete, this bond will resist any pressure which may develop. Many large jobs have been waterproofed by such a scheme as I have described. The waterproofing is ever in sight and the installation can be made on a brick foundation wall, with practically as good results as can be obtained on a concrete wall.

In conclusion, you yourselves can best determine the method to be employed based upon the local conditions. A suitable caption would be, suit methods to conditions and material to methods, and with this ever in mind, and without pre-supposing the nicety of workmanship guaranteed in ordinary labor, we are able to get good results.

HYPOCHLORITE STERILIZATION AT KANSAS CITY, MO.

By S. Y. High, Chief Superintendent of Water Works.

The water supply of Kansas City, Mo., is taken from the Missouri River about five miles above Kansas City, at the Quindaro station in Kansas. The water is pumped directly from the river into settling basins. The water is then treated with lime and sulphate of alumina. After leaving the basins through the back flow or suction pipe, the hypochlorite solution is introduced before the water gets to the pump, the pump agitation making a thorough mixture of the hypochlorite with the water.

From the Quindaro station the water is pumped to the Turkey Creek station twelve-million-gallon reservoir, and from this reservoir to the service mains.

Since the demonstration at Boonton, N.J., in 1909, of the reduction of bacteria by the introduction of minute quantities of "available chlorine" with water more or less polluted, and the acceptance of the process by the courts as a proper method to be employed in connection with a municipal water supply, the question of the efficient introduction of hypochlorite of lime solution and the mechanical appliances suitable for the purpose engaged the attention of the fire and water commissioners of this city. They ordered the city chemist, Dr. W. M. Cross, to make a trip of inspection of several cities known to have the hypochlorite sterilization system in satisfactory operation.

Dr. Cross found the method of installation of the system easy, cheap and satisfactory. During the year 1911 an experimental installation of the hypochlorite process for the approximate sterilization of the entire municipal water supply of Kansas City was so successful that the Kansas City fire and water commissioners undertook the construction of a permanent building and apparatus for the application of this purification process to the entire water supply.

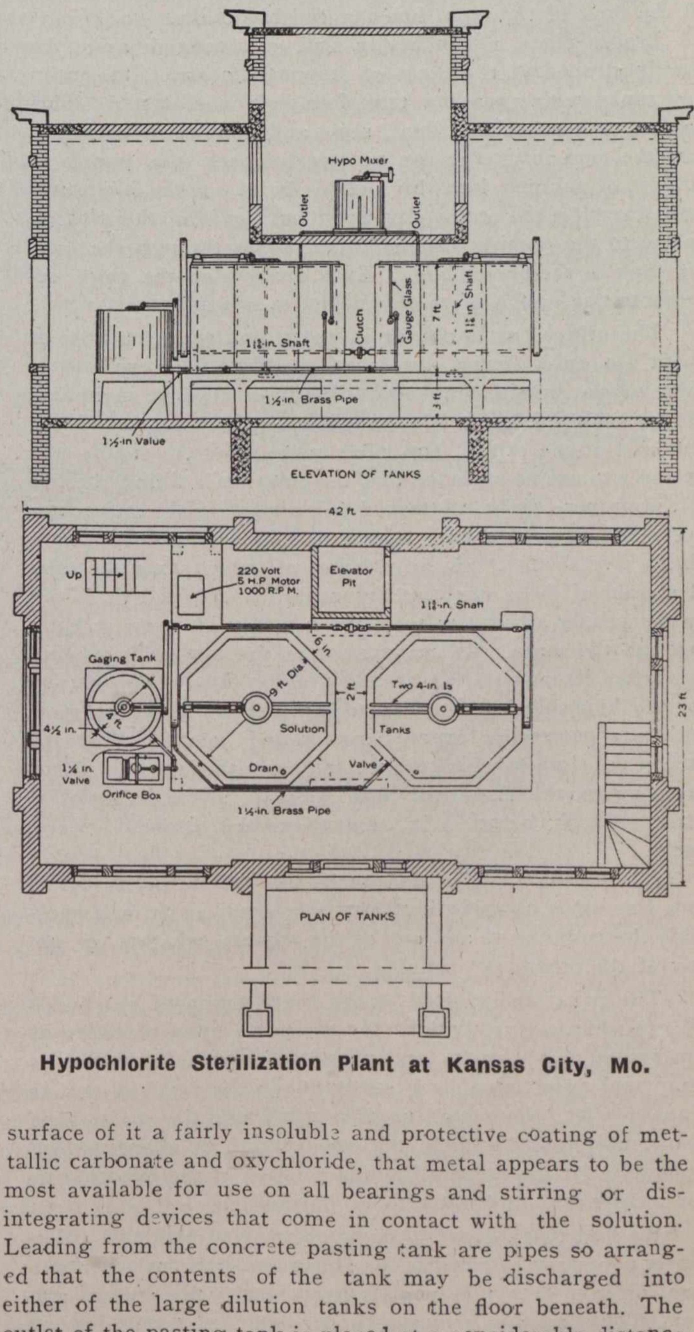
A separate building was constructed to make possible the satisfactory storage, handling and making of the solution of hypochlorite ready for mixing with the sedimented water. The building itself was designed by W. C. Root, an architect, and the apparatus for use in connection with the sterilization process was installed under the direction and supervision of Burton Lowther, engineer in charge.

The apparatus for the handling of the hypochlorite and the supports for it are of reinforced concrete. It is to be observed that no other material is so well suited for use in connection with this sterilizing agent as good concrete, for the reason that all other materials that are capable of oxidation are promptly attacked by the hypochlorite solution and become rapidly deteriorated. The prime consideration with regard to this class of installation is to employ methods of construction and to use material that is so permanent in character as to obviate the necessity of repairs which would force the discontinuance of the application of the sterilizing agent, even for an hour.

*Paper read before American Waterworks Association.

The basement of the building is used for storage of the reagent that is kept in reserve. The main floor is used to house the dilution tanks and the feeding devices, while on the floor above is placed the tank in which the hypochlorite is reduced to paste of a creamy consistency before being delivered to the dilution tanks beneath. This pasting tank, three feet in diameter and four feet high, is provided with a stirring device carrying two rather heavy rollers disposed horizontally at its lower end.

The rollers clear the bottom of the concrete tank only by a fraction of an inch, thus insuring the mashing and disintegration of all of the small lumps that are invariably present in commercial calcium hypochlorite. Owing to the fact that the action of the reagent on bronze is to form on the



Hypochlorite Sterilization Plant at Kansas City, Mo.

surface of it a fairly insoluble and protective coating of metallic carbonate and oxychloride, that metal appears to be the most available for use on all bearings and stirring or disintegrating devices that come in contact with the solution. Leading from the concrete pasting tank are pipes so arranged that the contents of the tank may be discharged into either of the large dilution tanks on the floor beneath. The outlet of the pasting tank is placed at a considerable distance from its bottom, so as to avoid the possibility of drawing off with the paste any fragments of considerable size. The pipes carrying the paste are so arranged as to be readily cleaned in a few minutes in the event that they become clogged. Ultimately, they are sure to become clogged if they are not occasionally cleared, because of the formation in them of carbonate from carbon dioxide absorbed from the air.

The dilution tanks are hexagonal in form, nine feet in maximum diameter and seven feet high. Their walls are six inches thick. Although the difficulty experienced in properly disposing the reinforcing iron in the construction of a hexagonal tank is much greater than is the case in the building of a round one, the hexagonal tank is to be preferred on account of the fact that in a round tank a rotary stirrer does not produce nearly such thorough agitation and mixing of the solution of hypochlorite as the same stirrer can do in the hexagonal tank. The paste is mixed with water in the dilution tanks until a uniform solution of a strength of 2 per cent. occurs. The use of two tanks makes it possible to accurately adjust the strength of the solution in one solution tank while the contents of the other are being utilized. The dilution tanks are placed on supports high enough to permit the use of a gravity feed to the orifice box, which is placed on the floor of the room housing the big tanks.

Bronze pipes, 1½ inches in size, so arranged as to be readily cleaned in the event of stoppage, connect the dilution tanks with a gaging tank four feet in diameter. This gaging tank contains a float, scale and pointer so arranged that the man in charge can accurately check the speed of outflow of solution from his orifice box into the big water main carrying the entire city water supply from the settling basins to the pumps. The solution passes through the gaging tank to the orifice box. Each division on the gage represents one gallon of the hypochlorite solution.

The orifice box is oblong in shape and carries a float of about 250 cubic inches displacement. The float operates a valve which, by either opening slightly or closing, maintains the hypochlorite solution in the orifice box to a constant level. One end of the orifice box is of plate glass to enable the operator to see at a glance that the solution is filling the box to the proper height. Attached to the plate glass and covering a hole in it is a hard rubber disc having near its periphery several slits, the adjustment of which fixes the size of stream of the 2 per cent. hypochlorite solution that will be the proper amount to treat the quantity of water passing through the main. All movements of the hypochlorite solution after its preparation are by gravity. Ample opportunity for the hypochlorite, after its addition to the water, to react with any putrescible organic matter and germs is afforded during the time in which the water passes through the centrifugal pump, the flow line and a small storage basin at Turkey Creek before it is pumped to the domestic water users.

All stirring devices are run by an electric motor belted to a line shaft carrying clutches so placed as to make possible the running of any one of the stirrers, whether or not any of the others are running.

The principle involved in the construction of practically all hypochlorite installations for the purification of water by the oxidation of germs and putrescible organic matter in municipal water supplies is substantially the same as that in Kansas City. Concrete, usually reinforced, is, so far as I know, universally used in the construction of all permanent apparatus for the preparation and solution of the hypochlorite for mixing with the water to be purified.

We find that .30 to .50 parts per million available chlorine is necessary to sterilize, or about one-half part per million, or from 8 to 12½ pounds hypochlorite per million gallons. This amount removes, under ordinary conditions, all B. coli and 99 per cent. of all germs. The cost is about 30 cents per million gallons for labor and material, not including interest and depreciation on plant. As the plant is not yet completed, we are unable to arrive at this additional cost. This additional cost will be small. The 30 cents cost for sterilization is based on a thirty-million-gallon consumption. When the consumption increases, the cost is less than 30 cents per million gallons, so that it probably will not exceed that amount, including interest and depreciation, as the pumpage during the hot and cold months averages over forty million gallons.

In view of the fact that a great many cases of typhoid fever are imported and that there are still open and being constantly used numerous springs, wells and cisterns, known to be contaminated with sewage, the result has been all that could have been anticipated. During the year 1910 no specific attempt was made to destroy pathogenic germs in the municipal water supply. During the year 1911 the hypochlorite process was used throughout the year.

The following tabulation, showing the number of deaths from typhoid fever, month by month, during those years, is illuminating:

Month.	Deaths. 1910.	1911.
January	17	6
February	21	6
March	10	4
April	8	3
May	3	4
June	7	1
July	9	5
August	8	6
September	6	3
October	6	8
November	4	6
December	8	9
Totals	107	61

Now, with this great source of danger from infection by the municipal water supply removed, it is possible for the health commissioner to so enforce the abandonment of questionable sources of water supply and regulate sanitary conditions as to make the occurrence of typhoid fever and most intestinal diseases an uncommon thing in Kansas City.

The following are some germ counts on the city water supply, showing the improvement of the water by the hypochlorite process:

Germs in one Cubic Centimeter of Water.

Date.	Quindaro, Missouri River Before Treatment.	Clear Basin Before Treatment.	City Hall Hydrant After Treatment.	B. Coli After Treatment.
March 20	10,000	1,200	75	0
March 21	8,000	1,800	70	0
March 23	4,000	800	100	0
March 24	10,000	500	55	0
March 25	8,000	600	90	0
March 27	8,000	400	25	0
March 28	5,000	260	20	0

The accompanying cut will give a fairly good idea of the disposition of the various parts of the purification installation.

A NEW USE FOR THE SULPHUR LIQUOR DISCHARGE OF GAS WORKS.

A French investigator, A. Demolon, found that when the soil was given a quantity of flowers of sulphur, the growth of roots and leaves was invariably hastened and the plants took on a deeper green. The investigation was suggested by the common use in northern France of gas-works waste as manure. Analysis showed 40 per cent. of sulphur in this waste, and the growth stimulaton was traced to this ingredient.

THE USE OF CHARTS IN THE PREPARATION OF ESTIMATES.

The following article by Mr. Edward G. Fiegehen, published recently in London "Engineering," contains material of so valuable a nature that we have reproduced it in full.

In the preparation of estimates of all kinds, time enters as a most important factor. It may become necessary, for instance, in order to take advantage of an unexpected opportunity of quoting, to compile a specification and estimate at the shortest possible notice, whilst, on the other hand, as in the case of tenders to public bodies, a definite date, generally two or three weeks ahead, is announced up to which tenders will be received; and since the tenders sent in remain unopened until after that date, no benefit is to be gained by posting them in advance. The bulk of inquirers, however, are content to receive tenders at the "early convenience" of the manufacturers concerned, and although the majority of firms will submit their proposals in the course of a few days, there are notable exceptions where the estimating departments appear to be constantly in arrears.

Without discussing, on the one hand, the advantages to be gained by being first in the field with a complete and attractive proposal, or, on the other hand, the risk thereby incurred of having one's price divulged for the guidance of a competitor, there can be no question that any method that will lighten the labor involved in preparing a tender by reducing the time absorbed by the merely mechanical portion of the work will thereby enable the estimator to give greater attention to the special features of each case, and will tend to prevent his work getting behindhand during those periods when inquiries are exceptionally numerous; furthermore, it will enable him in many cases to submit alternative proposals, for which, in the ordinary way, no time could be spared. We shall confine our remarks in what follows more especially to the preparation of estimates for electric-crane work; but it will be obvious that the methods advocated can be applied with equal facility to other branches of manufacture.

An advantage of such time-saving devices that appeals with special force to the estimator for crane-work is the ability thus secured to determine quickly the type, leading dimensions, approximate weight, electrical equipment, etc., appropriate to the crane he intends to offer, thus enabling him to get an estimate-drawing put in hand in ample time to allow the draughtsman to produce a satisfactory design.

By way of illustration, the charts described below will refer chiefly to the specific case of electric overhead traveling cranes. The number of types of cranes regularly manufactured is now very great, but perhaps no other is so popular, or exhibits more variation in its essential features, than that selected; for whilst it will frequently be possible to quote for a steam or electric jib-crane or winch directly from a standard price-list, with overhead cranes this is rarely the case, and each inquiry must be considered upon its merits to enable the most suitable offer to be put forward. In tackling such problems, it is found to be a good rule to deal with the known factors first, afterwards deciding the various points upon which the exercise of judgment is permitted.

In the case of established buildings the space available for the crane, and the nature of the current supply, are usually definitely stated by the customer; but since inquiries are frequently ambiguous even upon such essential points, it should be the rule to state definitely in the specification the basis upon which the estimate has been prepared, and to show clearly upon the drawing the space required for the satisfactory operation of the crane, indicating also any projections that would be likely to foul existing fixtures in the building, and also the position suggested for the main trolley-wires.

Such information is invariably of far greater service to the engineer than fullness of constructional details, which are far better indicated by photographs of similar jobs.

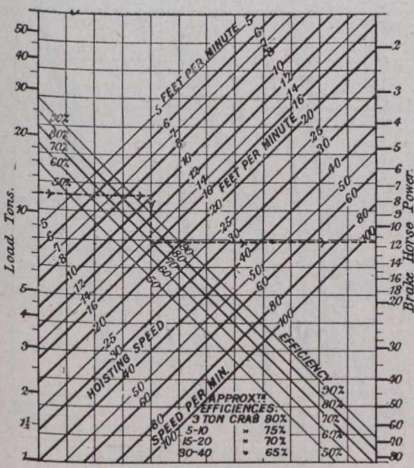


Fig. 1.

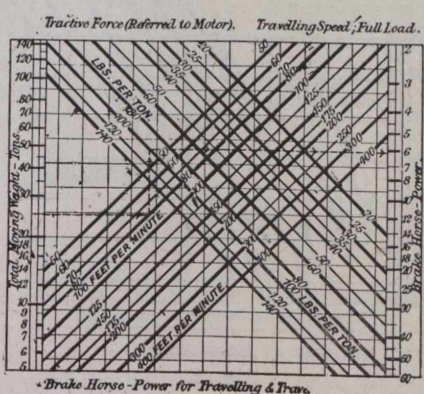


Fig. 2.

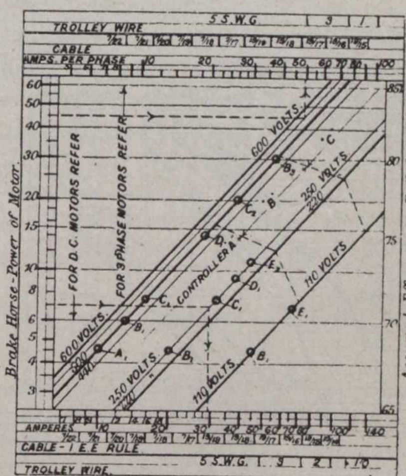


Fig. 3.

The speeds of the various motions under full load are sometimes specified by the customer, although in many instances these details are left to the judgment of the maker. In any case, however, it is generally open to the latter to submit speeds in accordance with his standard practice as an alternative, if by so doing he can quote a reduced price, or, perhaps more acceptable, earlier delivery, due to the use of stock patterns and parts. The first chart, Fig. 1, which is based upon the formula:—

$$\text{B.H.P.} = \frac{0.068 \times \text{load (tons)} \times \text{speed (f.p.m.)}}{\text{Efficiency}}$$

shows the connection between hoisting speed and brake horse-power for various loads, taking into account, of course, the mechanical efficiency of the crab-gearing under full load, which will vary both with the size of the crane and the type of gearing employed. The estimator will usually have access to test records for his guidance upon this point, but the approximate values given may be taken as typical of machine-cut spur-geared crabs under favorable conditions.

The next chart (Fig. 2) will, in a similar way, facilitate the calculation of the brake horse-power required for the traversing and traveling motions, and is based upon the formula:—

$$\text{B.H.P.} = \text{total moving load (tons)} \times \frac{\text{tractive effort} \times \text{speed (f.p.m.)}}{33{,}000}.$$

In working out test records of overhead cranes it is usual to express the "tractive effort" in pounds per ton as exerted at the motor thus:

$$\text{Tractive effort (pounds per ton)} = \frac{\text{Motor B.H.P.} \times 33{,}000}{\text{Traveling speed} \times \text{tons moved}}.$$

It will be noticed that the figure thus obtained contains an allowance for the transmission losses between the motor and the track-wheel treads, and is thus in the most convenient form for use, provided that the above qualification is not lost sight of.

To secure simplicity and, where possible, interchangeability of parts it is the commendable practice of many firms to confine themselves to a few standard powers and speeds of motors for use upon their cranes, and thus, in quoting, they will put forward the nearest standard motor that will be suitable for each motion.

This involves sometimes, it is true, offering a 10-brake horse-power motor where only 8½ brake horse-power to 9 brake horse-power is actually indicated; but the difference in cost is inappreciable, and in such cases the offer of increased speed that will thus be obtainable may sometimes be made available as a selling point.

The foregoing charts can thus be used in two ways:—

(a) Directly, to find the power required from the speed specified or assumed.

(b) Inversely, to find the speed that the nearest standard motor, when applied to the motion, will give.

Having fixed the size of the motors to be employed, the next chart (Fig. 3) will enable us to determine approximately the current consumption of each at full load, and can be used both for continuous current and three-phase induction-motors, the current in the latter case being, of course, the stator or line current, a power factor of 0.85 being assumed throughout.

From the same chart, and upon the basis of current and voltage, the most suitable sizes of controllers, resistances, cables, and trolley-wire can be ascertained for normal cases. The information afforded by the chart will naturally have to be supplemented by the user's judgment in every case, but it affords a rapid means of arriving at the above essential requirements, and admits of easy modification to agree with the current practice of the user. In Fig. 3 the lines and circles, indicating respectively the capacity of controllers and resistances, refer only to a certain make by way of illustration, and will have to be modified to suit the limits of the controlling apparatus actually put forward.

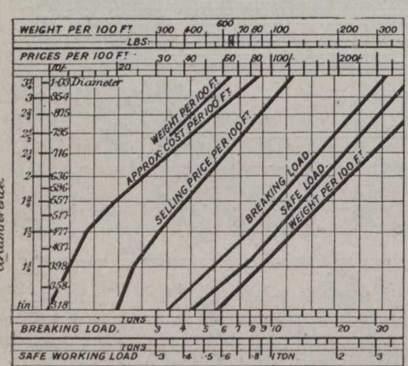
Turning now to the mechanical features of the crane, we have the chart (Fig. 4) giving the leading particulars of lifting-ropes.

Here, again, the prices shown refer only to a particular case, and the user would modify them to suit his requirements. The grade of rope covered is of 100 to 110-ton wire, up to 1¾-in. circumference, and of 90 to 100-ton wire for the larger sizes, and a variable factor of safety, from 8 in the smallest size to 6 for the 3-in. rope, has been introduced.

In the preparation of such estimates as we are now considering the greatest variant, perhaps, at least in cranes of medium and long spans, is the weight and type of the main girders.

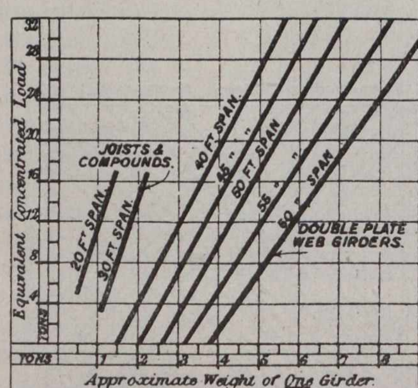
With the exception, perhaps, of deflection, it is rare for any stipulation to be made in the inquiry concerning these, and consequently it is not surprising that the offers submitted in any particular case differ materially in many respects, having regard to the difference of opinion that is bound to exist as to the most suitable type, depth, and working stress.

This discrepancy is generally most marked at those spans and loads where the carrying capacity and stiffness of joists and compounds reaches a limit, and it becomes, therefore, a matter of judgment or policy whether riveted girders should be put forward.



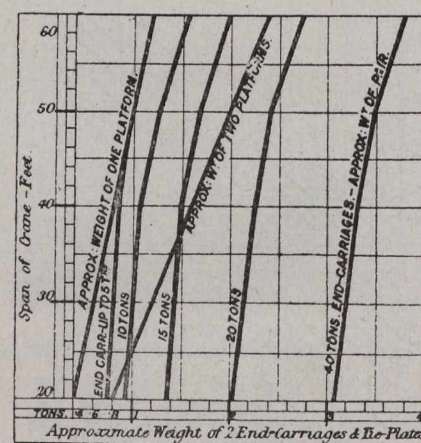
Crane Ropes.

Fig. 4.



Weight of Main Girders.

Fig. 5.



Weight of End-Carriages Etc.

Fig. 6.

The calculation of the approximate weight of a girder for a given duty involves of necessity a provisional estimate of this weight in order that the bending tendency of this can be duly allowed for. Upon short spans the accuracy of this preliminary estimate is of small importance, but upon long spans, especially when associated with the smaller lifting capacities, it becomes the paramount item of the loading, and it will, therefore, be necessary to exercise the greatest care in its determination.

The chart, Fig. 5, is intended to facilitate the estimation of the weight of main girders of normal construction.

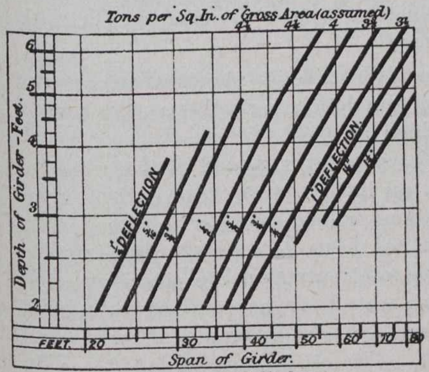
To ascertain the "equivalent concentrated load" upon each girder, we must add to half the weight of the crab and of the maximum load half the estimated weight of the girder itself and its platform, if any.

By reference to the chart we can now find the approximate weight of the girder required; but should our first attempt indicate that our provisional estimate of this weight was incorrect, the "equivalent concentrated load" assumed must be modified, and a second reading taken.

It will be noticed that the curves upon this chart, from 40-ft. span upwards, refer to double-plate web girders only.

Lattice-braced girders may be expected to show a slight saving in weight at this span, increasing to, say, 25 per cent. saving upon the longer spans and heavier loads. Since, however, it is usual to give the customer the option of plate-web or lattice-girders at the same price, the basis of plate-web weights for estimating is usually the safest.

The estimation of the structural weight of end-carriages cannot be systematized to any extent owing to the variation in their design due to different modes of attachment to the main girders, governed mainly by the amount of head-room available for the crane. The chart, Fig. 6, may, however, be taken as a rough guide in the absence of more definite data or of detailed calculation, the weights given referring to a pair of end-carriages with their appropriate tie-plates for attachment to the main girders in each case.



Deflection of Girders.

Fig. 7.

The chart also indicates the approximate weight of the usual timber platform with its hand-railing and brackets.

In the case of girders the estimator is frequently required either to work to a given maximum deflection, or to specify what maximum deflection he is prepared to guarantee under test.

To the case of a built-up beam of varying depth, such as the typical crane-girder, the ordinary theoretical formula cannot be conveniently applied. The chart, Fig. 7, has therefore been based upon an empirical rule, recommended by Thorpe, as follows:—

$$\text{Deflection (inches)} = \frac{(\text{span in feet})^2 \times \text{stress on gross flange area}}{4000 \times \text{depth in feet}}.$$

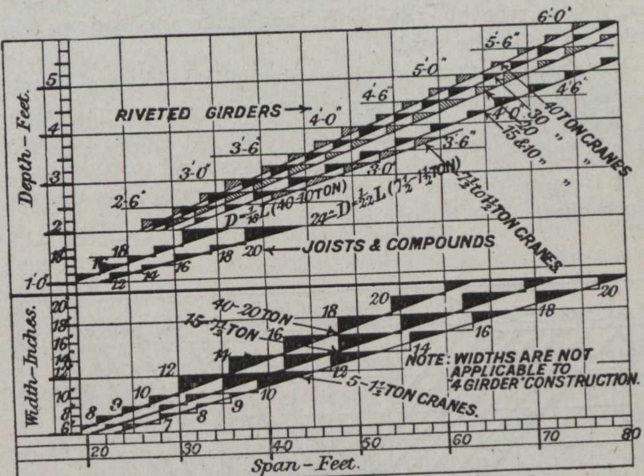
This represents the results of experience with riveted girders, and accords fairly well with practice. It should be noted particularly that the stress in the present instance is the mean stress taken over the gross area of the flange, no deduction being made for rivet-holes.

In preparing the chart, a stress of 4½ tons per sq. in. of gross flange area has been assumed up to 40 ft. span. Beyond this, some provision will be required upon the flange area of the girders to supply the necessary lateral strength, and to allow for this upon the chart the direct stress due to vertical loading only, and taken over the gross area, has been assumed to diminish uniformly from this value to 3½ tons per sq. in. only at 80 ft. span. By the use of this chart it can be readily seen whether the girder proposed will be stiff enough to comply with the specification, and, if not, to what extent the stress or depth must be modified to secure the desired result.

It is often desirable to specify the depth and width of the girders proposed, and although the designer's judgment will not mislead him greatly in this matter, a chart such as that shown in Fig. 8 tends to uniformity in this respect and prevents overlapping. It will be noticed that the depths and widths advance by steps at definite spans to correspond to market sizes or level figures, and that the proportion of both width to span and depth to span varies slightly according to the capacity of the crane.

It is fairly safe to assert that the bête noir of the average estimator is the preparation of the detailed shipping specification that must accompany all quotations for export trade. In the compilation of such sheets guessing plays an altogether too conspicuous part.

If, on the one hand, the result errs upon the side of too great weight and bulk, the tender may be ruled out at once on that account alone; whilst should a "light" specification assist in securing the order, the firm run the risk of losing the confidence of its client, who will not relish having to pay any unexpected additional freight.

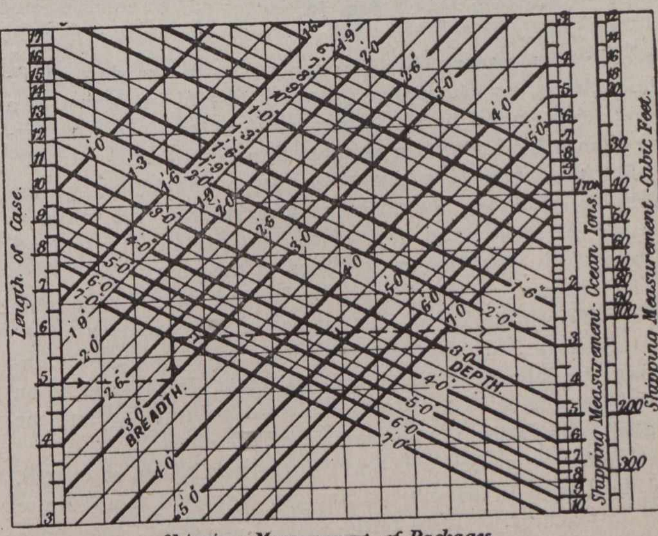


Overall Dimensions of Normal Girders

Fig. 8.

Any means, therefore, that will reduce the uncertainty and labor of the process is a step in the right direction. For standard cranes a form of specification should be decided upon and adhered to, and it will generally be found that many of the items remain unaffected by changes in span, etc.

For reducing the shipping measurements of the various items to cubic feet or ocean tons, as may be preferred, Fig. 9 will be found of great service, the accuracy obtainable being quite sufficient for all ordinary purposes.



Shipping Measurement of Packages

Fig. 9.

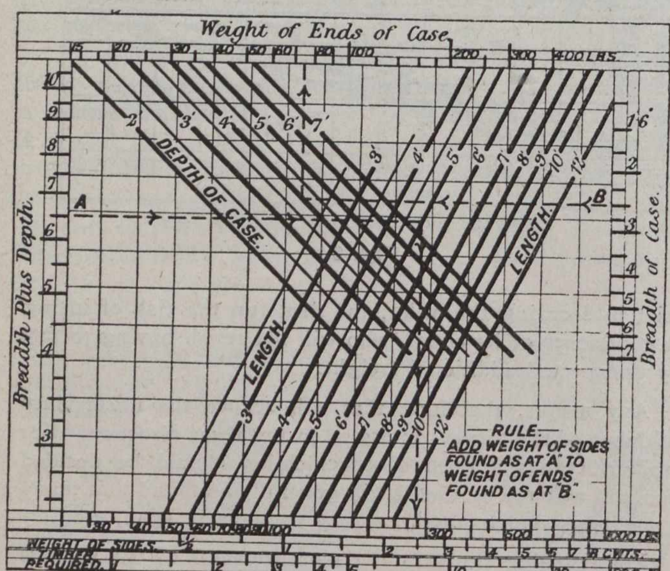
Clients frequently ask for both gross and net weights of packages to be stated. Owing to the time involved in looking up previous packing-lists of similar work, the weights of the various packing-cases are frequently guessed at, a process that can hardly be considered satisfactory. Our last chart, Fig. 10, is intended to show the approximate weight of ordinary unlined cases of 1¼ in. deal, and by its use consistent results of reasonable accuracy can be obtained with great rapidity.

By the use of the bottom scale in conjunction with those immediately above it the number of cubic feet of timber used in the construction of the case can be estimated.

In the foregoing we have endeavored to indicate briefly some methods of economizing time and labor in the preparation of estimates. Our examples have necessarily been confined to one type of crane only, but other applications will readily occur to the reader.

It is desirable that such charts should be boldly and clearly constructed to facilitate ready reference, to prevent mistakes, and, above all, to avoid that appearance of great accuracy that fine lines and close divisions always tend to produce.

It is quite possible to obtain great accuracy by the use of such charts, but for our present purpose such accuracy is



Approximate Weight of Packing Cases. 1¼ In. Deal

Fig. 10.

not only unnecessary, but inconsistent with the data available. Charts for estimating purposes should be drawn to a liberal scale, upon tough paper or tracing-linen, and arranged in a binder with a suitable thumb index.

For the greatest utility their scope should not be too ambitious, and they should be so clear that in the majority of cases the results can be read without the aid of a pointer to trace them from one set of lines to the next.

By the use of logarithmically-divided base-lines almost any ordinary formula can be represented by parallel straight lines, the location of which can quickly be found, thus eliminating the labor and likelihood of error introduced when curved lines have to be fitted to plotted points; further, the parallel lines facilitate the reading of the chart.

The foregoing remarks and illustrations touch, of course, only the fringe of the subject, and are restricted to a definite type of machine. It is fairly certain, however, that once the estimator has constructed a set of charts upon the lines indicated, suited to his special needs, he will be able to find constant employment for them.

GRAPHITE FOR GERMANY.

Nearly 32,000 tons of graphite is imported by Germany annually. The average price of American graphite is $135.66 a ton at Hamburg.

PRODUCTION IN CANADA OF STRUCTURAL MATERIALS AND CLAY PRODUCTS.

The value of the production of mineral water in 1910 for which returns were received by the Department of Mines, Ottawa, was $199,563, as compared with a value of $175,173 in 1909. The imports of mineral and ærated waters in 1910 were valued at $202,306, as against a value of $184,071 in 1909.

The value of the production of natural gas in 1910 was $1,346,471, as compared with a value of $1,207,029 in 1909 and $1,012,660 in 1908. Shipments of peat for fuel purposes in 1910 were 841 tons valued at $2,604, as compared with 60 tons valued at $240 in 1909.

The production of crude petroleum shows another large falling off in 1910, the production being only 315,895 barrels or 11,056,337 gallons valued at $388,550; as compared with 420,755 barrels or 14,726,433 gallons valued at $559,604 in 1909. Exports of refined oil in 1910 were 2,818 gallons valued at $462, and 7,768 gallons valued at $934 in 1909.

While the production has been decreasing the imports have been increasing; the total output of the petroleum oils, crude and refined, in 1910 was 84,629,334 gallons valued at $4,826,763, in addition to 1,362,235 pounds of wax and candles valued at $80,106. The oil imports included: crude oil, 53,604,053 gallons valued at $1,639,358; refined and illuminating oils, 7,656,727 gallons valued at $502,364; gasoline, 16,679,691 gallons valued at $1,693,296; lubricating oils, 4,081,257 gallons valued at $718,381, and other petroleum products, 2,607,606 gallons valued at $273,364.

The total imports in 1909 were 58,317,101 gallons, valued at $3,353,311, in addition to 467,731 pounds of wax and candles valued at $40,689. The oil imports in 1909 included: crude oil, 35,884,103 gallons, valued at $1,186,400; refined and illuminating oils, 9,632,595 gallons, valued at $705,971; gasoline, 7,452,762 gallons, valued at $706,994; lubricating oils, 3,909,117 gallons, valued at $558,632, and other petroleum products 2,038,524 gallons valued at $195,314.

Phosphate, Pyrites and Quartz.

Shipments of phosphate or apatite in 1910 were 1,478 tons valued at $12,578, as compared with 998 tons valued at $8.054 in 1909. There were no exports reported in 1910, as against 895 tons valued at $15,735 in 1909. The imports of phosphate rock (fertilizer) in 1910 were valued at $72,950; phosphorus, 6,752 pounds valued at $2,065, and manufactured fertilizers valued at $388,467.

The production of pyrites in 1910 was 53,870 tons valued at $187,064, as compared with 64,644 tons valued at $222,812 in 1909. The exports of pyrites in 1910 were 30,434 tons valued at $110,071, as against exports of 35,798 tons valued at $156,644 in 1909. The imports of brimstone or sulphur in 1910 were 22,835 tons valued at $474,619, as against 22,887 tons valued at $458,961 in 1909.

The quartz production in 1910 was reported as 88,205 tons valued at $91,951, compared with a production in 1909 of 56,924 tons valued at $71,285. There were imported during 1910, 628 tons of silex or crystalized quartz, valued at $11,996, and, in 1909, 559 tons valued at $8,733.

Production of Salt, Talc and Tripolite.

The total sales of salt in 1910 were 84,092 tons valued at $409,624 (exclusive of packages). The value of the packages used was $173,446. In 1909 the sales were 84,037 tons valued at $415,219, and value of packages used, $175,612.

Exports of salt in 1910 were 275,200 pounds, valued at $2,618, and, in 1909, 276,765 pounds valued at $2,488. The total imports of salt in 1910 were valued at $462,061, and included: 20,174 tons valued at $97,326, subject to duty; and 108,794 tons valued at $364,735, duty free. The 1909 imports were valued at $431,221 and comprised: 112,554 tons of salt subject to duty, valued at $352,165; and 16,857 tons duty free, valued at $79,056.

The imports of soda products in 1910 included: soda ash or barilla 35,596,006 pounds, valued at $306,167; soda bichromate 878,777 pounds, valued at $32,842; caustic soda in packages of 25 pounds or more 13,848,170 pounds, valued at $260,938; sal soda 9,715,272 pounds, valued at $72,845, and sulphate of soda 17,728,543 pounds, valued at $95,054.

The production of talc increased from 4,350 tons, valued at $10,300, in 1909, to 7,112 tons, valued at $22,308, in 1910.

There was a production of 22 tons of tripolite, valued at $134, reported for 1910 and no production in 1909.

Structural Materials and Clay Products.

The total sales of cement in 1910 were 4,753,975 barrels, valued at $6,412,215, as against 4,067,709 barrels, valued at $5,345,802, sold in 1909, showing an increase of 686,266 barrels. The exports of cement in 1910 were valued at $12,914, compared with exports valued at $113,362 in 1909.

The imports of cement in 1910 included: manufactures of cement, valued at $7,718; hydraulic cement, 365 hundredweight, valued at $349; and Portland cement, 1,222,586 hundredweight (349,310 barrels) valued at $468,046. The imports in 1909 were: manufactures of cement, valued at $6,374; hydraulic cement, 682 hundredweight, valued at $614; and Portland cement, 497,678 hundredweight (142,194 barrels) valued at $166,669.

The consumption of Portland cement in Canada in 1910 was approximately 5,103,285 barrels, as compared with 4,209,903 barrels in 1909.

The total value of the production of clay products in Canada in 1910 was $7,629,956, as compared with a total value of $6,450,840 in 1909. Brick and tile products alone were valued in 1910 at $6,377,728, as against $5,327,815 in 1909. The value of sewerpipe production in 1910 was $774,110, as compared with $645,722 in 1909. The only clay products exported in 1910 were: 390,000 building brick, valued at $2,762, and the manufactures of clay valued at $9,061; against 365,000, valued at $2,255, in 1909, and manufactures valued at $979. The total imports of clay products in 1910 were valued at $4,331,397, and included: brick and tile valued at $1,755,773; earthenware and chinaware, $2,283,116, and clays valued at $292,508. The total imports in 1909 were valued at $3,247,539, comprising: brick and tile, $1,249,450; earthenware and chinaware, $1,781,759, and clays, $216,330.

Lime, Sand Lime Brick and Slate.

The total production of lime in 1910 was 5,848,146 bushels, valued at $1,137,079, as compared with 5,592,924 bushels, valued at $1,132,756, in 1909. The exports of lime in 1910 were valued at $44,762, as against exports valued at $48,821 in 1909. The imports of lime in 1910 were 212,502 barrels, valued at $138,847, and in 1909, 168,357 barrels, valued at $118,239.

The total sales of sand-lime brick in 1910 by 13 firms reporting were 44,593,541, valued at $371,857, an average value of $8.34 per thousand. The sales in 1909 by 9 firms reporting were 27,052,864 brick valued at $201,650, an average of $7.45 per thousand.

The production of slate in 1910 was 3,959 squares valued at $18,492, and 4,000 squares, valued at $19,000, in 1909.

The imports of slate in 1910 were valued at $142,285, and included: roofing slate, valued at $67,063; school writing slate, $31,397; slate pencils, $6,948, and manufactures of slate, $36,877.

The imports in 1909 were valued at $135,221, comprising: roofing slate, $71,914; school writing slate, $34,085; slate pencils, $6,154, and manufactures of slate, $23,068.

Stone Production of all Kinds.

The total value of the production of stone of all kinds, in 1910, was $3,650,019, as compared with a value of $3,127,135 in 1909. The value of stone exports in 1910 was $27,471, as against $59,370 in 1909; and the total value of stone imported in 1910 was $845,123, as against imports valued at $683,801 in 1909.

The production in 1910 included: granite valued at $739,516; limestone, $2,249,576; marble, $158,779, and sandstone, $502,148. In 1909 the production of granite was valued at $454,824; limestone, $2,139,691; marble, $158,441, and sandstone, $374,179.

Classifying the output according to the purposes for which the stone was used, the production in 1910 comprised: building stone, valued at $1,504,001; ornamental and monumental stone, $147,421; paving and curbstone, $239,668; rubble, $352,000; crushed stone, $975,379; and furnace flux, $431,550; while in 1909 the production included: building stone, valued at $1,170,550; ornamental and monumental stone, $306,338; paving and curbstone, $279,227; rubble, $303,120; crushed stone, $664,287, and furnace flux, $403,613.

NEW RAILWAY FOR NORTH-WESTERN CANADA.

Forty survey parties, consisting of 800 men with teams and pack horses, will be sent into the field at once from Edmonton to make preliminary surveys for the Northern Territorial Railway company's line from Edmonton to tidewater at Fort Churchill on Hudson's Bay. This is to be part of a system of 1,450 miles, from the Hudson's Bay country to Port Essington on the Pacific Coast, connecting Edmonton with Lac La Biche, Fort McMurray and Lake Athabasca.

H. G. H. Neville, C.E., chief engineer for the company, which is financed by a British syndicate and capitalized at $40,000,000, has covered every portion of the proposed route and is fully satisfied upon the engineering problems presented in the construction of the system.

The route is from a point at or near Fort Churchill or Fort Nelson on the Hudson's Bay, thence westerly to a point at or near the south shore of Lake Athabasca, in the province of Alberta, thence westerly and north of the Peace River block, thence southwesterly by the nearest possible route through the Rocky Mountains to a point on the Pacific Coast at or near Port Essington at or near the Portland Canal and from a point on the said railway near the crossing of the Athabasca River, in the province of Alberta, southerly to a point at or near Fort McMurray, thence southerly to a point at or near Lac La Biche, thence by the most feasible route to the city of Edmonton.

Plans are under way to begin grading work early next season, when the laying of rails will also be carried on, and in two years, according to present calculations, the line is to be in operation from Edmonton to the shore of Lake Athabasca, opening to commercial development the vast mineral and timber wealth of Alberta's farthest north. The company will then proceed with the construction of the line in the province of Saskatchewan. The Edmonton cut-off will be built later. The line from Lake Athabasca westerly will tap the rich agricultural resources of the newest north, continuing thence to the Pacific Coast.

The Northern Territorial Railway Company will operate a line of steamships from its Hudson's Bay terminal to a British port. Engineers in the employ of the corporation have made a study of the construction of ice-breakers in the Baltic and are now working on designs of vessels capable of meeting the abnormal conditions which prevail in Hudson's Bay.

RAILROAD EARNINGS.

The following are the railroad earnings for the week ended July 7th:—

	1911.	1912.	Increase or decrease.
C. P. R.	$2,096,000	$2,571,000	+ $475,000
G. T. R.	943,095	1,012,051	+ 68,956
C. N. R.	346,500	391,900	+ 45,400
T. & N. O. R.	28,547	28,272	— 275
Halifax Electric	5,696	5,808	+ 112

The following are the railroad earnings for the week ended July 14:—

	1911.	1912.	Increase or decrease.
C. P. R.	$2,170,000	$2,701,000	+ $531,000
G. T. R.	994,800	1,037,863	+ 430,063
C. N. R.	364,700	436,700	+ 72,000
T. & N. O. R.	28,241	26,699	— 1,542
Halifax Electric	5,270	5,686	+ 416

The Grand Trunk Railway has issued its statement of earnings and expenses for May and for the five months of the fiscal year. Taken altogether, the results are favorable, notwithstanding the fact that the revenue for this has been largely cut into owing to extraordinary outlays for extensions and improvements all over the system.

The roads in the Grand Trunk system report for May and five months as follows:—

Grand Trunk of Canada.

	1912.	1911.	Increase or decrease.
May gross	£691,700	£628,800	+ £62,900
Net	207,000	206,500	+ 500
Five months' gross	691,700	2,831,600	+ 221,500
Net	696,400	724,800	— 28,400

Canada Atlantic.

	1912.	1911.	
May gross	£ 41,500	£ 38,100	+ £ 3,400
Net	def 450	4,700	+ 3,250
Five months' gross	172,750	163,600	+ 9,150
Net	3,900	18,900	— 15,000

Grand Trunk Western

	1912.	1911.	
May gross	£114,500	£108,550	+ £ 5,950
Net	23,800	def. 150	+ 23,950
Five months' gross	549,600	552,350	— 2,750
Net	61,900	48,950	+ 12,950

Detroit, Grand Haven and Milwaukee.

	1912.	1911.	
May gross	£ 36,500	£ 34,500	+ £ 2,000
Net	800	def. 850	+ 1,650
Five months' gross	170,000	167,950	+ 2,050
Net def.	13,300	7,600	+ 5,700

While the annual statement of the Canadian Northern Railway is not yet prepared for publication, it will be shown that the gross earnings for the year ended June 7, will be approximately $21,000,000 compared with $16,360,000 for the previous year, an increase of $4,600,000.

The general increase in business through the West is reflected in the fact that this increase of 29 per cent. in earnings compares with an increase of only 15 per cent. over last year in the mileage of lines being operated. At present the road is operating 4,297 miles of line against 3,731 miles last year.

Particularly in the movement of grain have traffic conditions been good. Between sixty and seventy million bushels of grain were carried in the year by the Canadian Northern west of Port Arthur, an increase over last year of over fifty per cent.

Two hundred and sixty miles of track have now been completed west of Cochrane, Ont., on the National Transcontinental Railway, according to latest reports, and an average of a mile a day is being laid. Rails have been laid from Superior Junction to Winnipeg, leaving a distance of 184 miles yet to be covered with steel between the former point and the present rail-head west of Cochrane. Those in charge of the work expect to have the entire line between Cochrane and Winnipeg finished by the end of September.

EXPERT WOODSMAN REPORTS ON FOREST CONDITIONS.

The timber of the Hudson Bay region (the southern part of the old district of Keewatin) is a topic that has lately become of considerable interest. Interesting observations with regard to it are found in the 1911 report of the Director of Forestry, published as part of the annual report of the Department of the Interior for 1911. These are in continuation of the report on the timber along the proposed line of the Hudson Bay Railway, published as Bulletin No. 17 of the Forestry Branch.

Mr. J. T. Blackford, an experienced woodsman, acquainted with the conditions in the north, reports on the conditions of the forest around Oxford House, his explorations covering some 5,400 square miles of country. Of this only about 1,600 square miles bears merchantable timber; on the remaining 3,800 miles the timber has been burned. There is abundant evidence that the whole country was originally forested with spruce, tamarack, jack pine, balsam fir, birch and poplar, and on islands which have by their position been protected from fire are dense stands of trees two to three feet in diameter.

The areas, after the first burning, have usually been covered with dense growth of trees, but the debris left after the first almost invites a second fire. In many places fire has swept the country many times, impoverishing the soil, destroying all seed-trees, and with them all hope of a second forest. "During the summer," the report states, "Mr. Blackford found no commercial timber of any quantity, but he states that, except for fire, the country would be covered with timber two or three feet in diameter."

THE HOLDING POWER OF SPIKES.

Tests of the holding power of spikes in railroad ties and of the resistance of the wood fibre to indentation by tie-plates have been made during the past year at the Armour Institute by the Board of Supervising Engineers of the Chicago Traction lines. The results are presented in a recent report. The principal object of the spike tests was to determine the comparative holding power of the standard track spike and the screw spike. It was found that though the holding power of the screw spike is approximately three times that of the square spike, the relative holding powers in different timbers is such as to make the screw spike in treated pine fully equivalent to the standard spike in white oak. The tests of indentation of the tie plates showed that the ratio of resistance of a flat-bottom plate to that of a corrugated-bottom plate is much greater than the ratio of the bearing areas. The indentation of the corrugated plate is considerably greater for the same load per unit of surface contact. The tests also showed that chloride-of-zinc treatment of loblolly and short-leaf yellow pine increases the fibre strength to an extent making them compare favorably with the long-leaf yellow pine in resisting the indentation of tie plates.

PERSONAL.

MR. M. K. ALLEN has resigned from the position of city engineer of Regina, Sask.

ALD. CHISHOLM has resigned his position as chairman of the Board of Works, Toronto, to become property commissioner of the same city.

MR. G. A. DUDLEY, of Windsor, N.S., has been appointed to a position on the engineering staff of the St. John Valley Railroad.

MR. A. S. RUNCIMAN, who was with the Canadian Westinghouse Company, at Calgary, is now assistant superintendent of the electric light department of Prince Albert, Sask.

MR. FRANK E. BELFRY, of the firm of Thomson and Belfry, has been selected for the position of architect assistant superintendent of buildings under the Board of Education for the city of Toronto.

MR. R. S. LEA, Mem. Can. Soc. C.E., Mem. Am. Soc. C.E., M.I.C.E., has recently removed his office from 405 Dorchester Street West, to Room 820 New Birks Building, Montreal. Besides conducting a consulting practice of his own, Mr. Lea is associated with H. C. Ferguson, 200 Fifth Avenue, New York City, under the name of Lea and Ferguson, consulting engineers for paper and pulp mill equipment and hydraulic developments.

MR. ALEXANDER LESLIE BLACK has recently joined the firm of Ford, Bacon and Davis, 115 Broadway, New York, as engineer in charge of southern properties. Mr. Black graduated from the School of Mines, Columbia College, in 1890, leaving the college to go into mining work in Mexico. In 1894-5 he had charge of the reconstruction for electric operation of the St. Charles Street Railway, New Orleans, remaining with that company until 1901. Since that time he has been the engineer for the New Orleans Railway and Light Company.

OBITUARY.

MR. H. J. BEEMER is dead in England, according to a cable despatch. Mr. Beemer was born at Holmesdale, Pennsylvania, in 1848. He began business in New York with Smith and Ripley, who brought him to Canada over twenty years ago. His first work as a contractor was on the Ottawa Railway bridge, followed by portions of the Dufferin improvements at Quebec. Later, he constructed a number of railways, bridges and waterworks. He built the Canadian Pacific Railway bridge at Ottawa, the Ottawa and Gatineau Valley Railway, the Pontiac and Pacific Junction Railway, the Quebec and Lake St. John Railway, the Quebec and Montmorency Railway, now the St. Anne division of the Quebec Railway, the Light, Heat and Power Company's system in Quebec, a new water main for the city of Quebec, and the new St. Louis and Kent gates, also in Quebec.

MEETINGS.

The twelfth annual meeting of the Union of Canadian Municipalities will be held at Windsor, Ont., on August 27th, 28th and 29th. Among the speakers and their subjects are the president, Mr. J. W. McCready, Fredericton; Ald. Harris, Halifax, "Capital Cities"; City Engineer Doarn, Halifax, "The Cleaning of Water Mains"; Ald. Cannon, Quebec, "Electric Franchises"; Mayor Hebert, Sherbrooke, "The Operation of Public Utilities in Sherbrooke"; Ald. Boyd, Montreal, "Metropolitan Parks"; Mayor Hopewell, Ottawa, "The Georgian Bay Canal Water Powers"; S. Morley Wickett, Toronto, "Municipal Government by Commission"; G. A. Walters, Detroit, "Motion Pictures"; Controller Harvey, Winnipeg, "The Price of Cement"; Controller Cockburn, Winnipeg, "Winnipeg's Hydro-Electric Power Plant"; J. N. Bayne, Regina, "Municipal Progress in the West"; Mayor Spencer, Medicine Hat, "Good Roads and Their Effect Upon Rural Life"; Ald. Clarke, Edmonton, "Equable Municipal Taxation"; Ald. Hepburn, Vancouver, "Municipal Taxation"; Councillor Richardson, Point Gray, B.C., "Point Gray as a Model City."

CANADIAN FORESTRY ASSOCIATION CONVENTION.

Mr. James Lawler, of Ottawa, secretary of the Canadian Forestry Association, has just returned from Montreal and the city of Quebec, where he was making arrangements for the Dominion Forestry Convention to be held upon the invitation of the government of British Columbia, in Victoria, B.C., on September 4, 5 and 6. He found great interest being taken in this convention, in which Sir Richard McBride and Hon. W. R. Ross will personally take part, and which will be held in the best time to see the Pacific Coast and the prairies. Hon. Jules Allard, Minister of Lands and Forests for Quebec, has consented to attend and he will be accompanied by some of the officers of his department. Eastern lumbermen and forest engineers will also be well represented. The railways have granted greatly reduced rates for the return trip to Victoria to delegates. Mr. Lawler, who is looking after the arrangements, states that everything is looking well for one of the largest conventions ever held on the coast.

AMERICAN ROAD BUILDERS' ASSOCIATION CONVENTION.

The invitation extended by the mayor and the Commercial Association of the city of Cincinnati to the American Road Builders' Association to hold its ninth annual convention in that city has been accepted. The convention of the American Good Roads Congress, which is always held in connection with the convention, will, therefore, be held in Music Hall, Cincinnati, December 3, 4, 5 and 6.

In connection with the annual convention of the association, there will be held, as usual, an exhibition of machinery, materials and methods of road construction in Music Hall in space which has been set aside for the purpose. The building has a floor space of over 50,000 square feet and it is expected that all this space will be required for the exhibits. Not only will the manufacturers of material and machinery be represented in this exhibition, but the several states will have booths set aside for them in which they will exhibit models of roads, photographs, drawings, road materials, etc. This feature will be especially attractive to road builders. It is proposed, in fact, to make the exhibition practically an exposition of everything that pertains to road building and street paving in all their phases.

The American Road Builders' Association was organized in 1902. The president of the association is Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment of New York city; first vice-president, Harold Parker, ex-chairman of the Massachusetts State Highway Commission; treasurer, Major W. W. Crosby, consulting engineer of the Maryland State Highway Commission; secretary, E. L. Powers, editor and publisher of "Good Roads." Among the directors of the association are: W. A. McLean, provincial engineer of highways of Ontario; Arthur W. Dean, chief engineer, Massachusetts Highway Commission; S. D. Foster, chief engineer, State Highway Department of Pennsylvania; W. J. Roberts, State Highway Commissioner, of Washington; James H. MacDonald, State Highway Commissioner, of Connecticut; Austin B. Fletcher, State Highway Engineer, of California; John R. Rablin, chief engineer, Metropolitan Park Commission, of Boston; R. A. Meeker, State Highway Engineer, of New Jersey, and Wm. H. Connell, chief of the Bureau of Highways and Street Cleaning, of Philadelphia.

While the association is made up primarily of technical men, everyone interested in street and highway improvement is made welcome at its meetings.

COMING MEETINGS.

THE WESTERN CANADA IRRIGATION ASSOCIATION.—Sixth Annual Convention Kelowna, Okanagan Valley, B.C., August 13, 14, 15 and 16, 1912. Secretary, Normon S. Rankin, P.O. Box 1317, Calgary, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

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

EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.—Opening Meeting, Washington, D.C., September 4th, 1912. Other meetings, Business and Scientific, in New York, beginning Friday, September 6th, 1912 and ending September 13th, 1912. Secretary, Bernhard G. Hesse, Ph. D., 25 Broad Street, New York City.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. The Secretary, 150 Nassau St., New York.

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

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

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B.C. Headquarters: McGill University College, Vancouver.

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

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

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

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

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

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

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

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

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

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

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

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

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

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

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

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

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

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

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

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

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

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

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

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

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

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

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

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

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

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

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

ONTARIO ASSOCIATION OF ARCHITECTS.—President, A. F. Wickson; Toronto. Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

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

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

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

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

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Hon. W. R. Ross, Minister of Lands, B.C. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.