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AN EMERGENCY STOP-LOG APPARATUS

NOTES ON THE DESIGN OF THE SYSTEM TO BE USED ON THE TRENT CANAL — APPARATUS INCLUDES AN EIGHTY-FOOT SWING BRIDGE, TRAVELLING CARRIAGE AND WINCH CARRIAGE—ONE-MAN OPERATION.

THIS apparatus, as designed and used on the Trent Canal, is designed primarily to shut off the flow of water through the lock, should the gate be carried away, and also to serve as a coffer dam, should unwatering be necessary. It is an apparatus that is seldom used, but it must be instantly available, under all conditions of weather and at any time; hence great precautions were taken in its design to provide for any emergency. Also, as the distance between entrance walls is 33 feet a heavy log was indispensable, and its effect is necessarily carried through the structure.

The logs, as shown in Fig. 1, are of a built-up section and are provided with double rollers at each end to lessen the friction in raising and lowering. The total weight of each log is 5,800 pounds, and the pull required to raise is about 5,700 pounds at each end, for load and friction.

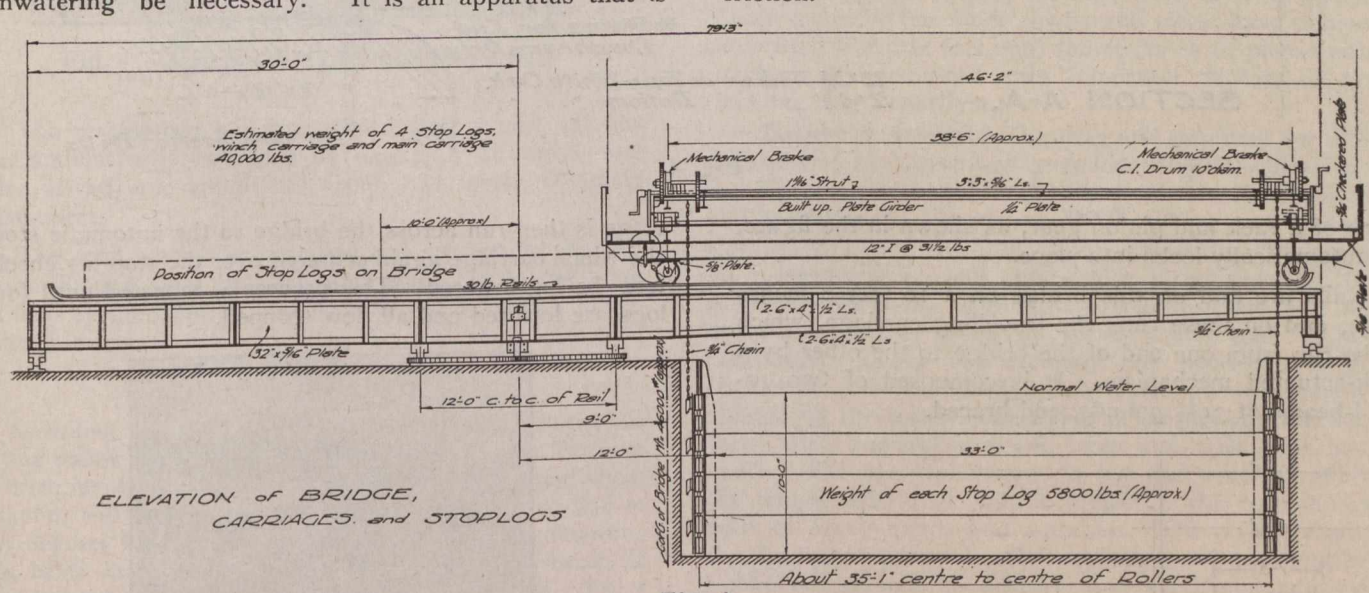

Fig. 1.

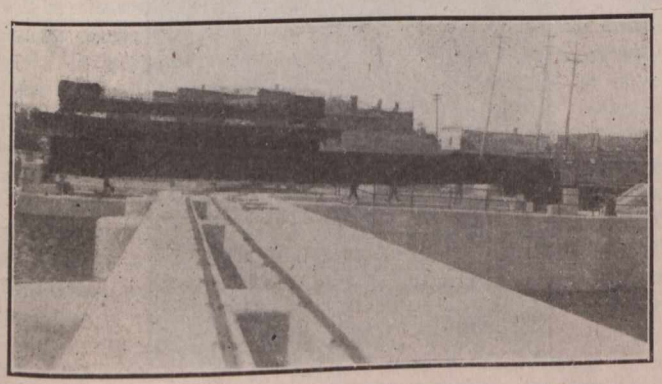

Fig. 2.—Normal Position on Entrance Wall.

The component parts are swing bridge, travelling carriage, winch carriage, and winch, as may be noted in the diagram of Fig. 4 and in the other illustrations.

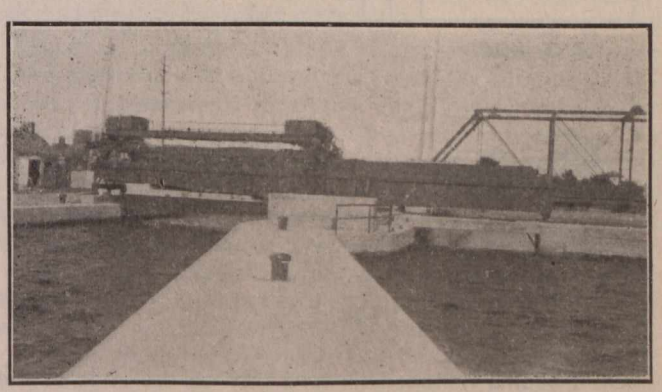

Fig. 3.—Apparatus Swung Across Channel, Lowering Stop-Log.

The swing bridge is pivoted on the upper entrance wall, and is 79 ft. 3 ins. over all. It is composed of 2 plate girders, as shown, spaced 10 ft. 6 ins. centre to

centre, and is braced transversely on the shore or anchor end, but with no lateral bracing on the channel span where it is held with an end brace frame. This leaves a clear aperture sufficiently large that the log may be dropped through. This bridge is swung across the channel by means of a rack and pinion gear, as shown in the figure, and automatically locks into place.

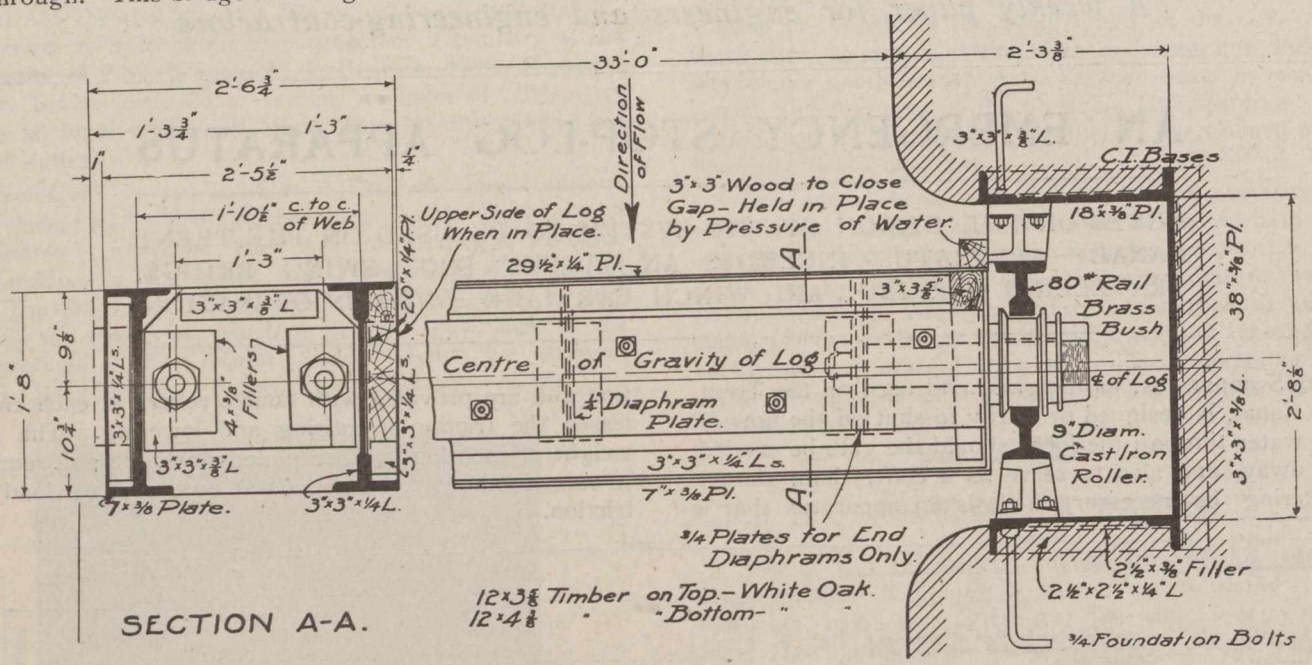

Fig. 4.

Rails are laid on this bridge on a 10 feet 6 inches gauge, and on these runs the travelling carriage, which can be run from one end of the bridge to the other by a crank-actuated mechanism. It is composed of two 12-inch I-beams at 31½ pounds, end braced.

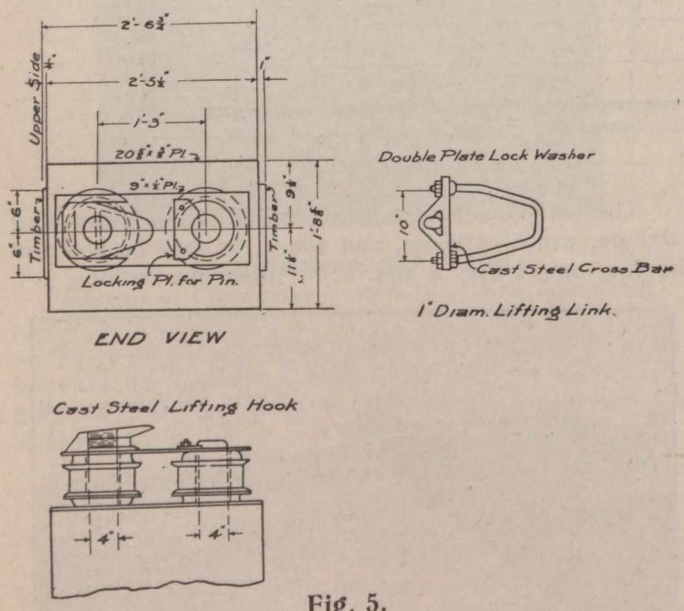

Fig. 5.

On I-beams fastened transversely on the ends of the travelling carriage the winch carriage runs. This carriage is made up of two built-up girders of ¼-inch plate and two 3-in. x 3-in. x 5/16-in. angles, and moves laterally the width of the travelling carriage. This carriage supports the winch. The method of operation is as follows: In its normal position on the upper entrance wall the four logs and travelling carriage rest on the shore end, and in this position the bridge is racked across the channel. The winch carriage is then centered over a log by its lateral motion, and by means of the winch the log is raised sufficiently to clear the floor. The travelling carriage is then run across the bridge to the automatic stop, the winch carriage again centered over the stop-log check, and the log lowered. This process is repeated until four logs are lowered and all flow stopped.

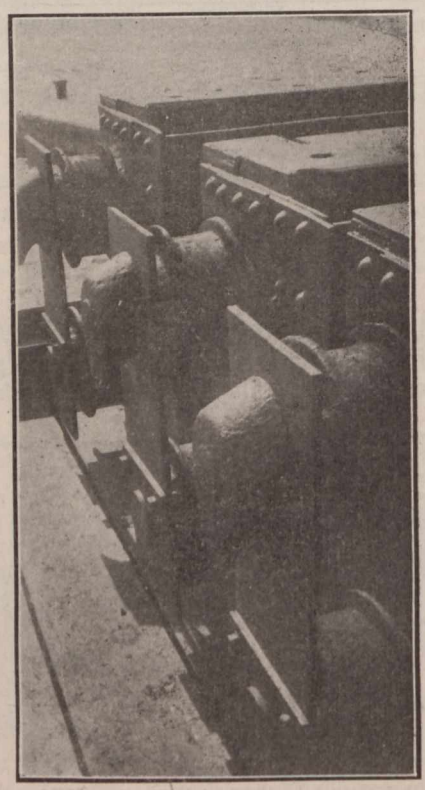

Fig. 6.—Detail of Ends of Logs on Bridge.

The whole operation can be performed by one man, but quicker gears are provided to be used if more men are available. As the majority of the reaches are of considerable size, both above and below the locks, speed in

shutting off the flow is not a highly important factor. However, the flow could be checked in twenty-five minutes, and completely shut off in an hour and a quarter.

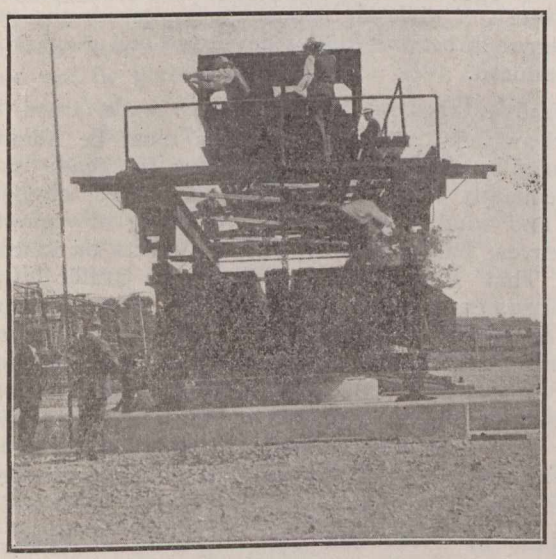

Fig. 7.—End View, Lowering Stop-Log.

The mechanism has been thoroughly tested. It has been satisfactorily operated by one man at night, and under all adverse conditions, and has given complete satisfaction.

The steel work was supplied and erected by the Dominion Bridge Co., Limited, and inspected in the shop and field by the Canadian Inspection and Testing Laboratories, Limited.

According to the United States Bureau of Standards, the melting points of fire brick are as follows: The most common fire brick, or those made of clay of which the main ingredient is kaolin, will melt at a temperature ranging from 2,831 to 3,137 degrees F.; bauxite brick, from 2,949 to 3,245 degrees; silica brick, from 3,092 to 3,101 degrees; chromite brick, at 3,722 degrees, and magnesia brick, at 4,929 degrees. These melting points, which represent the lowest temperature at which a small piece of the brick could be distinctly seen to flow, were determined in an electric vacuum furnace, the temperature being measured with an optical pyrometer.

The following is quoted from *Building Age;* "The freezing process in connection with excavations for the foundations of buildings appears to be something of a novelty in foreign countries, although many instances of it have occurred in America. The process, however, has recently been applied with economy and general satisfaction in Berlin, where the foundations of a large building had to be carried 10 ft. below the foundation of the abutting structures. As the latter were built on running sand, it was entirely out of the question to excavate for the new structure without special precautions, and the freezing process was adopted as an alternative to the pneumatic caisson method. Freezing pipes of 5-inch diameter were sunk around the space to be excavated and connected by headers with a brine pump and tanks. The cold brine was pumped through 1-inch pipes enclosed in the 5-inch pipes, and the brine was returned to the tanks through the latter. When the apparatus was put into operation the effect was to establish a stable barrier of frozen quicksand, permitting the foundation space to be excavated by ordinary means without difficulty."

TREE-PLANTING ON CITY STREETS.

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THE aims and objects of this paper are not so much to submit any fresh or original ideas on the subject as more particularly to awaken the civic conscience to a sense of its duty and obligation towards, and to enlist the sympathy of the public in, a matter which so much affects its personal and civic welfare. That there is a close connection between our civic well-being and the condition of our public places is generally conceded, and the relationship becomes increasingly more apparent as our public places are made more amenable and pleasurable through beautifying with well-kept boulevards and ornamental trees and shrubs. Although the subject is one which generally has the sympathy and approval of public and private bodies, as well as the majority of individuals, it is astonishing how little specific information there is concerning it, and how very little action is taken to make the matter a practical reality. So far as the West is concerned, the movement is in its infancy. While many of our older towns and cities have achieved something towards this end, the majority of places either overlook or disregard this important feature of civic planning and beautifying.

Design of Streets.—The uses and purposes for which streets and highways are intended may be classified in the following order of importance, viz., traffic, building and aesthetic considerations. While utility must of necessity precede aesthetics, the latter demands and deserves more consideration and attention in street planning than it usually receives. Although a well-designed and well-constructed street primarily serves traffic and building conditions, beauty and harmony are necessary to give the street character and tone. Such an atmosphere is created by the scenic beautifying of streets and thoroughfares with impressive shade trees and well kept boulevards. The accomplishment is not the work or skill of the single individual, but is indirectly the combined results of many minds and activities. The co-operation of the landscape gardener, the engineer, and a sympathetic public is essential to achieve any successful and satisfying results in street beautifying. Wise discretion, unlimited enthusiasm, and infinite patience are all necessary to further any beautifying scheme, and even after the designer and gardener have done their parts one has to watch and wait for results, for nature objects to be hustled and must have her own way.

Important preliminary steps in any permanent scheme for tree-planting and boulevarding are (a) the establishment of the permanent grades of the streets, and (b) the classification of streets, as far as possible, according to traffic and building requirements, present and prospective; (c) the proper proportioning of the street width to equally suit traffic and aesthetic conditions. While street trees can frequently be planted before the permanent grading by making due allowance for same, unless for merely temporary effect, it is not wise to carry out any extensive boulevarding until the permanent grade of same is fixed.

Where street widths have not been generally established, such as in this neighborhood, at a minimum width of 66 feet, they should be standardized and classified as business, residential, or semi-residential streets, and any construction or beautifying carried out along systematic lines to typical designs. To derive the best results and prettiest effects it is very essential to have the travelled roadbed, the sidewalk and the boulevard symmetrical pro-

portions of the entire street. While as wide a road reservation as possible is generally desirable, it is not good policy from either an aesthetic or economic standpoint to construct more than a certain proportion of the street for traffic purposes, but obviously this will depend upon whether it is a business or a residential street. Too frequently in narrowing the boulevard the aesthetic features of a street have been sacrificed for its utility. Just as the relationship of the roadbed, sidewalk and boulevard should be equalized, so should the disposition of the public utilities, existing or projected, be carefully planned so that the finished street shall be complete and in harmony with its component parts. The lack of judgment and foresight is seen in our neighboring cities, where matured trees have been wantonly cut down to make room for curbs, and also where in cutting sewer trenches the larger roots of the trees have been cut through, practically giving the death-blow to the tree. While such unfortunate instances are not always avoidable, regrettedly they are more in evidence than might be with careful and scientific planning of the entire street and its component parts.

In strictly business streets, or in streets where the boulevards are not sufficiently wide, the planting of shade trees is not to be commended. It is a question of trees versus traffic—one must make way for the other or both will suffer. Hence, unless for purely temporary effect, it is not a wise policy to plant trees in spaces more urgently required for roadway or sidewalk.

It is the most common of errors to provide trees with too narrow a planting strip for full development. Besides, the effect being crude or incomplete at maturity, the trees tend to force out curbs and undermine walks. The width of the parking strip will be somewhat affected by the species of the tree, but, generally speaking, a minimum width of six feet is to be recommended. On narrower spaces it would be preferable to substitute evergreen shrubs for shade trees. A factor which sadly militates against any street beautifying scheme is the presence of pole lines. Indeed, in most localities it is, or becomes, a question of pole system or tree system, as both cannot exist together harmoniously, the merciless lopping of branches and the stumping of beautiful trees interfering with wires being within common knowledge. This matter might be better controlled by limiting the height of the lowest wires above the ground to, say, 25 feet, or, better still, by enforcing the use of underground conduits.

Advantages of Tree-planting and Boulevards.—Commercially good streets regularly and systematically lined with beautiful trees are a paying investment, tending to increase the value of property abutting thereon. They are the index of a city's character and well-being, and attract the attention of the casual visitor or the prospective investor. Who that has visited Portland, Ore., is not favorably and delightfully impressed by the restful and refreshing atmosphere of its tree-lined and rose-girt residential thoroughfares?

Physically, trees have a beneficent effect on the atmosphere. In the heat of summer they serve the double purpose of cooling the air with the evaporation from their foliage and of affording protection from the sun's rays. In affording protection from the glare of streets and in tending to diminish the nuisances arising from noise and dust, trees add materially to the comfort of residents. The restfulness to the senses which their verdure, form and proportion produces is also a healthful influence. In short, shade trees add to the beauty, health, comfort, and charm particularly of residential districts and lend an air of dignity and repose to the thoroughfares therein. Socially, tree-planting and boulevarding foster civic welfare and further "community efficiency." The efforts and results are inspiring and contagious—property owners copying examples become imbued with the idea of beautifying the streets in which they live, move and have a good deal of their being—until the entire community has become affected and enthused. Thus is the sense of civic righteousness increased, the public taste elevated, beautiful cities developed and good citizenship produced.

Disadvantages of Trees.—That shade trees have their drawbacks and disadvantages must be admitted. Especially in rural districts they keep the roads damp, and frequently they do not admit of a free circulation of air and wind. The constant dripping of rain from their leaves has also deteriorating effects on macadam roads. That shade trees interfere with traffic is not a valid argument against their adoption, but invariably a result of injudicious planting or inefficient maintenance. Reference has already been made to the destructive effects of tree roots on curbs, sidewalk and pavements, and mention might also be made of instances where sewers have been rendered useless, but most of the above drawbacks could be avoided by foresight in the designing and planting of the trees.

Kinds of Trees and Characteristics of Each.—Although there is such a large variety of forest trees, comparatively few of them are suited to or adaptable for street planting, and altogether it is somewhat difficult to find a tree possessing all the desirable qualities for street use. Generally speaking, trees should be selected particularly with regard to locality, climate, quantity and quality of soil, extent of space and special environment. Hence shade trees suited or appropriate for one locality, or even for one street, might not be equally suited or appropriate for the neighboring locality or street.

Of the above requirements the nature and extent of the soil are of great importance. The most suitable soil is one which contains neither too much clay nor too much sand, but a proper proportion of both. A hole about three feet deep, with an area of not less than a square yard, is desirable to produce the best results, but obviously the depth and area of the hole will depend greatly on the size and nature of the tree. In any event it is important that the young tree should have ample room in which to properly develop. For the very best cultivation the use of prepared soil is recommended. The following are the general essential qualifications of a good street tree: It must be hardy and not adversely affected by extremes of temperature; it must be able to withstand spells of drought, the dust of rural districts, and the smoke and soot, etc., of cities. The hardier the tree, the less susceptible it will be to the insidious attacks of insects and borers. It should have such recuperative powers as to quickly recover from malicious or accidental injury. The best tree should have a straight, clean stem, with shady foliage and a compact root system. To fulfil its chief function it should be graceful in full leaf or when bare in winter, namely, the length of leaf period should be as long as obtainable, the finest trees being those which leaf early in spring and provide shade and beauty well into the fall. A too rapidly growing tree, being usually soft and brittle and short lived, is not always desirable. A slow-growing tree, having better staying qualities and being less liable to be broken by the wind, is to be preferred where the planting scheme is to be of a permanent nature. A good tree should not branch too low—8 to 10 feet from the ground is desirable in the interests of traffic. The foliage of a good tree should be attractive, but not too dense to prevent a free passage of air and sunlight.

Whatever types of shade trees are selected—and the selection demands the care and discrimination of the experienced—the following precautions should be observed to ensure the trees flourishing and eventually producing the best and happiest results. The trees should have been well nourished and tended in the nursery. They should not be planted in the street until they are about eight feet high, with the stem at least two inches thick. The stem should be clean and as straight as possible, and the entire tree symmetrical in shape. Trees about eight years old are preferable. If the ground and soil are not suitable, they should be made so; special treatment will be necessary in hardpan, where it is very essential that a hole should be made sufficiently wide to accommodate the roots of the tree in a well-advanced stage. Trees should not be planted any deeper than their original nursery marks indicate. Most trees flourish best when the tops are trimmed about a foot when planted, although many experts contend that young trees are best left to their own resources. It is generally wiser to erect proper wind protection shields, which will further tend to safeguard the trees from the ravages of animals and mischievous children. The age, nature and kind of tree and its environment will determine this matter. As moisture is next in importance to air in the nourishment of young trees, the roots should be well watered, especially during the first and second summers after planting. Sprinkling the foliage is also beneficial in removing the dust and soot therefrom.

In cities or districts where trees are to be planted extensively the establishment of corporation nurseries (which could be conveniently done in actual or prospective parks in play-grounds) will make for uniformity, efficiency and economy in tree-planting.

Setting-Out and Planting.—The setting-out and planting of shade trees are highly important matters so frequently ignored as to minimize the initial, and particularly the final effects. The spacing of shade trees will naturally depend upon their variety and nature and the extent of the boulevard. As a general rule they should be planted so far apart that at maturity they will not meet. Planting too close is the most prevalent error in setting out shade trees. In their desire to have immediate effect the inexperienced too frequently plant trees so close together that it is only a question of time before well-developed trees have to be cut down to make room for their neighbors. For permanent results it is better to err on the safe side and plant trees too far apart. Where temporary effect is the main object in view, trees and evergreen shrubs might be planted alternately and the shrubs transplanted when the trees begin to expand and require the maximum of space. Generally speaking, a spacing of from 30 to 40 feet should be adopted. As regards the distance from the property line, this will depend upon the width and layout of the street, but where possible a distance of from 10 to 12 feet is to be recommended.

To produce the most pleasing and aesthetic effects, shade trees should be planted at equal distances apart and on a line as parallel as possible to the curb or centre line of the street. It is a matter of opinion, but especially on the narrower streets trees should be planted alternately on opposite sides of the street. The practice of planting one kind of tree for one block and an entirely different type of tree on the next block on the same street, as has been adopted on the Grand Boulevard in North Vancouver, is not commendable, as naturally the different trees grow at different rates and in different shapes, and the results at maturity are unsymmetrical and the effects patchy at the best. Several sorts of trees of varying ages, sizes and shapes should not be adopted, although two kinds of a similar nature might with aesthetic advantage be planted alternately on the same street. Streets named after trees should, as far as practicable, be planted with trees to correspond. Very pretty after-effects can be produced if trees are properly and symmetrically disposed of at street intersections so as to produce the maximum of shade. Shade trees should not be planted in a careless and haphazard manner. As has already been said, the combined skill, taste, and experience of the engineer and the landscape gardener are essential to secure the most finished and most artistic effects. Truly, tree-planting and tree preservation is a science and not what it is too frequently thought to be, the easy, simple matter for the unskilled.

Maintenance of Trees.—Such necessary and important matters as the care and maintenance of shade trees are so often neglected for so long a time that frequently many originally fine trees are found to be beyond recovery. Trees should not be left wholly to their own resources, for with due care, constant watchfulness and regular attention they will flourish oftentimes in unfavorable conditions. Instances of trees having been stuck in rather than planted are too common, and in such cases, instead of being a thing of beauty and a joy forever, as often as not the carelessly planted and untended trees soon present a lifeless appearance and a sorry spectacle. Young trees should be regularly and properly trimmed, preferably in the late fall, all broken or rotten branches being removed. Any injuries to, or disease in, the bark should, however, receive prompt and careful attention whenever found necessary.

Trees affected by moths or insects should be sprayed at the proper season to keep the nuisance and blight from spreading. Where borers are the source of trouble special treatment will be necessary, "capital punishment" being, of course, most effective. Cavities in older trees, in which water and dirt lodge, tending to hasten decay of the tree trunk, have been successfully treated and the life of the tree thereby increased, by carefully filling with concrete. Reference has already been made to the necessity for regularly watering young trees during the summer months. Altogether, the "tree doctor" is an essential in successful tree culture.

In his Presidential address to the British Concrete Institute, Mr. E. P. Wells dealt with some practical matters connected with concrete construction. He urged the necessity of keeping a more careful watch on the cement used than had hitherto been done. During the past year it had been found in several cases that cement had been "air-slaked" to such an extent that it was almost useless for reinforced concrete work. Instances were mentioned of faulty storage by manufacturers' agents and of careless handling by builders, and it was suggested that cement should be brought on to the works in casks and stored in air-tight bins. Reference was made to the unsightly contraction cracks that took place in reinforced and other forms of concrete construction, but so far no remedy had been found. Some experiments had been promised to see whether it was not possible to stop cracking to a large extent, and if satisfactory the results would be given to the Institute. The extended use of reinforced concrete work in the Colonies, notably in New Zealand, was referred to, as was also the apparent slackening in the home production of steel. Touching upon the difficulty of obtaining assistants capable of designing reinforced concrete work, he stated that much of the inadequacy of reinforced concrete design was attributable to the inexperience and want of proper technical training among structural engineering draughtsmen.

LEGAL SUGGESTIONS RESPECTING ROAD CONTRACTS.*

By William Law Bowman, C.E., LL.B., New York City.

ETYMOLOGICALLY and technically the word "contract" should mean an agreement enforcible by law. "The Law of Contract may be described as an endeavor of the State . . . to establish a positive sanction for the expectation of good faith which has grown up in the mutual dealings of men of average rightmindedness." How do our present public contracts for road construction and their interpretation by officials satisfy these old definitions? As a part of the great work of properly linking our states and their cities and towns with uniformly good roads, it is incumbent upon us to better and if possible make uniform the contract conditions respecting the construction work and to secure that co-operation and esprit-de-corps between officials, engineers and contractors which alone will give us the best roads for the least money with a minimum of trouble and wasted energy. It has been wisely remarked that "you get only what you pay for" and in the long run that is as true in road construction work as in any other field.

Let us first consider some general principles respecting states, municipalities and roads which should be known in order to appreciate the special subjects which will be considered.

The state is a sovereign body and as such is not responsible by action at law or in equity. There are a few isolated cases holding that when a state goes outside its governmental capacity, it may then be used in the Federal Court. No dependence, however, can be placed upon these decisions by a contractor. The result is that a contractor with a state has no way to enforce his contract rights nor to secure redress against official oppression unless the state legislature has provided therefor. The best and usual plan is the formation by the legislature of a court or board of claims to hear and determine claims against the state, its departments and boards. One state allows a contractor to sue it, provided the legislature passes a special bill for the specific matter. The value of that right is well illustrated by a statement made to the writer by an offending official that when he got through with the matter I would have to have more political influence than he thought I had in order to get such a bill through the legislature. It is also the general rule that in such instances the offending official himself is beyond the legal reach of the contractor. Thus it is that except in those states having a court or board of claims, official oppression and even financial ruin can be honestly or dishonestly caused without any hope or prevention or redress for the contractor. A so-called agreement where the contractor depends solely upon the action of an official and his engineer should not be called a contract. It violates the true meaning and our understanding of that term. This inability of a contractor to enforce his contract rights or even to demand fair play and justice cannot but be detrimental to good economical road construction. Under such circumstances the work becomes political—only favorites dare bid or accept contracts—and the other results of political work naturally follow.

Due to this fact that most states could not and still cannot be compelled to live up to their contract conditions, the terms of a state contract have been considered practically unimportant by the contractor. He knew that he must follow the direction the plans and specifications called for. While conscientious and honest officials and engineers predominate in state work, yet they at times need the restraint which a chance to be heard by the contractor affords. Furthermore, the atmosphere and the mental attitude of all concerned is bad in such a situation. Those opposed to granting the contractor this right to properly and legally present his claims before a disinterested court or party will be interested to know that even so great a sovereign as Emperor William of Germany last year lost an action to one of his tenants in the German Supreme Court over the value of certain improvements. Therefore, unless a state has a board or court of claims open at all times to those contracting with the state, its departments and boards, or unless it provides for a submission to an impartial and disinterested arbitrator or arbitrators any changes in the present state contracts that are discussed or suggested will, of course, be useless except as they may influence the controlling official. In this connection it has been very noticeable that both the judges and the juries favor the state or municipality when they are sued. This is even found where it is necessary to construe the iron-clad terms and conditions of our present day one-sided agreements which are required to be signed by those desiring to engage in public work and where it would be expected there would be some sympathy for the contractor. In all seriousness, then, it is submitted that there seems to be no logical reason why the contractor should not be given an opportunity to get a square deal if he believes he is not being fairly or honestly dealt with.

Municipalities are the legal creatures of the legislature, and their powers and rights must be found in the law creating them. Throughout this paper the term municipalities will signify cities, counties, towns, boroughs, road districts, etc. As a governmental agent, a municipality is immune in respect to mere errors of judgment, but in its ministerial capacity it is liable for consequences of negligence and maladministration. As regards plans for public improvements some courts attribute negligence to a municipality in the adoption of a defective plan and the test of the liability of a municipality which causes injury is not the fitness of the engineer, but the efficiency of the work. Where a defective plan is the result of bad faith or oppression or is so clearly unreasonable as to inflict needless injury, a court may enjoin performance, or, if the work is completed, hold the municipality responsible.

Roads are in the control of the state. In doing road work a municipality acts as the agent of the state performing a public duty imposed by law. On this account those dealing with either roads or municipalities must ascertain the legislative acts pertaining thereto as a basis for any serious investigation. In determining the powers or rights conferred by such statutes the investigator must remember that the wording of the law will be strictly adhered to and that the tendency is to restrict powers granted and to deny any implied powers or rights.

Since a contract may be either wholly void or voidable at the option of the state or municipality unless certain preliminary steps are properly taken, and since in such instances it usually results in a total or partial loss to the contractor of his compensation for work done and material furnished it is essential that a brief warning in this regard should be given.

*Read at American Road Congress, Detroit, Mich., Sept. 29 to Oct. 4, 1913.

With respect to roads; the proceedings to acquire the land; the report upon the advisability of a road; the estimate of the cost; the description of the road; the survey and resurvey; the proper sanction of the voters or taxpayers; the proper formation and action of the boards or courts, etc., all must be in compliance with the statutes and laws pertaining thereto. In addition the actual preliminaries to the contract itself must be regularly and legally complied with:—A proper and sufficient appropriation or available funds; a proper advertisement for bidders; a proper letting to a proper party; a properly constituted board or official acting strictly in accordance with its or his authority; a proper bond for performance, etc. The contract itself must be in the required form properly executed, for the purposes allowed by the special statute, with proper persons entitled both to give and to have such contract and in accordance and in conformity with the preliminary reports, plans, specifications, survey, description, etc. As has been previously stated, failures, omissions, or negligence on the part of any of the state or municipal officials or agents in the above respects may cause the contractor to lose his compensation for work done and for benefits actually conferred by the contractor. There are some decisions and some statutes which are based on equity to prevent such unjust enrichment of such bodies at the expense of a contractor, but it is not safe to rely on such law in any particular instance. The general rule may be likened to the ancient rule of "caveat emptor" or, as it might be expressed here, "let the contractor beware." This warning, while primarily for the contractor, should be taken to heart by the official who is trying to do right and be honest, since usually he is the unfortunate party that causes the contractor's troubles and losses.

Contracts.—As we have already seen, most present day state contracts for road construction are not really "contracts," because of the inability of the contractor to sue thereon. In addition, I have also seen one state contract which stated that "all right or rights of any action at law or in equity under or by virtue of this contract and all matter connected with it and relative to the same are hereby expressly waived by the contractor." Practically the same result is accomplished by other states and especially by municipalities by the requirement that upon or before final payment the contractor must execute a release in full of all claims arising out of or by reason of the work done and material furnished under the contracts. Is this *good* faith in the dealings of men of average right-mindedness? I cannot conceive of but one answer to this question. The remedy then is simple. Provide either fair and disinterested boards of arbitration to pass upon a contractor's claims or provide a court of claims and eliminate any waiver of appeal to such arbitrators or court and the general release as a condition precedent to final payment from all road construction contracts. In other words, give the contractor a chance for a square deal upon a two-sided mutually agreeable contract. In passing, it might be noted that the United States Government is probably the worst offender in this matter of unfair and objectionable clauses, including that requiring a release, and it is setting a disgraceful example for the states and municipalities.

Satisfaction Clauses.—It is probably a safe statement that there is no state or municipal contract in use to-day which does not provide for the "satisfaction" of some official, board or engineer or all combined. Is this a necessary, fair and honest requirement in road construction contracts, or is it merely a club to compel the contractor to do what the official or engineer wants regardless of the plans and specifications?

In most states it has been properly held that this requirement merely necessitates work satisfactory to the mind of a reasonable man. Thus if the work has been performed substantially in compliance with the contract, the law will hold the official, engineer, etc., to be satisfied. With plans and specifications so clear and concise as they generally are in road construction, and especially with the work required to be done "under the direction" of an engineer and under constant inspection, it would seem that legal satisfaction would be presumed in 99 out of 100 cases, and hence the use made of this requirement in such states would be merely to bluff or bulldoze the contractor. In no way does it improve the requirements of the plans and specifications.

In such a state as Pennsylvania, where work can be held unsatisfactory by the official or engineer even though the plans and specifications are rigidly adhered to and where only honesty of purpose is required, the result of such a contract requirement may be heartbreaking. Under the guise of dissatisfaction I have known an official in that state to deliberately violate every essential provision of an agreement and to settle at his own figure with the contractor; or, in plain English, to rob the contractor not only of his contract right but also of thousands in money with no redress. A contractor who accepts state work in a state where this personal satisfaction of private taste in road construction is required must understand that he is at the beck and call of the official or engineer regardless of his contract requirements and conditions. What could the contractor in such a state do when he has to satisfy not only the engineer in charge, but the Road Commission and a state board? Suppose the work satisfied one and not the other two, or two and not the third party?

Our considerations recommend that "satisfactory" requirements be dropped from road construction contracts as either unnecessary, harmful or unfair and as not being a sanction for the expectation of good faith between men of average right-mindedness.

Contract Work.—In looking over many of the latest forms of road construction contracts it is noticeable that there is a very decided improvement in the manner and method of setting forth the contract work and specifying what is variously designated as alteration, addition, miscellaneous, or extra work, etc. Road work is now generally specified in various units and a price bid for each respective unit. In one such contract we find this definition: "Extra work is any work in connection with the execution or completion of the contract for which no price is included in the proposal sheets and contracts." Compare this simple and concise statement with a New York City form which had different requirements for ordering additional work as differentiated from extra work, the distinction not being stated and being such that there would be times when the average engineer or contractor would not know to which class the work belonged to. Result—the contractor would be refused payment for additional work done pursuant to extra work requirements or vice versa.

In the same regard why should a contractor, as is now frequently demanded, be responsible for unknown or underground conditions? Just lately in New York City a paving contractor found a lot of rock above grade which should have been taken out by a prior grading contractor. Under notice to bidders to examine the site, etc., the

Court of Appeals held that the plans of the completed grading contract on file in the city offices did not constitute a representation to bidders of the condition of the road bed and hence the paving contractor had to do this work of grading without extra compensation.

Let us, then, have definite contract units of work at unit payments clearly specified, and provide payment for any other work necessary which may arise either at the unit prices or, as is becoming popular, upon a percentage basis. This latter method seems a fair means of providing for extra work as hereinbefore defined but the contract must specify exactly what is to be considered the "cost" upon which the percentage is based, as there is great difference of opinion on the subject. For example, in one state, the statute provides for certain construction work at cost plus 15%. There being no provision against subletting, the actual work was done by subcontractors at a fixed price. The "cost," as sustained by the highest court, included the cost to the contractor for the work as agreed and paid to the subcontractor, the contractor's overhead expenses for supervision, engineering, office rent, etc. In this way the state actually paid 53⅓% on the actual cost of labor and materials at the job which is the popular conception of the word "cost" in percentage contracts. The rules of law applicable to percentage contracts are the same as those to the ordinary lump sum contracts. Under proper contract conditions with definite plans and specifications and with honest officials and contractors, contracts on the percentage basis of "cost of labor and materials at the job" would, in my opinion, give as wide scope for competitive bidding and should give better results in actual construction work. It should do away with many of the conflicts now common between the official, the engineer, or both, and the contractor. The tendency would also be to give closer competition between the large corporation with heavy overhead charges and the small concern with practically no such expenses. There would seem to be no question but what in the long run this would be less expensive to the municipality because it would tend to cut out the contracts with enormous profits and at the same time lessen the broken contracts because no contract should be given out for less than the defined "cost" price. This is merely a suggestion in passing, but I should like to see it given a fair trial.

Duties of the Engineer.—Under most of our road construction contracts the engineer takes his time-honored dual capacity of agent for the state or municipality and arbitrator between the contracting parties. It has been noted that if the contract provides that the engineer will make an estimate and issue a certificate he will often do so where he may refuse if such wording is not used. There is no question but what the engineer is given too much "discretion" under our present contracts. In road construction work there would seem to be no excuse for a lack of definite plans and specifications which of themselves should reduce the engineer's discretion to a minimum.

There always will be objections to the salaried or paid engineer of a state or municipality acting as an arbitrator without appeal as is the result accomplished by practically all state and municipal contracts. Upon the wording of such contracts some courts have even gone to the extent of holding the contractor but not the state or municipality bound by the engineer's decisions within the scope of his authority. Clearly such a result is unjust. In addition to this, state and municipal contracts are so replete with oppressive or "club" clauses for the engineer that a contractor knows he must take care of that official one way or another. It has been well said that no man should be placed in such a position where bribery and graft is often the easiest and cheapest solution of differences or disputes. Whether or not the engineer is an arbitrator depends upon the strict wording of the pertinent clauses of the contract. All such clauses will be strictly considered and no implied powers will be given the engineer. Where an engineer is made an arbitrator he must remember that he has greater powers than the judges on the bench, because he may intentionally decide contrary to the law and still have his judgment stand. On this account an engineer's decisions should be beyond reproach. The fact that in the exercise of his duties as arbitrator he cannot be held legally responsible for lack of skill, carelessness and even negligence should create an ambition to merit the honor bestowed. The engineer should never forget that he is, under present day clauses, taking the place of the court and that his action may close the door to either party to appeal from his decision. Professional honor and reputation often depends more upon the engineer's action in such matters than upon his pure engineering knowledge. However, the engineer must know that he cannot ordinarily deprive the contractor of his right to judicial construction of the contract after it has been performed so far as such construction involves matters of law. These considerations show us that the engineer holds under our present day construction contracts an almost impossible position for a human being. Would it not be better to relieve him of some of these onerous duties? Experience seems to show that better feeling, better work, and co-operation between the engineer and contractor may be secured by more precise, concise and definite plans and specifications, and the elimination of all unnecessary "discretion" and "arbitration without appeal" clauses respecting the engineer.

Construction of Contracts.—Since we cannot expect any sudden change in present road construction contracts, this paper would not be complete without a statement of some of the most general legal principles which should govern the actions of officials and engineers even if the contractor cannot sue or get a fair hearing for his side. Since all state and municipal contracts emanate from the contracting official the ordinary rule is that the contract provisions should be construed most strongly against the author. Especially is that so when such construction is necessary to save a contractor from fraud and injustice, or where, as in these contracts, one party is at the mercy of the other. The following instances where municipalities have been held responsible in damages on account of the actions and orders of officials and engineers should be known and avoided:—

(*a*) Mistakes in lines, grades, elevations, plans or specifications or directions whereby the contractor had either to do additional work or do over work already done.

(*b*) Requirement that the contractor do the work in a way not called for by the contract, entailing more expensive work than would customarily or otherwise be entailed.

(*c*) Requirement that the contractor do over work already done properly or repair or maintain the same unreasonably.

(*d*) Requirement that the contractor do work not within his contract as contract work.

(*e*) Refusal to permit contractor to perform work called for by his contract.

A substantial performance of a contract creates a situation where the contractor is entitled to his full con-

tract price less the expense of supplying the omissions and defects. From a study of cases all over the country the following rule would seem practical for contracts under $25,000. Provided the contractor has honestly attempted to complete his contract, and particularly when he has followed the directions of the official or engineer, and when the omissions or defects do not pervade the whole work or make the object of the parties impossible or difficult of accomplishment, or when the usefulness or value of the construction is not materially impaired, and provided the cost or reasonable value of correcting such defects or omissions does not exceed 6% of the contract price, then there has been a substantial performance. No practical working rule can be given for contracts over $25,000. Substantial performance also excuses the production of an engineer's certificate.

In this connection it is important to note that in correcting defects, supplying omissions or completing a contract the state or municipality becomes bound by the terms of the contract and its plans and specifications. For example, if the contract permitted the use of native stone the state cannot use trap rock and expect to charge that against the contractor. In such instances a burden is imposed upon the official to complete the performance in good faith pursuant to all the contract provisions and with reasonable care and regard to the rights of the contractor. There seems to be a tendency on the part of some officials to make an example of a contractor who has defaulted. Their chief object often seems to be to spend all the retains and, if possible, all they think they can collect on the contractor's bond. This is neither legal nor honest. The completion work must be done diligently, and the damages mitigated as much as possible. High-priced men cannot be used for cheap labor, nor can completion be delayed until market prices have risen. Thus it has even been held that a municipality was bound by the date of completion when it assumed a contract.

If a contract calls for liquidated damages for delay after a specified date, such damages are waived or are not recoverable by the state or municipality where they render the contract incapable of performance within the specified time or where they assume as agents of the contractor to complete the contract. Similarly if the delay after a specified date is caused, both by the state or municipality and the contractor, the liquidated damages cannot be apportioned. It has been held that a city cannot retain a substantial sum under the guise of liquidated damages for delay when in fact only nominal damages have been sustained. Where the liquidated damage clause falls, then actual damages caused by the contractor must be proved as an offset. There is still one very important matter pertinent in this respect. Where a contractor follows detailed plans and specifications and the directions of the engineer and completes any part or all the work there should be no deductions for variations from the contract since the parties have practically construed the contract as one for work in accordance with the engineer's directions and such construction must prevail over the literal meaning of the contract. Also under these same conditions and circumstances a contractor is not responsible for a result nor is he responsible for any defects or repairs (except where there is a repair clause) beyond those required by the failure of the contractor's materials or by the contractor's own work. In other words, a road contractor usually does not warrant the road as capable of standing any particular traffic, etc., that should be determined by the plans and specifications.

Naturally the most important thing to the contractor is prompt payment, not only of his partial but also of his final payment. It is a general rule of law that a failure of a state or municipality to pay an instalment on the due date causes a breach of contract which relieves the contractor from further performance and enables him to collect the contract price or reasonable value of all work done to date. The failure of the engineer to make his estimate and issue his certificate may not excuse a failure to pay partial payments even if they are required to be made only upon engineer's certificates. The refusal of an engineer, under ordinary circumstances where there has been work done, to make his estimate and issue his certificate in time so that the contract payment can be made is of itself presumptively fraudulent. Again, it is often found to be the case that the engineer refuses to act upon the direction of the official, which, of course, is collusion, and which excuses the production of such certificate. It is a rule of law that an engineer's certificate will not be considered as a condition precedent to a partial or final payment unless it is definitely and distinctly stated so to be in the contract. The control of the money bag is often supreme and in this way engineers and officials have it in their power to make or break a contractor. A reputation of an engineer for prompt and fair estimates and of an official for prompt payments is sure to result in lower bids and better construction work.

Having considered these few most important matters and with an understanding of the legal principles involved cannot we in the future have justice and equity and not vengeance, spite or bossism in road construction work? The result of such a change, where it is necessary, cannot but be beneficial to all concerned.

Repairs.—There seems to be a tendency in some of the present day road contracts to require a contractor to maintain the road for a specified length of time, usually one to five years. Is that a good and economical requirement? Does it not, to a certain extent, restrict bidding and contracting to local parties? Are not the unit prices and hence the contract total largely increased to take care of an unknown amount of repairs? Is there not a gamble on that matter? The best of roads require constant inspection and repairing to keep them in shape. That work should be done either under a strictly repair contract or by the state or municipality itself. This criticism, of course, is more applicable to country roads as differentiated from city streets.

Summary.—In a late article of mine advising architects respecting employment by state or municipalities the following rules were formulated which would seem pertinent here:

(1) Know that the municipal corporation is acting pursuant to the law creating it.

(2) Know that your contract does not cause the indebtedness of the municipality to exceed its constitutional or statutory limit.

(3) Know that your contract does not exceed a limit above which advertisement and acceptance of the lowest bidder is required or that proper advertising, awarding, etc., has been done.

(4) Know that assessments or taxes to pay for public improvement work which include your compensation are valid.

(5) Know that the board or official employing you do so in the proper legal method required by the oct incorporating the body or by the charter or by the local rules governing such body.

(6) Know that funds are available or a specific appropriation made by the proper authorities to pay you before proceeding with your contract work.

(7) Have your contract in writing and know that it is worded properly.

(8) Have and put everything in writing and act only upon the strict wording of all contracts.

(9) In state work ascertain first if there is a state board or court of claims; if not you must depend on the official honesty and integrity of the official with whom you deal. Remember personal honesty and official honesty are contradications in some officials.

(10) Never consider or do any public work without first consulting competent legal advice.

While the above advice for the contractor will give him some knowledge of his position in a road contract, yet it does not protect him from the many abuses now possible under such contracts. Those must be corrected by honest, conscientious officials who will countenance only the same character of engineers. Contracts and general specification conditions for road work must be drawn solely for that class of work and not copied slavishly from ancient documents used for buildings, etc. There must be no discrepancy between the contract clauses and the general conditions or other parts of the specifications. Unit prices for unit quantities of specified work with full details in the plans and specifications or cost plus percentage contracts for definite work with opportunities for honest, competitive bidding and awards to lowest bidders are essential. All unnecessary "satisfaction," "discretion," "warranty," "final and conclusive decision," "waiver of damages," "waiver of claims," "waiver of right of action," etc., clauses and other similar oppressive or "club" clauses for the official and engineer must be eliminated. They certainly are anything but a sanction for the expectation of good faith . . . in the mutual dealings of men of average right-mindedness. Lastly, and most important, the agreement between the parties must be made a real contract by giving the contractor the power to assert and prove his claims before a competent court or board.

It is probable that next year a commencement will be made with the construction of the railway bridge between Rugen and the mainland, which will be the longest in the world, exceeding even that over the Hohangho, with its 3,580 yards. The cost of this great engineering work is not expected to amount to more than $5,000,000, or less than a third of that on the Forth bridge. When the bridge, which, it is said, is to include a track for pedestrians, though none for road traffic, is completed it will substantially shorten the journeys between Berlin and Hamburg on the one hand, and Stockholm and Christiania on the other.

The value of the mineral production of Queensland for 1912, according to the annual report of the Minister for Mines, was £4,175,355, including coal. The increase over the preceding year was £514,292, due to the stimulating influence of high prices for metals, together with a noticeable advance in the yield of copper, tin and other minerals. The value of the gold yield for the year was £1,477,979, less than that of copper, and a decrease from 1911. Mount Morgan continues to be the leading mine. Of the copper mines, the Cloncurry is the foremost producer, making a contribution of 10,435 tons. The total copper production was 23,120 tons. While prospecting for tin was active, there were no new discoveries of importance made during the year. The tin-ore production was 3,230 tons, valued at £364,503. The silver production was 569,181 oz. Lead, tungsten, manganese, bismuth, molybdenite, opal and other gems were also produced.

A NEW PROCESS OF CLEANING PRODUCER GAS.

IN 1902 Mr. H. F. Smith, Mem. Am. Soc. M.E., instituted a series of investigations to determine the nature of the mechanical impurities present in producer gas from bituminous coal with a view to devising more effective methods for their removal. These investigations have since been continued and have resulted in the development of a commercial apparatus involving some new and interesting principles which are described in the following article, recently presented as a paper to the American Society of Mechanical Engineers, and appearing in the Journal of the Society:

The tar and other mechanical impurities present in raw bituminous producer gas are in an extreme state of subdivision. The number of particles present is so great and the quantity of gas to be handled in commercial plants so large that the problem presents more than ordinary difficulties. The effectiveness of the ordinary types of mechanical gas washers and purifiers leaves much to be desired. The primary object has accordingly been to produce equipment that will be capable of yielding gas of a higher degree of cleanness than obtainable by ordinary

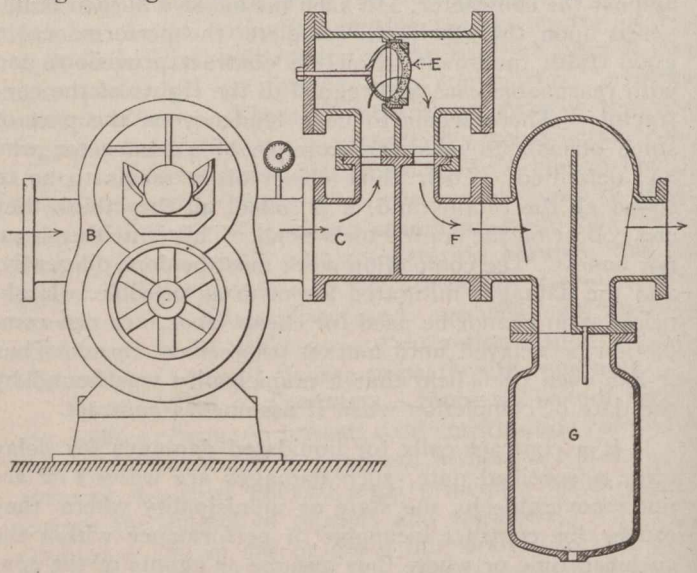

Fig. 1.—Static Scrubber Layout.

methods. The apparatus in its present stage of development can be readily understood from Fig. 1.

The raw producer gas, on leaving the producer, is first cooled to a point where the tar vapors are condensed by being passed through a primary cooler or condenser. From this the gas is carried into an ordinary rotary gas pump *B* which delivers the gas under pressure into the main *C*; it is then delivered through a porous diaphragm *E* and discharged from there into the main *F*. A sump or separator *G* is provided in which the tar accumulates.

The structure of the diaphragm *E* is a matter of considerable importance for the successful carrying out of this process and the materials used seem to have an important bearing on the operation of the equipment. The diaphragm must be sufficiently porous to permit the gas and tar to pass freely, otherwise it will soon become blocked with deposits from the gas and fail to operate. Many materials may be used for this purpose, but at present spun glass is preferred. The glass fibres are not only entirely unaltered by chemical action but seem to possess the necessary physical properties for the successful carrying on of this process. The spun glass in the form of ordinary glass wool (which should be carefully distinguish-

ed from slag wool, as the latter is not practicable for this purpose) is built into the form of a uniform diaphragm and is retained between two metal screens. The density of the diaphragm can be regulated by the quantity of glass used and by the degree of compression maintained between the metal screens. Ordinarily, this diaphragm is made up to a thickness of approximately one-quarter of an inch. The diameter of the diaphragm must be adjusted in accordance with the quantity of gas to be treated. Ordinarily, about 400 cu. ft. per hr. can be handled for each square inch of diaphragm area. No tar is retained in the diaphragm, both tar and gas being discharged together.

In passing the diaphragm an important change in the physical state of the tar occurs. On the entering side the tar exists in a large number of minute particles, ordinarily known as tar fog. In passing the diaphragm these particles are caused to coalesce so that on the discharge side the tar particles are of relatively large dimensions, so large in fact that they can no longer be carried forward in the gas current and immediately separate out by gravity. All that is necessary for the complete separation of the tar from the gas is to provide a sump, or drip, into which the precipitated tar can drain.

It appears to be possible to secure almost any desired degree of gas cleanness simply by regulating the pressure maintained across the diaphragm. In ordinary commercial operation, it is found that a difference in pressure of from 2½ to 4 lb. will give a degree of gas cleanness that is ample for any commercial requirement. Thirty cubic feet of gas cleaned in this way can be passed through a white filter paper without producing any discoloration.

The distinction between this process and the process of purification by filtration can be best shown by outlining the conditions essential for each process:

(1) In filtration the best separation is secured when the rate at which the materials to be separated pass the filtering medium is slow. One of the substances to be separated remains in the filter.

(2) In the process in question good results can be secured only when the velocity of the gas passing through the diaphragm is very high. Nothing whatever remains in the diaphragm.

At low velocities the gas will pass through the porous diaphragm used in this apparatus without any apparent alteration, and the degree of effectiveness of cleaning is directly related to the velocity of flow. For example, the degree of cleanness produced with the velocity of flow resulting from 1 lb. pressure, and when the velocities are as low as those produced by a pressure of a few ounces only, there is no perceptible change in the tar content of the gas after passing through the diaphragm.

No water is used in connection with this process except that required to cool the gas. As a consequence there is no production of tar emulsion and the water flows from the condenser perfectly clear. The tar separated by this process is practically water free, and can accordingly be used for any purpose to which cool tar is adaptable. One sample of tar drawn directly from the receiver showed on distillation a water content of less than 1 per cent. as compared with from 20 to 60 per cent. which is ordinarily present in gas producer tar from mechanical washers. The calorific value of producer tar from Hocking coal is approximately 15,800 B.t.u. per lb., about 140,000 B.t.u. per gal.

For the maintenance of continuous operation the tar must be sufficiently fluid to pass through the porous diaphragm without creating undue resistance, and therefore it is necessary to maintain the temperature of the gas entering the diaphragm at a point that will reduce the viscosity of the tar to as low a point as is consistent with complete condensation of the tar vapors.

It is also apparent that this apparatus would not be well suited to use on gas containing large quantities of lamp black or for purification of gas from coals yielding very heavy viscous tars. For high volatile coals, however, such as are found in Ohio, Indiana and Illinois, and for lignite, it has been found in practice to be thoroughly practical and effective. It is possible that further developments may extend the applicability of this method to conditions which are not now considered practical.

The exact method by which this tar extractor operates has not been conclusively demonstrated. Two theories have been advanced which may possibly cover the ground: The first and most obvious is that the tar particles are precipitated by being brought into direct collision with the threads or filaments of the porous diaphragm.

That this does not constitute a complete explanation of the process is indicated by the fact that the material of which the porous diaphragm is constructed has a marked bearing on the effectiveness of the process and would indicate some action other than simple mechanical collision. For example, if the porous diaphragm is made up of steel wool instead of glass wool (the physical structure of the diaphragm being as nearly as possible the same in each case) the process does not operate with anything like the effectiveness secured with glass diaphragms. It would seem that the possibility for collision would be the same in both cases.

A phenomenon, first observed by the writer in 1902 during some experimental investigations, gives further credence to the theory that there is some action other than pure mechanical collision. If the gas is caused to pass through a small tube with perfectly smooth walls, as for example a tube of glass, no particular precipitation of tar occurs as long as the velocities of travel are slow. However, as the velocities increase to a point where there is considerable friction between the gas and the surface of the containing tube a heavy precipitation of tar occurs on the surface of the glass. This fact leads to the conclusion that friction is in some way concerned in this process, since the probability of mechanical collision is rather remote. Since friction between rapidly moving gases and enclosing tubes is known to be productive of electrical phenomena, it was assumed that this might possibly have some bearing on the action of this process. In fact this interpretation was the one first placed upon the phenomenon observed in 1902 and an effort was made to work out a tar extractor along this line.

An experimental apparatus was constructed at that time in which heavily charged electrodes were employed to precipitate the tar particles and it was found that fairly effective results could be secured. Experiments along this line continued for a number of years, but the difficulties in the way of producing commercially practical apparatus caused its final abandonment. The rate at which the tar particles could be moved through the gas under the influence of moderate potential gradients was very slow. It was accordingly necessary to use exceedingly high potentials in order to secure effective results. With the spacing of electrodes of approximately 1½ in. a potential dif-

ference of 25,000 to 35,000 volts was required for effective precipitation. On account of the difficulty of maintaining proper insulation under these potentials and on account of the great danger of serious injury to an unskilled operator in manipulating apparatus of this kind, this method was not considered practical. It was noted, however, that by decreasing the distance between the electrodes a very marked decrease in potential was observed. Accordingly another experiment was devised which will perhaps throw still further light on the method of operation of the process under consideration.

A series of electrodes was prepared with exceedingly small intervening spaces, and placed in connection with a source of direct electro motive force, the potential difference between the plates being much below that required to produce any ionizing discharge. It was found that at these small distances distinct cleaning effects could be obtained without ionization. Maintenance of the electric charge from external sources was troublesome owing to electrolytic short circuits occurring between the electrodes through deposits of tar and moisture from the gas. The fact, however, that there is a distinct attraction exerted by electrified plates at comparatively low potentials (which is sufficient to cause a precipitation of tar particles from gases) leads to the conclusion that if the distance between the electrodes could be reduced sufficiently the potential differences required for effective electrical action would be very small.

It would seem possible, therefore, that in addition to the effects of mechanical collision there might be a distinct electrical attraction exerted by the glass fibres constituting the porous diaphragm which are located at microscopic distances from each other and which are undoubtedly subjected to some electrification from friction with the gas currents. If the possibility of such electrical action is considered, the increased effectiveness of glass as compared with steel for the construction of the porous diaphragm is satisfactorily explained. That friction of this nature is capable of producing electrical disturbances of considerable magnitude is well established.

It might be interesting in this connection to refer to recent experimental determinations by Professor Dolezalek of Charlottenberg, Germany, who showed that the friction of liquid benzol against the sides of containing pipes may set up potential differences of as much as 3,000 volts. As a very small fraction of this potential would be sufficient to account for the observed effects, it would seem only reasonable to presume that in addition to the effects of mechanical collision which undoubtedly exist, there is some electrical action which is of material aid in causing the coalescence of the particles of tar fog.

Whatever may be the correct explanation of the phenomenon, its effectiveness and practical importance are beyond question. The first commercial equipment of this kind has now been in continuous operation for approximately 18 months. This outfit is handling gas for a producer gas power plant of approximately 1,000 h.p. capacity. The second commercial equipment is handling approximately 900 h.p. producer gas, and has been in daily service for approximately ten months. The largest single installation is an equipment for cleaning 200,000 cu. ft. of gas per hour. This installation is operated in connection with a single producer unit which is of interest because it is one of the largest single unit plants ever installed in the United States. This producer has an effective grate surface of 250 sq. ft. and is rated to gasify 3,000 lb. of Illinois bituminous coal per hour.

SUCTION CONVEYERS.

By Reginald Trautschold, M.E., New York City.

THE economical handling of ashes from the furnace in power stations, etc., has always presented one of the most difficult of conveying problems, for the hot ashes cause rapid deterioration of any apparatus that they come in contact with, and the fine dust is detrimental to bearings, links and all pivoted connections as well as any surfaces of contact as it works into or lands on surfaces and produces destructive abrasive wear of the moving parts. Quenched ashes may be even more destructive owing to chemical properties of the ashes, so that the handling of ashes, either as they drop from the grates or after being sprayed with water to lower their temperature, cannot be performed with maximum economy by any of the continuous conveying or elevating systems of mechanical handling. Systems of the intermittent type are usually more satisfactory, owing to the fact that the ashes may be thoroughly cooled before delivery to the conveying apparatus, but ordinarily some car system or even more manual system of handling the ashes proves the most satisfactory in the long run—at any rate, in installations where but a relatively small quantity of ashes have to be disposed of. In a power house developing less than 2,000 h.p., the skip-hoist, a heavy bucket elevator or some car system is generally the most economical equipment for the handling of the ashes, but for larger plants —from 10 to 15 per cent. of the coal consumed being converted into ashes that have to be removed from the ash-pits—the suction conveyer proves an economical system to install.

The suction conveyer may also be employed for the handling of cement clinkers, comparatively fine materials of any description, etc., which, on account of their heat, chemical properties, fineness, etc., prove unsuitable for conveyance or difficult to handle by the ordinary mechanical types of conveyers. Even fine coal and similar materials have been economically and efficiently handled by the suction conveyer, but as the logical field for its operation is the handling of ashes, cement, lime, wood chips, etc., and the progress made in the development of this comparatively new method has been largely limited to ash handling installations, a description of a typical installation of such character will serve to show the advantages and convenience of the system.

Primarily, a suction conveyer consists of a heavy steel or cast iron duct in which the material to be handled is carried; an overhead storage tank of steel or concrete, in which a partial vacuum is maintained by an exhaust fan, to which the conveyer duct discharges; and a water spray in the storage tank for cooling the ashes, precipitating the fine dust, etc. In an ash-handling installation, the duct, consisting of an ordinary pipe, runs directly in front of or under the boilers below the boiler room floor, and is provided with a small intake in front of or under each grate. These intakes are each provided with an easily removable but tight-fitting cover which is kept closed except when the conveyer is being charged at that particular intake. On leaving the boiler room, the conveyer duct rises to the top of the elevated storage tank to which it discharges downward, the discharge pipe or conveyer duct extending downward in the storage tank for some little distance. From the storage tank, usually also from the top, an exhaust pipe extends to an exhaust fan which sucks the air from the storage tank, creating a partial vacuum throughout the conveying system. Below the ex-

haust pipe from the storage tank and above the discharge end of the conveyer duct, a water pipe in the storage tank delivers a fine spray over the material from the conveyer duct, quenching the ashes and precipitating the fine particles of dust and thus preventing their being drawn up into the suction pipe by the exhaust fan. As a further precaution against damage to the exhaust by fine particles of material that might not be precipitated by the water spray, the exhaust pipe is frequently equipped with a special dust collector.

The operation of the system consists simply in removing the cover from an intake and bringing the ashes or other material to be handled to the opening, the air rushing through this open intake then picks up the material and carries it to the storage tank. The velocity of the air through the conveyer duct being at a maximum at the centre of the pipe and decreasing towards the walls of the conveyer duct, the tendency of the load is to remain in suspension while being swept along by the rushing air, thus reducing the wear on the sides of the duct to a minimum—in fact, no wear or deterioration of the conveyer duct pipe on straight stretches is apparent even after several years' operation, the rapidly moving air preventing the gathering in the duct of any moisture or other agents that might have injurious effects. Any depreciation of duct, on level stretches, must therefore come from the outside and this can, in large manner, be guarded against and prevented. At elbows, however, the abrasive wear is great, the particles of material striking the elbow obliquely and being deflected back into the path of the moving air. This scouring action is so marked that ashes will wear away an ordinary elbow in short time. To overcome this drawback, the elbows are constructed with removable backs of manganese steel, carborundum or other substance possessing high resisting qualities to abrasive wear which may be easily and relatively inexpensively replaced as they wear out. Such wear-resisting elbows are placed wherever the general path of the conveyer duct changes direction. The scouring effect of the load on the elbows, which is so great as to bring them to a high state of polish, tends to keep the reduction in speed of air and load through the duct, due to a sudden change of direction, at a minimum.

For a simple installation of small capacity, the rotary exhauster for removing the air from the storage tank consists of a centrifugal fan, while for a larger and more complex system a cycloidal blower is employed. The exhauster discharges to the atmosphere and is in operation for only long enough to create the necessary vacuum in the system before the load is delivered to the conveyer duct intake and while the conveying is in actual productive operation. At other times, the vacuum in the system gradually disappears and the material handled may be removed from the storage hopper, the emptying gate of the hopper discharging to wagon, car or other conveying system, as the case may be. Though the conveyer duct of a suction conveyer may have several intakes, any one of which may be used to load the conveyer, the discharge from the duct must always take place into the storage hopper of the system. In the case of handling ashes, this is no great drawback, as, ordinarily, no further handling of the ashes is necessary, the ashes being discharged from the storage tank to the vehicle removing them from the plant. When handling other material than ashes, such as coal, other systems of conveying machinery or some type of car is necessary for delivering the material from the storage tank to storage or to whatever point it is to be used. If material is placed in storage before being used, it can frequently be reclaimed by the suction conveyer through a duct running under the stor-

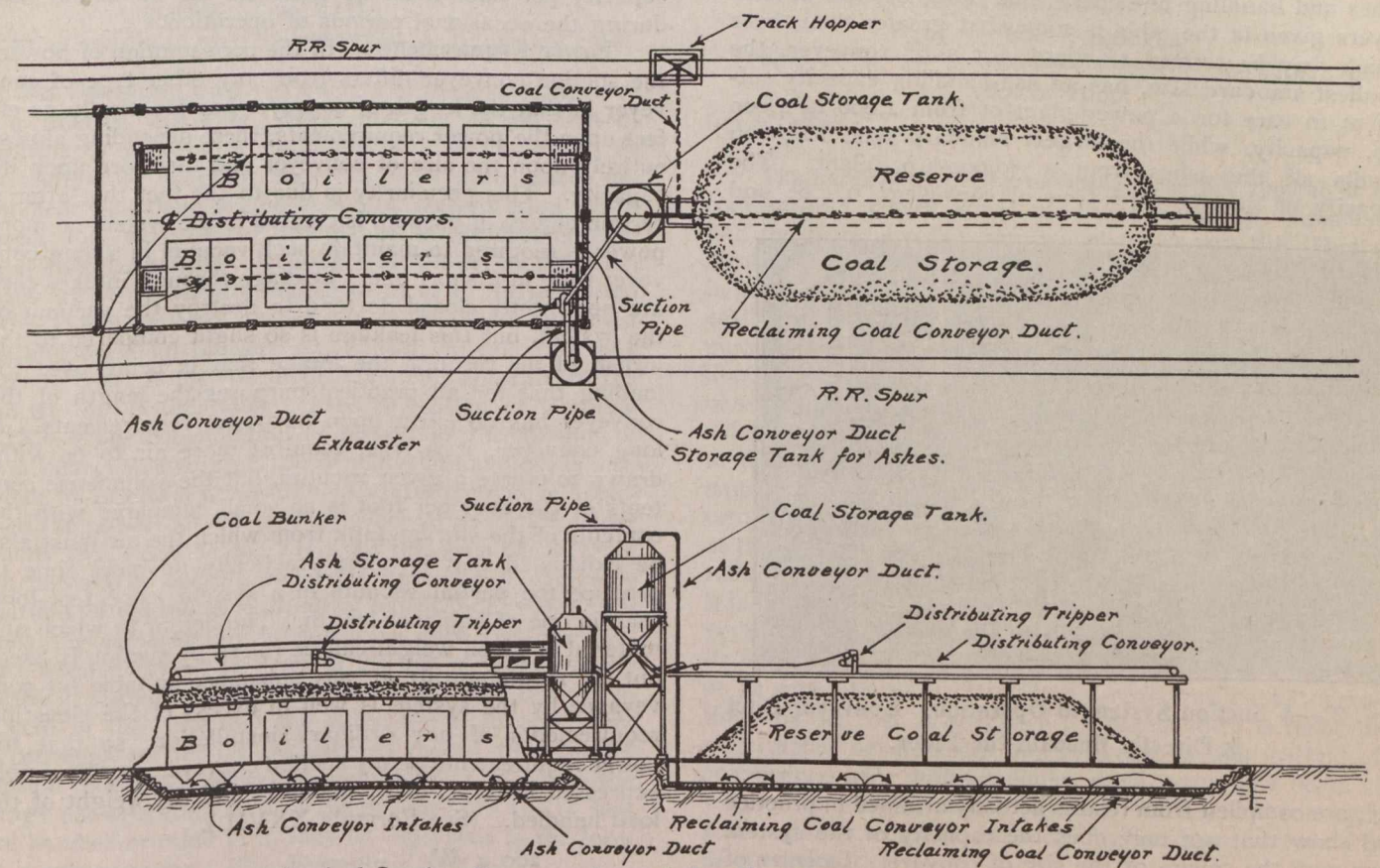

Fig. 1.—Typical Suction Conveyer Layout for Handling Both Ashes and Coal

age pile and discharging to the same storage tank serving for the conveyer duct handling the material before it is put in storage, distribution to point of consumption, either before the material is placed in storage or after it is reclaimed, being performed by other type of conveyer or car.

Capacity.—With a fixed velocity of air through the conveyer duct, quantity of air that can be removed by a centrifugal exhauster varies with the square of the diameter of the duct and as the degree of vacuum that can be maintained also depends upon the rate of air removal, the carrying capacity of a suction conveyer varies directly with the square of the diameter of its duct. The diameter of the conveyer duct being used to designate the size of the conveyer, Table XIII. gives the carrying capacity of the various sizes of suction conveyers handling ashes and handling fine coal. The range of sizes of conveyers given in the table is somewhat greater than those which may be termed standard, for a 6″ conveyer, the smallest standard size, has an ash-handling capacity sufficient to care for a power plant of from 2,000 to 4,000 h.p. capacity, while the largest standard size, 10″, can handle all the ashes from a 30,000-h.p. plant. The capacity of the standard sizes of conveyers, 6″, 8″ and

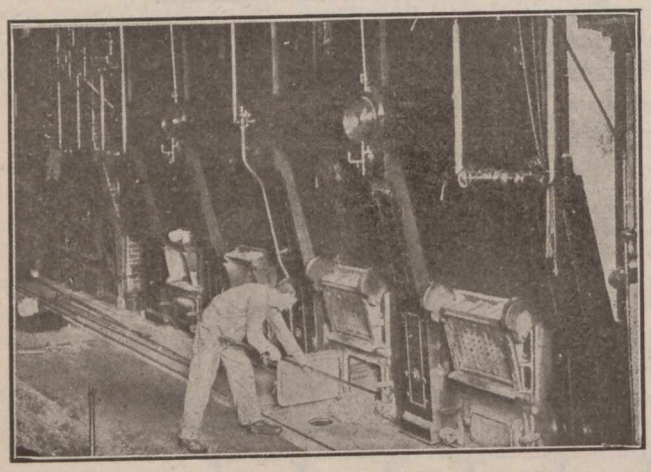

Fig. 2.—A Suction System in Operation. Conveyer Duct is Directly Beneath the Floor.

10″, are compiled from results actually attained in practice and show that not only does the capacity of the system vary with the square of the size of conveyer, diameter of its duct, but that the capacity appears to vary directly with the respective weight of the material handled. Though this appears to be so for ashes and fine coal, it is doubtful if such a relationship can be taken as a law. However, for the materials particularly adaptable for handling by the suction system such relationship is doubtless sufficiently general for all practical purposes. Expressed in the form of a convenient equation the relationship existing between capacity of the conveyer and its size (diameter) and weight of material handled is given as Formula XXVI.

Table XIII.—Capacity of Suction Conveyers in Tons Per Hour.

Diameter of duct. Size of conveyer.	—Capacity of handling— Ashes. Tons.	Fine coal. Tons
4″	2.60	3.70
6″	5.85	8.00
8″	10.35	14.10
10″	16.30	23.05
12″	23.50	32.25

$$W = 0.00385\ w'd^2 \quad \text{.....Formula XXVI.}$$

Where:—

W = Capacity of suction conveyer in tons per hour.
d = Diameter of conveyer duct in inches.
w′ = Weight of material handled in pounds per cu. ft.

Though the foregoing capacity table and formula are approximately correct, it must be remembered that suction conveyers, which may be classified as belonging to the class of conveying apparatus of the continuous type, cannot be operated continuously and the results attainable in practice must be based on very occasional service. That is, such a conveyer must necessarily be idle much of the time, so, in choosing the proper size to install, the capacity per hour must be taken as the maximum rate during the occasional periods of operation.

Power Requirements.—In the consumption of power, the suction conveyer differs from any other type of conveyer in that the length of conveyer has practically no effect upon the power requirements, these depending almost entirely upon the size of conveyer and therefore upon its capacity. This peculiarity is due to the fact that after a certain degree of vacuum is created in the system no more power is required to maintain such vacuum in a long conveyer than in a short one. Leakage through intakes that are not tightly closed do tend to destroy the vacuum of the system, but this leakage is so slight compared to the inrush of air through the intake that is being used for loading that for all practical purposes the length of the conveyer has no effect upon its power requirements. A long conveyer, it is true, requires more air to be withdrawn to create a given vacuum, but the volumetric contents of the duct per foot is so small compared with the contents of the storage tank from which the air must also be exhausted that it takes practically no more time to produce the partial vacuum in a system 1,000 feet long than in one of half that length. The height to which any material of given weight can be raised by suction is fixed, but the maximum lift for any substance suitable for conveyance by the system is well in excess of the elevating requirements of any ordinary installation, so that the power requirements of any suction conveyer may be simply expressed in terms of its diameter and the weight of the load handled. (See Formula XXVII.).

$$d^2 = \frac{260.4\ W}{w'}$$

$$HP = 0.555\ d^2 = \frac{144.52\ W}{w'} \quad \text{.....Formula XXVII.}$$

HP = Average HP required
d = diameter of conveyer duct in inches.
W = Weight of load conveyed in tons per hour. (Table XIII.)
w′ = weight of material conveyed in pounds per cu. ft.

By far the most expensive pieces of apparatus required for a suction conveyer are the exhauster, storage tank with its accessories and the dust collector, and the cost of these depends not upon the length of the conveyer but upon its size. The cost of the balance of necessary equipment, including the conveyer duct, suction pipe, intakes, elbows, etc., varies with both the size and length of the conveyer, but form such a relatively small part of the total cost of equipment that there is really little difference in the cost of the average installation of any given

size. That is, the length of conveyer for the average installation may be neglected in figuring an approximate initial cost for the installation—it being understood, of course, that the length of conveyer be neither extremely short nor unduly long. Neglecting the question of length, then, its cost will vary closely with the square of its diameter, or with its carrying capacity. The average relationship existing between initial cost and size of conveyer and capacity of conveyer, deduced from an examination of actual costs of numerous installations, is given as Formula XXVIII.

$$C = 145\ d^2 = \frac{37{,}750\ W}{w'} \quad \text{.....Formula XXVIII.}$$

C = Initial cost in dollars.
d = diameter of conveyer duct in inches.
W = Weight of load conveyed in tons per hour—capacity, Table XIII.
w' = weight of material conveyed in pounds per cu. ft.

Net Operating Cost.—To arrive at the economic value of a suction conveyer, represented by its net cost of operation, a number of assumptions must be made, as this method of handling materials is of such recent development that there are no authentic records from which depreciation, expense for attendance or the cost of incidental supplies can be calculated. However, as these expenses are all practically limited to those in the operation of the exhauster and as records of similar centrifugal fans and cycloidal blowers are known, calculations may be made that should be approximately accurate in the majority of installations. (See derivation of Formula XXIX.). The consumption of power, or the amount of power chargeable to each ton of material handled, is also difficult to ascertain accurately. Careful tests have ascertained the power consumed during actual operation under capacity (see Formula XXVII.) but this type of conveyer must necessarily operate under frequent and considerable variations of degree of load, all of which require approximately the same supply of power as does also the conveyer when carrying no load at all but maintaining the necessary degree of vacuum. Assuming that during 20 per cent of the time that the exhauster is in operation, the conveyer carries its capacity—a record that careful attention to efficient operation should make possible—the average net operating cost of the system, per ton of material handled or other unit, may be expressed in the form of a simple equation. (See Formula XXIX.).

$$\text{Average cost of equipment per ton capacity} = \frac{145\ d^2}{NW}$$

Average hours of operation per year at capacity = 180 = N

Average cost of equipment per ton capacity = $0.806\ d^2/W$

Cost of Power:

Net = $0.555\ d^2\ P_o/W$
Actual = $5 \times 0.555\ d^2\ P_o/W = 2.775\ d^2\ P_o/W$

Attendance—
Average = $1.850\ d^2\ P_o/W$

Supplies—
Average = $2.375\ d^2\ P_o/W$

Interest 6% total cost
Insurance 1%
Taxes 2% ¾ cost
} = $0.0685\ d^2/W$

Depreciation, renewals, etc.
Dep. acc't., 10% of dep.
} = $0.0265\ d^2/W$

$$\text{Net operating cost} = 0.0950\ d^2/W + 7.000\ d^2\ P_o/W$$

$$\text{N.O.C.} = \frac{(95 + 7000\ P_o)d^2}{1000\ W} \quad \text{.....Formula XXIX.}$$

N.O.C. = Net operating cost per ton handled, in dollars.
d = diameter of conveyer duct (size of conveyer) in inches.
W = Weight of load (capacity) conveyed in tons per hour.
P_o = Price (cost) of power per horsepower.

Example:

Conditions—
Size of conveyer .....8″
Material handled .....Ashes
Cost of power .....$0.02 per HP.

W = 10.35 tons (Table XIII.).

$$\text{N.O.C.} = \frac{(95 + 7000 \times 0.02)\ 64}{1000 \times 10.35} = \$1.424 \text{ per ton of ashes.}$$

The conditions of the example cited are typical of a coal-burning power house of about 8,000 hp. capacity, and the work entailed consists of conveying the ashes a total distance of some 500 to 1,000 feet and placing them in an overhead storage tank from which they can be easily removed for final disposition. The total cost of performing such operations is equivalent to a charge of about 14¼ cents for the disposal of ashes per ton of fuel consumed. In such a plant, the expense of disposing of ashes ordinarily amounts to from 15 to 25 cents per ton of fuel consumed, depending upon the conveying system employed. The difference between such rate and 14¼ cents does not, however, indicate the full economic value of the suction conveyer. The cleanliness, convenience and reliability of the system adds greatly to its real worth and it is unfortunate that the high initial cost of a suction conveyer installation and its consumption of power prohibits its use for small plants. When handling heavier materials, or at such service as permits its more continuous operation, the net cost of operation per ton handled is reduced, and further development and progress in this method of conveyence will, without doubt, open many new fields in which the peculiar advantages of the suction conveyer will enable it to show decidedly higher financial economy in operation.

The list of the various awards made at the International Building Exposition, held in the city of Leipzig, Germany, during the past summer has now been received. Among those who were awarded the gold medal of the Exposition and the various silver and bronze medals and diplomas is found quite a number of United States firms, mostly of a commercial nature, but it is gratifying to find near the end of the list three engineering organizations and an individual engineer. The Alsace Lorraine prize was awarded the Board of Water Supply of New York, while Gustav Lindenthal, the American Bridge Company and the Strauss Bascule Bridge Company, of Chicago, were awarded the gold medal of the city of Leipzig. Mr. Lindenthal, in connection with the American Bridge Company, exhibited plans of the Hellgate Bridge, etc., while the Strauss Company had a small exhibit of models and photographs of Strauss bascule and lift bridges, which, however, attracted considerable attention, owing to the large number of successfully completed structures which the exhibit represented.

SALT IN CONCRETE.

In July 31st issue of *The Canadian Engineer* an article appeared containing a summary of observations made by the U.S. Bureau of Standards upon the action of salts in Alkali and sea water on cement and concrete structures. The reader is referred to the conclusions therein, in connection with the following report of a series of tests to determine the effect of sodium chloride and calcium chloride, separately and together, upon 1:2:4 concrete were made at the University of Wisconsin during the winter and spring of 1912 by Messrs. H. E. Pulver and S. E. Johnson, instructors in mechanics. The test pieces were cured at temperatures of from 60 to 75 deg. Fahr. and below freezing. The results have been published in the "Wisconsin Engineer" by Mr. Pulver.

All mix was by volume and the salts were dissolved in the mixing water. The test pieces were 4-in. cubes, and those cured at a temperature below freezing were broken after fourteen and sixty days, while those cured at normal room temperatures were broken after fourteen, sixty and three hundred and sixty days. Four pieces were tested at each age for each batch of concrete. Atlas Portland cement was used, and to prevent variation in the quality it was mixed thoroughly in the beginning and a sufficient quantity stored in airtight cans.

The test curves show that as the percentage of NaCl is increased there is a nearly straight line decrease in the strength of the concrete cured under normal conditions. The effect of NaCl alone, when added to concrete cured at low temperature, is probably to reduce the freezing temperature, and hence retard the freezing of the concrete, thus permitting of its setting and hardening. The curves show an increase in strength for the addition of NaCl up to 12 per cent., after which there is a decrease. It may be that beyond 12 per cent. the weakening of the concrete due to the excess of NaCl more than offsets the strengthening due to the reduction of the freezing temperature.

When $CaCl_2$ alone is added to the concrete, cured either at normal or low temperatures, the effect is to increase the strength up to about 4 per cent. $CaCl_2$, at which point the maximum strength seems to be obtained. This increase in the strength of the concrete may be due to the acceleration of the setting of the cement by the $CaCl_2$. Serious disintegration was observed on the surfaces of the cubes cured at low temperatures with 6, 8 and 10 per cent. of the $CaCl_2$. This disintegration did not appear on any of the cubes cured at normal temperature or where NaCl was used.

With concrete cured at low temperatures, the best effect seems to be obtained by using both NaCl and $CaCl_2$ in the mixing water. It was noted that a 2 per cent. $CaCl_2$ and 9 per cent. NaCl mixture appears to give the most satisfactory results. For concrete cured at low temperatures this mixture gives about as much strength as any of the mixtures tried, and for the concrete cured normally there was not a very great reduction in strength due to the addition of the salts in those percentages.

All tests were made with only one brand of cement. It is probable that there would be some variation in the results with other brands, but it is not thought that this variation would be great enough to affect the general conclusions. It is also possible that some brands of common salt might contain a sufficiently high percentage of calcium sulphate to affect the results to some extent.

TRAFFIC SUITABLE FOR VARIOUS ROAD SURFACES.

The Massachusetts Highway Commission, after some years of study and experiment, has made the following statement of the effect of traffic on roads and the necessity of legislation governing the relation of width of hard tires to the loads carried by them:

A good gravel road will wear reasonably well under a daily traffic composed of 50 to 75 light teams, 25 to 30 loaded one-horse vehicles, 10 to 12 loaded two or more horse-drawn wagons, and 100 to 150 automobiles. With a larger number of automobiles, the gravel should be oiled. The oiling presents what is spoken of as a "blanket surface" consisting of heavy asphaltic oil and sand. If the oil be applied hot, the blanket surface will last 3 to 5 years, if cold, it must be renewed every year.

Oiled gravel will stand fairly well under 75 to 100 light teams, 30 to 50 heavy one-horse vehicles, 20 heavy wagons with two or more horses, and 500 to 700 automobiles daily.

Waterbound macadam will stand under a daily traffic of 175 to 200 light teams, 175 to 200 heavy one-horse vehicles, and 60 to 80, perhaps more, heavy wagons with two or more horses. If even 50 to 100 automobiles per day go over the road at high speed dust-layers will be serviceable. With a really good dust-layer the road will stand 300 to 500 automobiles a day, although the stones will wear.

Waterbound macadam with an oil and sand blanket, applied hot, will be economical with 150 to 200 light teams, 75 to 100 heavy one-horse vehicles, 25 to 30 heavy wagons with two or more horses, and automobiles, up to 1,400, or more with fewer teams and with 50 or more motor trucks. The large number of automobiles seems to keep the oil rolled down when it would cut up and crumble without this traffic.

Dr. Alfred Thompson, M.P., stated recently that this year in the Yukon more than $5,000 in gold was taken out, chiefly by the Guggenheims and the Boyles. The production of gold by individual miners was comparatively a negligible quantity. Most of the gold was taken out by dredges, the two big companies each operating four mammoth diggers. Two of the dredges operated on the Boyle concession are among the largest in the world. Power for operating the dredges was furnished by the development on the Yukon River, installed and controlled by the Treadwell people. During the low-water period in September a steam power plant installed some years ago at Coal Creek, a short distance down the river from Dawson, was brought into service, so that the dredges were operated for full six months.

The main line of the Transcontinental will total a trackage of 3,550 miles from Moncton to Prince Rupert; but that does not comprise the whole system by any means. There are to be many branch lines taking care of settlements in sections of the country hitherto unprovided with transportation facilities. These lines, upon which, in some instances, a beginning has been made, will amount to over 1,000 miles of added trackage, and will tap large territories hitherto inaccessible. These branches, or lateral lines, are to serve new populations, which will follow them in line of the system, and then spread over the new country served by spur trackage, which will connect them with the great artery through which their products will be brought to the centres of population in older Canada.

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CONTENTS OF THIS ISSUE.

OTTAWA'S WATER PROJECT AND ENGINEERING FEES.

The letter, which appears in another column, relating to the nature of the contract between the City of Ottawa and Sir Alexander Binnie in connection with its Gatineau Lake water supply scheme, is misleading in a general way and does not do justice to the Ottawa civic authorities. The writing of this letter was evidently occasioned by the editorial comments of a New York journal which apparently created an erroneous impression by associating statements and comparisons respecting percentage fees, with the Binnie contract.

In *The Canadian Engineer*, October 16th issue, an article appeared outlining the proposal accepted by the City of Ottawa to bring its water supply from the Gatineau Lakes, a distance over all of fifty miles, at a total cost approximating $8,000,000. It was later announced that Sir Alexander Binnie, a well-known English engineer, whose recommendation had been adopted, had been retained by the city as designing and supervising engineer of the entire work.

In the letter, and in the New York editorial as well, the impression is conveyed that the engineer is receiving a fee of $75,000 for the privilege of drawing $1,000,000 for "engineering and contingencies," and of allowing a lawyer to buy $500,000 worth of land. From a $400,000 contract to carry out an $8,000,000 scheme, it is deduced that the fee is on a five per cent. basis, which is pronounced "good." Further, the editorial urges engineers who have become discouraged at the lack of financial recognition of the engineering profession, to take heart.

It was never proposed to pay Sir Alexander Binnie on any percentage basis whatever. The $400,000 fee includes $250,000 to pay assistant engineers and inspectors, while $50,000 more will no more than provide for the working out of the plans, specifications, salaries of draftsmen and office staff, etc.—leaving approximately $100,000 as the engineer's remuneration. The city had the alternative of paying the assistant engineers and inspectors, and leaving to Engineer Binnie the financing of drawing office and other disbursements. From this proposition he was to receive $140,000, and, as in the other case, his own remuneration would approximate $100,000. The city accepted the former proposal as the better of the two, although it thereby created apparent food for discussion.

As it stands, $100,000 is a good fee for an engineer on an undertaking such as this. For, analyzing this expenditure of $8,000,000, deducting the $500,000 for land purchase, on which small engineering service is required, also $976,000 for engineering and contingencies, and $3,600,000 for the gravity flow steel pipe line, on which the cost of design and supervision of construction is also comparatively small, (but essential, nevertheless, as it is a vital question with Ottawa), we have $2,900,000 left to be expended on construction work requiring a considerable amount of high-class engineering ability. But if Ottawa pays its engineer $100,000 for his services on this alone, what can we say by way of criticism, when Toronto has paid out $72,000 for engineering services in connection with the filtration plant that has cost $778,000 all told, designed and supervised by a New York engineer? Ottawa is taking no chances on the possibility of unsatisfactory work. It is not to be inferred that we parallel the case with that of the Toronto filtration plant, or that the expenditure connected with the latter was wasted. However, in Nov. 27th issue of *The Canadian*

Engineer we reviewed specifications for a new mechanical filter plant large enough to handle Toronto's entire requirements; and the name of the New York engineer who drew the $72,000 for the old (two years old) Toronto plant is not connected in any way with the design of the new plant.

Mr. Macdonald's reference to the new intake pipe and aqueduct has recalled an instance which may or may not have been in the minds of the Ottawa City Council. An editorial observation in a previous issue of the journal referred to, that two previous supply schemes were voted down by Ottawa, presumably owing more or less directly to the fact that each had been worked up by a New York engineer, may or may not have had its weight. With the first instance, Mr. Macdonald associates the word "disastrous." In the second, an engineer referred to has designed and superintended the construction of a number of Canadian engineering enterprises, and if there is a single one that has been popularly pronounced satisfactory, we have yet to learn of it, and it is our belief that the City of Ottawa cannot outdo us in the enumeration of instances.

Ottawa has an excellent source of supply in the Gatineau Lakes. The city is sorely in need of it. A satisfactory job is essential to the scheme. It is a big undertaking and it is worth money to the city to know that the man to carry it out entertains no scruples in the matter of remuneration.

Ottawa's recognition of engineering ability is not to be depreciated but praised. Deduct, however, the $75,000 which has been regarded as questionable, and who would care to undertake the work?

EDITORIAL COMMENT.

The last of a series of eight articles by Reginald Trautschold, M.E., appears in this issue of *The Canadian Engineer*. The series entitled "The Mechanical Handling of Materials," has created a good deal of interest among manufacturers, engineering-contractors, mining and structural men. The separate instalments, with the date of issue of each, are as follows:—

"Mechanical Handling of Materials," August 21st.
"Spiral or Screw Conveyers," September 4th.
"Belt Conveyers," September 18th.
"Belt Conveyers" (Part II.), October 2nd.
"Bucket Conveyers," October 16th.
"Handling Materials by Bucket Carriers," Nov. 6th.
"Skip Hoists," November 20th.
"Automatic Railways," December 4th.
"Suction Conveyers," December 18th.

* * * *

The piercing of Mount Royal within a few hours of the time at which it was estimated some months ago that the headings of the tunnel would meet, took place on the morning of Dec. 10th, and a train went through in the afternoon. How successfully this work has been carried out is indicated well in the extreme accuracy with which the headings were found to align. There was a difference of 0.75 inch in line and 0.25 inch in grade. The remarkable speed at which this accurate work was carried along shows that the undertaking was attended by clever supervision and excellent engineering skill throughout.

LETTERS TO THE EDITOR.

Fixed Carbon Limitation.

Sir,—In connection with the articles on the desirability of introducing a fixed carbon determination into specifications for the purchase of asphalt, I have only to add that, based on an experience of 25 years in the determination of this and other characteristics of the native bitumens, I believe it to be of the utmost value in several directions, and I may say that in the hands of a person of experience and enjoying daily practice in conducting the operation, there is no difficulty in obtaining results which are reliable within any error which is of importance.

The value of the determination of fixed carbon in any bitumen, and I should preferably denominate its residual coke, ash free, as involving less uncertainty as to the nature of this material, depends upon the direction in which it is applied and the manner in which the results are interpreted. Determinations of fixed carbon aid in differentiating bitumens of various characteristics or origin, and the requirement for such a determination in any specification may mean that under such specification bitumen of only a certain character is desired. If an engineer, in the light of service tests, prefers material which has been well proved to be satisfactory rather than residual pitch which has been a failure or is of an experimental nature, he will properly introduce into his specifications a provision that no bitumen would be acceptable under them which contains more than 15% of fixed carbon. In this direction a requirement of this nature is of the greatest value. On the other hand if he desires to purchase the cheaper and more experimental forms of bitumen, there would be no object in such a provision. In another direction, as Mr. Pullar has shown, the determination of fixed carbon in bitumens, representing any particular class of materials is most important in determining their uniformity, and the fact that they have not been overheated in the process of manufacture.

The value of the fixed carbon test, therefore, may be said to be based upon the care with which it is carried out, the objects for which it is used. and the intelligence with which the results are interpreted. We are certainly very much indebted to Messrs. Kirschbraun and Pullar for the efforts that they have made to show in what directions this determination is important and how it is to be interpreted.

If a city desires to use some of the cheaper and carelessly prepared residuals to the exclusion of the more expensive natural asphalts, there would be little object in introducing a fixed carbon clause in the specification, but if the highest grade of material is desired to the exclusion of the cheaper residual pitches made from oils which are unstable at the high temperatures used in their production, such a clause should certainly be one of those which should be provided.

CLIFFORD RICHARDSON.

New York, N.Y., Dec. 11th, 1913.

[NOTE—See issues of *The Canadian Engineer* for Nov. 13th, Nov. 20th, Nov. 27, Dec. 4th and Dec 11th for previous articles and discussions concerning the value of the "Fixed Carbon Test" in specifications for asphalt. This is an important subject for Canadian city engineers to consider, and the opinions which have already been expressed in these columns respecting the limitation of the percentage, being those of well-known engineering

chemists who have given the subject a careful study, differ to a degree warranting thorough discussion.—Editor.]

* * * *

Discussion on "Stresses in Circular Pipes."

Sir,—The bending moments in Circular pipes due to an uneven distribution of the internal pressure, the subject of Mr. Hogg's very interesting and timely paper, have been persistently ignored by many alleged experts to the detriment of the structure.

In reading over Mr. Hogg's paper, it appeared to the writer that, besides those formulæ Mr. Hogg has given for the bending moments due to a vertical load distributed over the horizontal section of the pipe and to a horizontal pressure uniformly distributed over a vertical section, it might be useful to give formulæ for the case

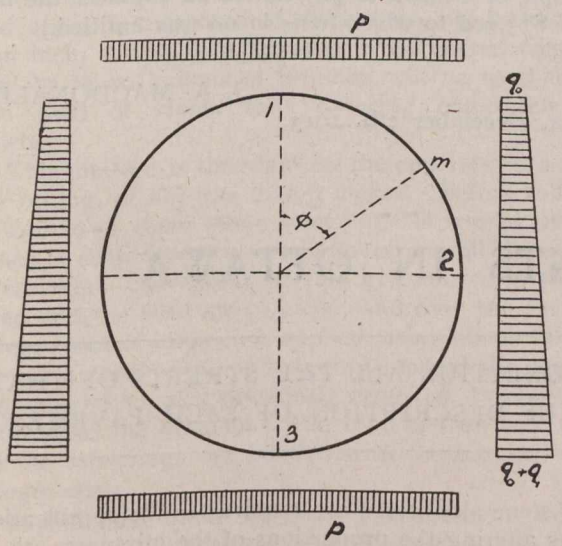

Fig. 1.

when the horizontal pressure is unevenly distributed, as shown in the accompanying diagram.

A circular structure is, generally speaking, three times statically indeterminate, but on account of the vertical diameter in this case being an axis of symmetry for the load, there will be no transversal force at the top of the pipe; by choosing the stresses at the top as the statically undeterminate quantities, it will be seen that there are only two in this case, the horizontal force and the bending moment.

By proceeding in the usual manner it will be found that the bending moment and normal force at the top (point 1) is

$$M_1 = \tfrac{1}{4} r^2 (p - q - 5/12\ q)$$
$$N_1 = -(q_0 + 5/16\ q) r$$

p being the vertical load per unit length, q_0 and $q_0 + q_1$, the horizontal load per unit length at the top and bottom respectively (see Fig. 1) and r the radius. The bending moment is taken positive when it produces compression on the convex side of the pipe and the normal force positive for tension.

At the end of the horizontal diameter (point 2) the forces are

$$M_2 = \tfrac{1}{4} r^2 (p - q_0 - 6/12\ q_1)$$
$$N_2 = -pr.$$

and at the bottom (point 3)

$$M_3 = \tfrac{1}{4} r^2 (p - q_0 - 7/12\ q_1)$$
$$N_3 = -(q_0 + 11/16\ q_1) r$$

The bending moment and normal force at the various point in (see diagram) can readily be determined from the values of the statically indeterminate quantities which (acting from the centre of the circle on the top section) are for this loading case

$$\text{(Normal force) } X_n = r (q_0 + 5/16\ q_1)$$
$$\text{(Moment) } X_m = -\tfrac{1}{4} r^2 (p + {}^2 q_0 + 5/16\ q_1)$$

and the bending moment M_m and the normal force N_m at the point which has the co-ordinates X and y.

$$M_m = M_{01m} - X_m - X_n y$$
$$N_m = N_{01m} - X_n \cos \phi$$

where M_{01m} and N_{01m} are the corresponding values in the statically determinate auxiliary system.

V. J. ELMONT.

Montreal, Dec. 9th, 1913.

* * * *

The Binnie Contract.

Sir,—The engineering papers are taking considerable interest in the Ottawa pure water scheme, and particularly in the terms of contract which the city of Ottawa has made with Sir Alexander Binnie, who, after proposing the scheme, has been retained as its designing and supervising engineer. A New York engineering paper, which has always taken a sympathetic interest in Canadian engineering matters, apart from the size of the fee, appears to be struck with the peculiar nature of the contract. It points out that he is to substitute his own staff and force for the ordinary city department, which usually has control of the construction of a new waterworks for its own city. It calls this "an extraordinary contract," and decidedly unique "in a civilized, modern city the size of Ottawa." The contract is certainly both unique and extraordinary. One would expect to see such a contract, as the journal suggested, in those out-of-the-way countries where local authority is not sufficient to undertake the establishment of its own engineering force.

It certainly does seem ridiculous, if not manifestly unjust, to pay Sir Alexander Binnie a percentage on the costs of his own services; for, in this contract a sum of $1,000,000 (to be exact, $976,320) has been included for "engineering and contingencies," on which amount Sir Alexander Binnie gets $50,000, or 5 per cent. Again, there is the sum of $500,000 for land damages, and on this amount Sir Alexander is to receive $25,000. One would imagine the lawyers as best entitled to receive this latter sum. What engineering features there exist in the purchasing of right-of-way, and of the lands to be flooded, is difficult to discern, being little more, at any rate, than the survey of the outlines of these lands. Here, then, is a sum of $75,000, which is to be paid Sir Alexander Binnie, but to which, manifestly, he has no right, either by reason or engineering ethics.

By all means let Sir Alexander Binnie be paid his 5 per cent. on the cost of the construction of the Ottawa pure water scheme, estimated, apart from land damages and engineering, at $6,500,000, the percentage allowance of which would be $325,000, a fairly good fee as engineering pay goes; but there is no logical reason, ethically or morally, and least of all from a business point of view, in paying him $75,000 on a percentage basis for "engineering and contingencies" and for "land damages."

The total cost of the new system will be $8,000,000, on which Engineer Binnie, at the rate of 5 per cent. of

this cost, gets $400,000. The items of cost are approximately:—

$5,500,000 for gravity flow steel pipe line.
500,000 for land, compensation, etc.
1,000,000 for engineering and contingencies.
1,000,000 for cost of construction.

In the first item, which is also the chief item, the cost of design and supervision is comparatively small. In the second item the engineers have little or no work to do. The third comprises the cost, not of any part in the construction of the water scheme, but the time and skill of the engineer. The fourth item is wholly constructional, but of a kind that does not involve any excessive amount of high-class engineering work. Evidently, there is room for criticism and objection on the most practical ground.

In justice to the city of Ottawa, it should be stated that if there was one thing more than another that decided the City Council in favor of placing the whole responsibility for the construction of the Gatineau Lake project on the shoulders of the eminent engineer who recommended the scheme, it was, undoubtedly, the disastrous experience which the city had had with its new intake pipe and aqueduct. "Once bitten, twice shy." This probably accounts for the almost perfect unanimity of the citizens with the agreement, in the face of the most extraordinary conditions, as above set forth, in the provisions of the contract.

Ottawa people have the greatest confidence in the Mayor, and heartily congratulate themselves on having at the head of their municipal administration, a man so capable of grappling with any new situation as it comes up. But Mayor Ellis is not an engineer, and, however faithful and honest his intentions, he is scarcely capable of judging the merits of this agreement submitted by Sir Alexander Binnie.

The proper course to be taken by the Mayor and Council, would be to consult some capable engineer, not necessarily "eminent" or "knighted," of which there are men residing in Ottawa, or at any rate, in other Canadian cities, before agreeing to the Binnie contract, and binding the people of Ottawa to pay out to an engineer the large sum of $75,000 to which he is in no way entitled.

Yours truly,

J. A. MACDONALD.

Ottawa, December 4th, 1913.

PAVEMENT REQUIREMENTS IN OTTAWA

A REPORT ON THE COST OF PUTTING INTO GOOD CONDITION ALL THE STREETS OF THAT CITY—RECOMMENDATIONS INCLUDE TEN TYPES—BRIEF DESCRIPTION OF EACH PAVEMENT

PURSUANT to instructions from the City Council of Ottawa to prepare a report on the estimated cost of placing all the thoroughfares within the city in good condition, Mr. Arch. Currie, the city engineer, has presented to the Board of Control the following summary (Table I.) of the lengths, areas and costs of the various classes of roadways it is recommended should be constructed:—

TABLE I.

	Miles.	Length, lin. ft.	Area, sq. yds.	Cost.
1. Asphalt	9.81	51,814	183,263	$ 502,297.50
2. Asphalt macadam	15.24	80,495	260,308	558,370.00
3. Asphalt and stone blocks	5.53	29,205	140,672	472,955.00
4. Asphalt macadam stone blocks	1.20	6,340	36,320	96,068.40
5. Concrete	1.09	5,770	23,520	39,420.00
6. Macadam tar painted	47.01	248,214	783,013	1,300,266.80
7. Macadam tar painted and stone blocks	.42	740	2,460	5,072.50
8. Macadam tar painted and granitoid	.75	3,970	13,055	23,755.75
9. Stone blocks	.87	3,560	15,338	66,782.00
10. Tar macadam	2.87	15,150	52,912	107,121.60
	84.32	445,258	1,511,361	$3,172,119.55

In deciding on the various classes of roadways proposed to be constructed, very careful consideration had to be given to the amount and nature of the traffic on any particular road, with a certain assumption of what it might be in the future.

The following descriptions of each type of roadway will be of some interest.

Asphalt.—As there is nearly 40 miles of asphalt pavement in Ottawa at present, very little need be said about it, but some alterations are required in the specifications, such as altering the proportions of the mixtures, etc. It is proposed to construct asphalt pavement on streets with very heavy traffic, such as will be found near railway freight yards and on streets where street cars are running, except in the track allowance and 18 inches on either side, which should be paved with stone blocks or setts. It has to be understood that asphalt pavement should not be used on grades steeper than 5 per cent. The advantages of this pavement are:—

(*a*) Ease of traction.
(*b*) Comparative noiselessness under traffic.
(*c*) Imperviousness to water.
(*d*) Ease of cleaning.
(*e*) Pleasing appearance to the eye.
(*f*) Suitability to all classes of traffic.
(*g*) No vibration or concussion in travelling over it.

The defects are:—

(*a*) Slipperiness under certain conditions of the atmosphere.

(*b*) Disintegration if excessively sprinkled or otherwise subjected to constant moisture (although asphaltum is impervious and insoluble in either fresh or salt water).

(*c*) Tendencies to become soft under traffic in extreme heat and to present a wavy surface, and under extreme cold it may crack and become friable.

(*d*) Unsuitability for steep grades.

Asphalt Macadam.—It is proposed to use this form of construction on streets where the traffic is not quite so heavy as would be on asphalt pavement, and with the same foundation course, viz., concrete. It takes the place of sheet asphalt on grades steeper than 5 per cent.

The most common type of asphalt macadam roadway is laid on a Telford base, this base consisting of stones about 8 inches thick, laid on edge. The course on top of the concrete base, or the Telford base, whichever is decided upon, is composed of stone from 1¼ inches to ⅜ of an inch, mixed with bitumen in its melted condition. From 17 to 20 gallons of bitumen will be used to each cubic yard of stone, thus covering completely each particle.*

This mixture is then laid on the concrete to a depth, after rolling, of not less than 3 inches. Before rolling, a grit course of clean stone screenings is spread over the surface in such quantity as will cover and fill the voids in the surface. The excess of this grit course is then removed and the road swept clean, and over the surface a squeegee coat of bitumen is applied, using about ½ gallon per square yard. Over this again is spread the excess of screenings which was previously removed, to correct the stickiness of the bitumen. The road is then well rolled, until the screenings are bonded with the bitumen of the squeegee coat.

Asphalt and Stone Blocks.—This refers to work on streets where street cars are running. Asphalt has already been dealt with, while, as formerly stated, it is considered necessary to have stone blocks for the full width of the track allowance, and 18 inches outside on both sides. Several of the streets at present have sheet asphalt or some other bituminous mixture in the track allowance with, in some cases, only one or two courses of blocks outside. This, it is contended, is poor construction, as with the continued vibration of the rails, the sheet asphalt soon becomes disintegrated and crumbles to pieces, causing holes adjoining the rails and consequent danger to vehicular traffic. While stone blocks are not perfect, owing to surface drainage difficulties, they are preferable to asphalt, and failures in the blocks can be easily and rapidly repaired.

Another form of construction in the track allowance is solid concrete. This has been used with considerable success in Montreal.

Asphalt Macadam and Stone Blocks.—This is practically the same form of construction as described for asphalt macadam and asphalt with stone blocks, it, of course, being understood that sheet asphalt macadam is introduced for vehicular traffic on a grade with a concrete base for heavy traffic and, as already described, with a Telford base for traffic of a somewhat lighter nature.

Concrete.—Concrete for roads is somewhat of a modern idea, but so far seems to have been very successful and with proper care, particularly in drainage, there is no apparent reason why construction of this nature should not be successful. It will be necessary to reinforce this concrete and also provide transverse expansion joints about 50 feet apart. The surface of the road might well be painted with some bituminous mixture, and afterwards sprinkled with sand, all tending to give a good surface.

Macadam Tar Painted.—This type of roadway will be built on the principles laid down by that well-known Scotchman, Thomas London Macadam, and not by some of the modernized versions of them. It is considered that many of the residential streets in the city, where traffic is light, should be macadamized. Where a foundation course is necessary a Telford base, as already described, should be put in. However, in numerous cases in the city it is not necessary to build a foundation course, some streets having had a good stone foundation course for years, in which cases all that is required is that this old foundation course be trimmed off to the proper convexity, then stone to pass through a 2-inch ring be laid to a depth of 5 inches. It should be then thoroughly blinded with gravel and a little clay, watered and thoroughly rolled. This is admittedly a cheap form of construction and suitable for light traffic in residential districts, and it is submitted that this form of construction is most suitable for a very large number of streets in the city of Ottawa.

The control and prevention of dust on this class of road is one which should have very serious and careful consideration, and particularly in view of the automobile traffic which in all likelihood will develop. Dust has always been a feature of macadam roads, being at the same time the result of use and a check upon excessive wear. Prior to the introduction of automobiles, dust was considered as nothing more or less than a nuisance; to-day, however, the existence of macadam roads depends upon the retention of the road dust formed by the wearing of the surface. It has been found from experience that the broad pneumatic tires of heavy automobiles driven at high speeds draw out by suction the small particles which bind the material of a macadamized road, with the result that the road soon disintegrates.

Various methods are in use for preventing or reducing dust, amongst which might be mentioned sprinkling with fresh or salt water, a mixture of water and calcium chloride, oil emulsion, and impregnating or surfacing with crude oils or coal tar products. The writer has tried all these methods and has come to the conclusion that good tar, properly applied, is the cheapest and best dust preventative and preservative of macadam roads, being both effective and durable. The quality of the tar is very important. If it is heated too much, and refined to too great a degree, it becomes brittle and makes black dust. If not sufficiently refined, and the light oils taken off, it will disintegrate.

Before tarring a road surface the weather should be warm, to be favorable; and the road thoroughly brushed and cleaned. The tar should be heated to its boiling point at convenient positions on the works, and should be applied as hot as possible, so that it may flow freely. Immediately on application the liquid tar should be brushed in so far as necessary to ensure regularity in the thickness of the coating.

The quantity of tar required will vary according to the physical conditions of the road, but generally, in the case of a road to be treated with tar for the first time, the quantity should be one gallon to coat from 5 to 7 superficial yards.

*The mixing will be done at the city's asphalt plant.

If the road must be opened for traffic before the tar has set hard, grit should be spread on the surface to prevent the tar from adhering to the wheels of the vehicles, but gritting should be dispensed with as long as possible, and the quantity of gritting material to be spread should be no more than sufficient to prevent the tar from adhering to the wheels. Stone chippings, crushed gravel, coarse sand, or other approved material (free from dust) not larger than will pass through a ¼-inch square mesh should be used for gritting, in quantity not exceeding 1 ton for 300 or 350 superficial yards, if grit is used, and 1 ton for 200 superficial yards if coarse sand is used.

Precautions should be taken to prevent liquid tar passing directly through drainage gratings or outlets.

For the safety of the public, precautions should be taken by lighting, watching and warning.

The question of tarring has been dwelt upon at considerable length, but it is one which is all-important, not only as a dust preventative, but in increasing the life of the road.

Macadam Tar Painted and Stone Blocks.—This construction is intended for residential districts in which street cars are running and ordinary vehicular traffic is light. Both forms of construction have already been described.

Macadam Tar Painted and Granitoid.—This is another form of construction for residential districts in which street cars are running. Granitoid is really a concrete roadway with a specially finished surface. The concrete above the foundation course is laid with a very strong mixture of cement with a ¾-inch top laid with cement and granite or marble screenings, the latter being absolutely free from dust. Particular attention has to be paid to the sub-drainage of the concrete, otherwise there is sure to be trouble and subsequent failure of the work.

This form of construction has been tried successfully in Montreal, Westmount and Maisonneuve.

Stone Blocks.—It is considered that stone blocks should be used on streets traversed by extra heavy traffic. The stone for block paving should be specially selected and tested, the requirements being a tough stone which at the same time will not become unduly slippery under horse traffic.

The difficulty with stone block, or, in fact, with any block paving, is the laying and jointing. The usual custom is to lay the blocks on a cushion of sand, but the opinion is expressed that this is more of a detriment to this type of paving than otherwise. If moisture could be kept out it would be useful, but as soon as the moisture gets in, the sand starts to run, leaving the blocks suspended in one place and heaved up in another. All this trouble can be greatly overcome by laying and jointing these blocks with a cement grout, but most important of all is ample subdrainage.

Tar Macadam.—Tar macadam is a comparatively new road material. As a material for footways it has long been used in different forms. In some of the northern towns of England it has been used for roads for some years past, but its increasing employment is mainly due to the development of the motor and cycle traffic, and to the attempts that are being made to cope with the "dust problem." Its superiority over ordinary macadam is generally acknowledged. Some of its advantages, in this respect, may be summed up as follows:—

(1) It is more unperishable. The metal being coated and partly permeated with a viscous coating of tar, the stone does not absorb water. The surface coat is finer than ordinary macadam, and has fewer voids in it, so that water does not penetrate so easily.

(2) It has a longer life. The tarry coating, besides preserving the stone from the influence of the weather, largely nullifies the attrition accruing in ordinary macadams, and the tar is a better binder than any of those employed. In general, the road is more homogeneous and elastic.

(3) It is practically noiseless.

(4) It preserves a smoother surface than ordinary macadam. The dust is reduced to a minimum so that the cost of scavenging and watering is practically avoided.

(5) The coat of maintenance as regards repairs is less.

Its disadvantage is that of a slightly greater initial cost, but this is compensated for by its longer life. One engineer has complained that the surface is apt to be slippery in frosty weather and others have urged that the surface will become soft and sticky under hot sun. In most cases it is mentioned as suitable for "light traffic," or traffic "not too heavy." From this it might be erroneously inferred that tar macadam is inferior to ordinary macadam as regards wear. Tar macadam will take heavier traffic than ordinary macadam, but that it can be substituted for the necessary pavements in the streets of large towns and cities is too much to suppose. Its chief purpose will be to supersede ordinary macadam in small country towns and villages, main country roads, and suburban and residential quarters of the larger towns and cities.

Stone.—The stone most recommended for tar macadam is limestone, but iron slag has been found equally good and is of greater strength. Many satisfactory roads have been made with a mixture of limestone and slag. Some of the igneous rocks have been tried, but as a rule, these are too compact for crystalline to absorb any appreciable proportion of the tar, which, therefore, remains as a surface coating that easily wears off. A few engineers have, however, employed igneous stone and have been satisfied with the results; so that the question is still open. Derbyshire dolomitized limestone, Kentish rag, and Scarborough grit stone, have been largely employed for tar macadam. Mr. Purnell Hooley, who has long studied and experimented with this material, is an advocate of iron slag, and he is the patentee of a specially prepared brand of tar macadam. The question of adding coke-breeze or other fine material to the topping coat is one in dispute. At Harrogate 12% of coke-breeze is invariably added, and the borough engineer finds the topping coat improved thereby.

Tar.—The tar requires very careful watching. As previously mentioned, the surface of tar macadam has in some instances become exceedingly sticky and troublesome in hot weather; in some cases so much so that pedestrians' boots have stuck to the road and had to be left there. This is due to (*a*) the stone used not being suitable; (*b*) the material not being properly prepared, and, (*c*) the tar being defective.

In nine cases out of ten, defects in tar macadam may be attributed to the tar. The tar produced by different works varies exceeding in quality. The most recent tar-extracting apparatus employed in gas works does not appear to produce such good tar as formerly, and the brand of coal used also has a bearing on the subject. Unfortunately, the difference between poor and good tar cannot at present be established by analysis; samples of both

appearing chemically the same. The advice given by one well-known engineer is to find a gas works producing good tar, and use only the tar produced there.

The tar macadam is laid on the roadway in three grades, over a good foundation, which is always shaped up to the proper convexity. The aggregate of the surface is composed of broken stone, obtained in the vicinity: 60% broken to a size of 2½ in.; about 30%, 2½ in. to 1¼ in.; and 10%, ¾ in. to ½ in., for closing up interstices. The last-mentioned size is kept separate and used during rolling operations. The tar macadam, after being spread and levelled, is rolled into a smooth surface but not rolled to the same extent as an ordinary water-bound macadam road. A 10-ton roller is used for this work, as better results are obtained than when a heavy roller is used. After the roadway has been open for several weeks, a coating of tar is applied to the surface of the road, and covered with stone chippings, not larger than will pass through a quarter-inch mesh.

Engineers differ considerably about the preparation of materials, and no standardization is at present possible. Heating the stone dries it, and renders it in a better condition to absorb tar. On the other hand, it is contended that artificial drying is detrimental, and also that it is better to dry the stone by storage under cover. It is doubtful whether the latter method can be effectual for, though the stone is preserved from actual wetting, it will, in wet and humid weather, absorb moisture from the air.

As to the necessity of boiling the tar, there should be little doubt. Tar varies very much in the amount of volatile matter present and careful boiling for 2 or 3 hours will render the consistency more stable and more tenacious. If the tar is poor a little pitch may be added to enrich it. The boiling, however, must never be carried too far or the residue will be brittle. Considerable care must be exercised with the boiling. In preference to boiling, some engineers store their tar for some months before use, and in this case it is kept in concrete or iron tanks, set below the ground level, and fitted with valves, etc., to permit the escape of volatile gas. The tar should, in this case, be drawn from the bottom of the tank, and a pump must, therefore, be fitted to effect removal under this condition.

General.—The estimate of $3,172,119.55 would appear at first sight to be an enormous expenditure, but a study of the details and close examination of the streets in the city will convince anyone of the vast amount of work that has to be done and it has to be remembered that good roads cannot be constructed without a heavy expenditure of money.

The opinion is expressed that the first work to be undertaken is the construction of roadways which form the main arteries or trunk roads in the city.

The report is concluded by a paragraph pointing out that proper maintenance is as important as good construction, but that it cannot reasonably be expected that the small amount of about $50,000 given annually for the maintenance of roads in Ottawa is anything like sufficient.

Maintenance consists in keeping a roadway as nearly as practicable in the same condition as it was when originally made. The repair of a roadway is the work rendered necessary to bring it up to its original condition after it has become deteriorated by neglect to maintain it. There is a wide distinction between the two operations; the former keeps the road always in good condition, while the latter makes it so only occasionally.

ELECTRIC IRON SMELTING.

By Jens Orten-Boving, M.I.Mech.E., London, England.

THE method of producing iron and steel by the use of electric current has lately received much and well-deserved attention in Canada. It may, therefore, be of some interest to learn some data regarding the recent experiences and developments in Sweden. Before doing so, the fact might be pointed out that there is no other country in the old world so like Canada as Sweden. Both are mainly agricultural countries with a relatively sparse population; both have an abundance of water power, forest and high-class iron ore; both have splendid transport facilities, i.e., rail, lake or canal, and the climate is marked by similar fluctuations of temperature and by the remarkably clear, invigorating atmospheric conditions.

During the last five years some very remarkable developments in the iron industry of Sweden have taken place by the introduction of electric reduction of iron ore, producing pig iron, and by electric refining of low-quality steel to high-grade steel.

This article will deal with the two processes separately, although in many plants the refining should be an integral link in converting the ore into fine steel by one continuous process.

Electric Reduction of Iron Ore.—The system which has met with real commercial success is that of Electro-Metals, Limited, which has been described on several occasions in various technical papers. Other methods have been tried repeatedly but they have all been abandoned and to-day the Electro-Metal furnaces are the only ones in use in Sweden. The following is a list of Swedish furnaces:—

Working now.	Number.	Power consumed per furnace.	Total power consumed.
Strömsnäs Jernwerks A. B.	1	3,000	3,000
Uddeholm A. B. Hagfors ..	3	3,400	10,200
Stora Kopparbergs Bergslag A. B. Domnarfvet.....	1	3,600	3,600
Building now.			
Strömsnäs Jernwerks A. B.	1	3,000	3,000
Nykroppa Jernwerk	2	3,400	6,800
	8		26,000 h.p.

These furnaces will produce approximately 80,000 tons of pig iron per annum. The Stora Kopparberg Co. are putting down 10 more furnaces, not included in the above.

There are, further, a great many installations contemplated and it is certain that wherever there is cheap water power the old blast furnaces will be replaced by electric producers. Generally speaking, it holds good that wherever one horse-power per annum can be produced cheaper than the cost of two tons of charcoal or coke (depending on what class of iron is to be produced) it is a commercially successful undertaking to substitute electric heat for carbon heat.

The operation of the electric reduction furnace is much simpler than that of a blast furnace and everybody who has been visiting the Swedish works returns impressed by the extreme simplicity of the affair. Fewer hands are required as well as less skill than for a blast

furnace. The prime costs for the electric plant are also lower.

The following tables give all the data required for calculating the cost of one ton of iron produced. For a plant of, say, three furnaces of each 3,000 h.p. capacity the following staff and labor would be required: 1 chief engineer, 1 assistant, 2 chemists, 3 foremen, 2 electricians, 10 men in each of 3 shifts.

TABLE I.

Continuous Run of One Furnace Belonging to Strömsnäs Jernwerks A. B. from Oct. 1, 1912, to Sept. 1, 1913.

Number of charges	26,549
Weight of ore used, tons	11,338
Weight of limestone, tons	907
Weight of charcoal, tons	2,700
Produced pig iron, tons	7,258.3
Weight of charcoal used per ton of pig iron, lbs.	830
Total number of hours when running normal, hours	7,957
Total power consumed kw. hour, kw. hour	15,291
Total power consumed per ton iron, kw. hour	2,107
Weight of pig iron produced per 1 horse-power year, tons	3.05
Weight of pig iron produced per 1 horse-power year, tons	4.14
Total consumption of electrodes, tons	28.42
Consumption of electrodes per ton of pig iron produced, lbs.	8.7

operation, in August No. 2 was running, and now No. 3 is ready for starting up.

"The plant was originally designed for two furnaces only of 3,000 h.p. capacity each (the power consumption is actually 3,400 h.p.). The furnaces are placed in the central bay; on one side all the electrical gear is placed, transformers, switches, regulators, etc., this part being entirely isolated from the metallurgical part. The power is generated 9½ miles away at Forshufvud which power station belongs to the company. The voltage is 12,000 on the line and is reduced to low pressure by the transformers and adjusted by the regulators to between 50 and 100 volts as required.

"The furnaces, as well as the whole of the plant, have been designed by the Electro-Metals Co. and are mainly following the lines of the well-known Trollhattan furnaces, although the various details naturally show modifications based upon the experience from Trollhattan. There are 6 electrodes, cylindrical in shape and arranged to be used continuously without waste by screwing the ends together.

"The pouring bay is conveniently fitted with an electric overhead traveller as well as trolley tracks for transporting iron and slag. The iron can either be poured to pig or conveyed in ladles to the Bessemer and open-hearth works. The slag is run into block moulds and makes excellent building stone.

"The crushing room is at the end of the furnace building. There are 3 crushers of the ordinary jaw type. There is a railway track outside and the daily requirements are supplied in the trucks so that there is no need

TABLE II.

Continuous Run of the Trollhattan Furnace for Three Three-month Periods from 1st October, 1912, to 30th June, 1913.

(This furnace was run by the Swedish Association of Iron Masters with a view to establishing the practical success of the system as well as to give the various members an opportunity of trying their various kinds of ore. Thus, in the table below different kinds of ore were used during the period indicated.)

Period.	1 Oct., 1912, to 31 Dec., 1912.	1 Jan., 1913, to 31 March, 1913.	1 April, 1913, to 30 June, 1913.
Number of charges	6,193	7,107	7,281
Kiruna A ore ..... Tons	1,047	223·3	799.8
Tvollavara ore ..... "	973·4	123·3	762.6
Klacka-Lerberg ore ..... "	885.6	1,453	1,426.5
Persberg ore ..... "	8.82	47·97	148.4
Total ore ..... "	2,914.8	3,047.6	3,137·4
Limestone ..... "	169.94	252.8	273·5
Charcoal ..... "	699	719	738
Pig iron produced ..... "	1,905.86	1,933·32	2,000.14
Charcoal per ton pig iron ..... Lbs.	825	835	830
Actual Working time ..... Hours	2,158.5	2,113.7	2,147
Consumed power kw. hours ..... Units	3,957,565	4,095,588	4,216,544
Consumed power per ton pig iron ..... "	2,076	2,118	2,108
Produced pig iron per kw. year ..... Tons	4.22	4.14	4.15
Produced pig iron per h.p. year ..... "	3.10	3.04	3.05
Consumption of electrodes, total ..... "	5·307	8.670	7.896
Consumption of electrodes per ton pig iron ..... Lbs.	6.2	10.0	8.8

NOTE—The ore from Kiruna and Tvollavara is of the highest quality obtainable in Sweden. It will be seen that the output of the furnace as well as the consumption of electrodes depends largely on the quality of the ore used.

At a meeting at Kristinehamn of the iron masters in the district last spring the following observations were made by the chief engineer of the Hagfors electric furnace plant after the first year's running:

"The work with the foundations of our plant was commenced at the middle of April, 1911; eleven months later, or the 15th of March, 1912, furnace No. 1 was in

for big storing bins. One of the crushers is fairly large with wide enough jaw space for the biggest lumps, and the ore passes from the crusher to the smaller ones, and thence by a bucket elevator up to a belt conveyer above the charging platform so that the raw material may be unloaded where required. There is a small ore store but this only contains some limited reserve amounts of the

various kinds of ores used. These are from Taberg, Finnmossen and Nordmark. The charcoal is transported from the stores by a ropeway.

"Up to now three different kinds of pig iron have been produced: (1) Pig iron for open-hearth treatment; (2) pig iron for Lancashire treatment; (3) pig iron for Bessemer treatment.

"The quality which is desired for the open-hearth pig is semi-spiegel and contains Si, 0.40-0.60%; Mn, 0.30-0.50%; P., 0.011-0.018%; S., 0.015%.

"It will be seen later on that it is more economical to produce pure spiegel iron in the electric furnace, and arrangements are being made to alter the open-hearth furnaces so as to use spiegel iron only.

"It has been assumed in various quarters that it would probably be difficult to maintain a constant product in an electric furnace. Experience shows, on the contrary, that a much more constant product is obtained from the electric furnace than from our old blast furnaces. One of the reasons for this fact is that there is such a large receiver or collecting basin in the lower part of the electric furnace that this collector acts as a regulator on the quality.

"The Lancashire pig needed is quite white and has the following analysis: Si, 0.20-0.30%; Mn, 0.20-0.30%; P., 0.011-018%; S., 0.015-0.020%.

"In the beginning there was a tendency for the sulphur to be unduly high but this was put right by making the slag more basic whenever the furnace was run for Lancashire pig.

Bessemer Pig.—"The analysis of the quality used is: Si, 1.00-1.40%; Mn, 2.50-3.00%; P., 0.015-0.019%; S., 0.005%.

"Excellent Bessemer has repeatedly been made of this pig. At first the result was not good, but it was soon found that we had to increase Si and Mn. It had been assumed that the amount ought to be as usual, but the reason for the higher content being required is probably that the temperature of the electro-Bessemer pig is lower than for ordinary Bessemer pig from blast furnaces.

"We intend, however, to re-arrange the receiver in our electric furnace with a view to increase the temperature. Our general experience points to the following results: It is cheaper to make spiegel than grey pig because: (1) More current can be put through the furnace; (2) the current consumption is lower; (3) thus the production is higher; (4) the electrode consumption is lower; (5) the repair costs are lower.

"It may further be stated that rich charges give better results than poorer. The quality of the pig is not influenced by the percentage of iron contents of the ore.

"The electrode consumption has been relatively high and this is influenced by the following conditions:—

"1. High power consumption (which, of course, increases if the charges are poor).

"2. Too lively gas circulation and too large a proportion of CO_2 in the gas. (Of course the carbon consumption is correspondingly lower).

"3. Too large electrodes for the load.

"Since the 15th of January we have used the gas from the furnaces as fuel under our open-hearth furnaces and I estimate the value of the gas at from 2 to 3 shillings per ton of pig iron produced.

"Finally, regarding the influence of the electric pig on the finished steel, our experience shows that the change tends to make better steel; this holds good both for Bessemer as well as soft and hard open-hearth steel."

The steel produced at Hagfors is of the highest quality and is mainly used for locomotive boiler tubes, piano wires and high-tension wires generally. Practically the whole of the output is exported.

In Sweden generally the electric reduction of iron ore is regarded as revolutionizing in this industry and elaborate preparations are being made for constructing mills of considerable capacity. Recent experiences have shown that larger electrodes can be used at the same time as the current intensity on the electrodes is increased. Larger furnaces will therefore be designed and some of those now projected will have a capacity 8,000 h.p. each.

It has been found that when using coke instead of charcoal it is advantageous to run on burnt lime, as otherwise the power consumption is too high, which largely depends on too much CO_2 being produced.

Refining Furnace.—The Electro-Metals refining furnace is designed for 2-phase current, although 3-phase may be used by suitable design of the transformers and coupling the connections on Scott's system. The furnace has been correctly and carefully described in the July 25th, 1913, number of the *Electrical Review*, as well as in the *Iron and Coal Trades Review* and various other publications. A number of these furnaces are now in operation in Sweden and in Sheffield, England, and the working results are highly satisfactory.

To run this type of refining furnace is extremely simple, everything being so well arranged and balanced that any steel melter who knows open-hearth work can take charge of the electric furnace. No special training or skill is required from an electrical point of view.

These furnaces give a marvellous product inasmuch as it is quite easy to produce a high-class steel from any ordinary scrap with the greatest ease. The ordinary steel smelter used to open-hearth work will not believe the results in the beginning, but once he has familiarized himself with the proper use of various slags to remove sulphur and phosphorus, as well as how to determine the carbon content or to add alloys, he will be loath to return to the open-hearth furnace which, indeed, is a very clumsy and incomplete apparatus compared with the electric refining furnace.

The process is equally suitable for high and low grade steel, for castings, drills, tool and quality steel of every kind and use.

In a country like Canada, where electric current may be produced cheaply from water power the resmelting and refining of ordinary cheap scrap in an electric furnace becomes a very attractive undertaking, and it is curious that it has not been started long ago.

The following figures, taken from an article published in the *Electrical Review* of July 25th, give the actual costs of production.

Working Costs.	Per ton steel £	s.	d.
Electrode consumption	0	4	0
Lining, roof, felting	0	6	0
Slag materials	0	2	6
Labor (assuming auto-regulation)	0	6	0
Tools	0	1	0
Electric energy, 825 kw. hours @ .6d.	2	1	3
	3	0	9

These are actual figures taken from the Works cost sheets and are obtained from a furnace of 2½ tons capacity, so, naturally the figures are considerably reduced in larger furnaces.

It should also be noted that a very high rate is paid for the electric energy, as this is obtained from the municipal supply and is generated by steam. In Canada, utilizing water power, the current could easily be supplied at 0.2d. per kw.hr. corresponding to a charge of £6 per horse-power year based on 300 days a year continuous full load; consequently, in using the above figures as a base to figure out cost of production in Canada it must be borne in mind that although the cost of labor would be undoubtedly higher, the cost of electric energy would be only one-third and the total cost, as shown by the above figures, would be in the neighborhood of £2 os. od. per ton.

If a new iron works were planned in Canada electric reducing and refining should be used throughout and it is certain that with judicious arrangements adapted to the special requirements of the country such an undertaking would pay handsomely and the quality obtained would be so high that it would exclude the importation of a good many standard products of iron and steel.

Anybody interested in these matters need only look up the government's statistics on import to compile a very long list of raw material and half finished goods which could and should be made in the country.

THE OXIDATION OF COAL AND OF THE PROCESS OF COMBUSTION.*

By Horace C. Porter.

IT is well known from the work of several investigators in European laboratories and from earlier work at the Bureau of Mines that all coals unite with oxygen more or less at ordinary temperatures. The action is at ordinary temperatures largely a simple addition, very little gaseous products of combustion being produced. There is, however, a development of heat by the simple addition of oxygen, and this heat development is the primary cause of spontaneous combustion.

As the temperature rises, the oxidation reactions increase rapidly in rate, and the simple-addition reaction becomes complicated with the development of water and oxides of carbon as products of the oxidation and with the production of water and of methane and other gases by destructive distillation.

Under whatever conditions coal burns, as for example on the fuel bed of a boiler furnace or in suspension as dust in the air of a mine, the earlier stages of oxidation proceeding at the lower temperatures have important bearing on the ease of ignition of the fuel and the degree of inflammability of its dust. In order to throw more light on the nature of the combustion reactions at successive stages and to determine how the various kinds of coal differ in their rates of reaction with oxygen, a laboratory study has been made of the oxidation of coal, at temperatures ranging from 80 deg. to 300 deg. C.

A series of experiments has been run with samples of different coals placed in atmospheres of pure oxygen at a pressure reduced so as to equal the average partial pressure of the oxygen in air. The rate of absorption of oxygen by the coal was determined by admitting pure oxygen at such a rate as to maintain constant pressure in the apparatus. Large differences in rate were found between different kinds of coal, and the comparative oxidation rates thus found conform in general to the known comparative degrees of inflammability of these coals.

At temperatures above 200 deg. C. the production of CO_2 and other gases causes a considerable error in an experimental method which does not remove these gases as they are formed. A rapid-stream method was, therefore, devised in which weighed samples of dry coal were heated at definite temperatures in a rapid stream of dry air for one hour, the change in weight of the coal being accurately determined as well as the amounts of H_2O, CO_2 and CO produced. From these data the total oxygen used and the oxygen fixed were calculated.

It was shown that the oxidation of coal consists in the earlier stages of the formation of an unknown complex of the coal substance with oxygen, and the more or less gradual dissociation of this complex as the temperature rises into water, CO_2 and CO. Below 200 deg. water is the chief product of this dissociation, the proportion of CO_2 in the products increasing as the temperature rises. Carbon monoxide is a primary product of the oxidation of coal at temperatures between 100 deg. and 300 deg. C. and possibly also outside of this range. Triangular diagrams representing the relationship of the three products H_2O, CO_2 and CO at different temperatures show interesting tendencies, e.g., toward constancy in ratio between CO_2 and CO within a certain temperature range.

The production of water by oxidation of coal at 100 deg. C. or lower is of interest in connection with the devising of methods for accurate moisture determination in coal. The direct production of CO at moderate temperatures is of interest in connection with mining operations and the storage of coal.

*An address delivered at the annual meeting of the American Chemical Society, Rochester, N.Y., Sept. 9-12, published by permission of the Director of the Bureau of Mines.

Returns made to the Bureau of Mines show that the metal output of Ontario for the first quarter of 1913 was as shown in the accompanying table:—

Product.	Unit.	Quantity.
Gold	Oz.	50,637
Silver	Oz.	7,264,559
Copper	Tons.	3,075
Nickel	Tons.	6,311
Iron ore	Tons.	15,389
Pig iron	Tons.	181,042
Cobalt and nickel oxides	Lb.	280,096

The principal gold producers are the Hollinger and Dome; but the McEnany and MacIntyre also contributed, as well as the Cordova in Hastings County, and the Canadian Exploration Company at Long Lake. The Foster-Tough mine at the new camp of Kirkland Lake is turning out some rich ore. The quantity of ore milled in all was 69,905 tons, the average yield of gold being thus a little under ¾ oz. per ton. The production of silver was nearly equal to that for the corresponding period of last year, being only some 74,485 oz. less. The mines of Cobalt proper furnished 7,253,595 oz.; South Lorrain, 198,381 oz.; Gowganda, 54,350 oz., and from gold bullion, 10,964 oz. Shipments amounted to 7,053 tons ore, 2,130 tons concentrates, and 1,926,160 oz. of bullion. Silver refineries in Ontario recovered 2,754,292 ounces. The Sudbury mines yielded 1,589 tons more of nickel and 538 tons more of copper than during the first three months of 1912. The producing companies are the Canadian Copper Company and the Mond Nickel Company, but a third company, which acquired the holdings of the Dominion Nickel-Copper Company, is actively preparing for production.

EXPERIMENT AT SHERBROOKE, QUE.

Professor Barnes, of McGill University, and Lieutenant Daw, a post-graduate student of the same institution, have studied the flood question at Sherbrooke, Que., and believe that a proposed scientific experiment will prove a solution to the problem. Every spring the country at Sherbrooke is flooded by the anchor ice in the rivers, which causes the pack ice to form and, thereby, holds back the water, which spreads over the low lying country to its great detriment.

Lieutenant Daw has been given permission from his commanding officer, Lieutenant-Colonel Harrison, of Montreal, to form a field corps of Canadian engineers. The matter has been submitted to head authorities by Colonel Harrison, and Lieutenant Daw has been informed that the authorization of his scheme is expected to be in orders within two months.

The services of forty-two engineers will be utilized, in conjunction with those of Professor Barnes, to relieve Sherbrooke from its annual floods. The scheme is that at a crucial moment, when the anchor ice is about to accumulate the pack, this troop will be summoned by alarm bombs from the armory to assemble post haste and proceed by motor, oar, or horse to the scene of danger, either in the night or day time. Arriving at the anchor ice field, they will drill the ice in a scientific manner, place gun cotton primers in the holes, attach electrical connection carrying leads to a safe point of observation, and after receiving the trumpet calls from up and down the river, on both sides, to the effect that the inhabitants within range of the explosion are out of danger, and have opened their windows to prevent them being broken by the dynamic and static shocks of the explosion, the mine will be fired.

Lieutenant Daw has received a request from the town of Richmond asking him to organize a corps on similar lines for that town's benefit; and also letters from the Minister of the Interior informing him that he is so interested in the matter that he has laid the scheme before the Ministers of Public Works and Militia.

If the scheme is successful, and those who advocate it are very confident that it will be, it may also be tried on the St. Lawrence River to prevent the floods on the South Shore, which also take place in the spring every year, through somewhat similar causes.

ARCH BRIDGE AT SASKATOON.

Though the contractors—the R. J. Lecky Company, of Regina—were delayed in getting their outfit on the ground, good progress has been made on the construction of the arch bridge over the Saskatchewan River from the intersection of 25th Street and Spadina Crescent on the west bank to the intersection of Clarence and Saskatchewan Streets on the east bank. The work was commenced on September 2nd, and already the excavation for five piers has been completed; and one pier, one retaining wall, and one pedestal, have been finished. Boring tests have been put down in all the excavations with a view to determining the nature of the foundation and all were found highly satisfactory.

Throughout the winter months, a force of 80 men will continue building operations; but in the spring this number will be greatly augmented. And by December 1, 1914, Saskatoon is to have an arch bridge unsurpassed by any like structure in Canada, being the largest reinforced concrete bridge in this country, and taking high rank among the great bridges of the North American continent. Its approximate cost is $400,000; and under the terms of the agreement entered into between the city and provincial government, the former is to pay one-third and the latter two-thirds of the cost of the structure.

The plans prepared through the instructions and under the direction of the highways commissioners, call for a bridge consisting of a series of arches with a floor on practically a 3 per cent. grade from east to west, in order to meet the rise on the university side of the river. The total width of the structure is to be 65 feet. Two 8-foot sidewalks are to be cantilevered from the roadway, while provision is made for two street car tracks and two 14-foot roadways, making ample room for each section.

The arches of 150 feet are notable as being longer in span than any in the Dominion of Canada. The total length of the bridge and the retaining walls at its approaches is to be about 1,490 feet. It consists of one arch of 25 feet span, one arch of 66 feet span, one arch of 92 feet span, one arch of 103 feet span, one arch of 136 feet span, four arches of 150 feet span, and one irregular arch of 94 feet span.

Special care was used in working out the design and the allowable stresses are considered most moderate. The variations of temperature cause the concrete to expand or contract, the bridge being designed for a temperature range from 50 degrees below Zero to 90 degrees above. In all probability this variation of temperature is larger than that contemplated for any other concrete bridge ever built.

The site selected presented various engineering difficulties. Chief among these was the elevation of the east side bank about fifty feet higher than on the west bank. During high water the river is 1,100 feet wide at this point. Special care also had to be exercised from an aesthetic standpoint, for the bridge will cross from a park on the east side to the University grounds on the opposite side of the river.

A new company has been formed to connect North and South Shields, Eng., by tunnel, through which an electric railway will run. A quarter million pounds sterling has been assured and the sanction of Parliament for the project is to be asked at the next session. At present communication across the mouth of the Tyne is by ferry only, and the service is frequently interrrupted by stormy weather. Liverpool and Birkenhead were successfully linked by tunnel some years ago.

A concrete hardening material now being introduced contains 95 per cent. iron dust or iron flour, which is mixed with cement for finishing the surface of concrete floors, says "Engineering News." From 15 to 25 lbs. of the material is mixed with 100 lbs. of the cement while dry, and one part of this mixture to two parts of sand makes the slush for the top coat, which varies from ½ to 1 in. in thickness. It is said to make a hard and durable floor, which is waterproof and not slippery. The hardening material is used also to make new concrete adhere to old concrete in repair work. This concrete hardener is made by the Globe Steel Company, of Mansfield, Ohio.

COAST TO COAST.

Mawer, Sask.—The steel of the Grand Trunk Pacific has now reached Mawer, a town staked out but three months ago, but now having a population of 450 people.

Calgary, Alta.—Two new street car lines have been put into operation at Calgary—e.g., the extensions to Bankview and Glengarry, in the south district, and to Capitol Hill on the north.

Guelph, Ont.—At the November meeting of the Light and Heat Commission, Manager Heeg reported that there had been 323 electric services and 10 power services installed during the past year, as well as 338 gas services. In addition to these, 37 electric street lights have been installed.

St. Marys, Ont.—At a meeting of the water, light and heat board, Superintendent Miller stated that from January 1st to October 31st the board had a net profit from the electric light department of $650. The waterworks department showed a deficit.

Montreal, Que.—The C.P.R., G.T.R., and C.N.R., all reported an increase in weekly earnings for the first week in December of this year over the corresponding week of 1912. The increase for the C.P.R. was $238,000; for the G.T.R., $10,102; and for the C.N.R., $15,100.

Brandon, Man.—The report on the street railway for the month of November shows that the returns for that month average $7.46 daily in excess of the month of October, although the cost of operating is practically the same, and although the number of miles operated is approximately 2,000 less.

Fredericton, N.B.—The inauguration ceremony in connection with the commencement of the operation of a regular train service on the new Gibson and Minto Railway was conducted by Sir Thomas Tait; while that in connection with the Southampton line was carried out under Manager Sherwood's management.

Vancouver, B.C.—Owing to the high price at whi... water frontage and suitable sites for shipyards are held on the mainland and points on Vancouver Island, it has been stated with authority that it is improbable that the famous Yarrows Shipbuilding Company, of Scotland, will locate a site for a plant in British Columbia.

Vancouver, B.C.—A statement that the appropriation of $5,000,000 for Vancouver's harbor development includes the cost of the $4,000,000 government dock, has been contradicted. Neither is the cost of dredging False Creek included in the appropriation. The dock and dredging are being done under the supervision of the department of public works.

Calgary, Alta.—The surplus of the city of Calgary's municipal electric light department for ten months amounts to $40,000, according to figures that have just been compiled. The city buys power en bloc from a company which develops it at a hydro-electric plant on the Bow river, and also generates a greater quantity itself by means of a steam plant.

Peterborough, Ont.—The erection of the ornamental iron standards in connection with the Hydro-Electric street lighting system on Hunter and Simcoe Streets is progressing, and when these have been erected and the lamps placed, the downtown lighting system as originally proposed and outlined by Mr. Jeffery, engineer for the Hydro-Electric Commission of Ontario, will be complete.

Berlin, Ont.—Extensions to the Berlin waterworks system, costing $100,000, are practically completed. Water from nine artesian wells will be pumped by Hydro power instead of by steam plant. The new concrete stand pipe in North Ward, the largest on the continent, and the immense reservoir at the pumping station were filled some days ago, and will provide high pressure in case of fire.

Kaslo, B.C.—The arrival of the first locomotive at Kaslo over the new standard gauge railway line from Whitewater was celebrated by a smoking concert, attended by the municipal officials, prominent members of the board of trade, and citizens. Credit for the prompt completion of the line was given to W. P. Tierney, the Vancouver contractor, and to E. A. Sharpe, the C.P.R. engineer.

Montreal, Que.—According to the recent statement of J. McMillan, general superintendent of western lines, nearly 6,000 miles of wire and new lines have been constructed by the C.P.R.'s telegraph in the west this season. More exactly the figures are: 3,240 miles of copper wire, 1,420 miles of iron wire, 689 miles of railway equipped with train telephone despatching circuit, and 475 miles of telegraph along new railway and extension work still in progress, making a grand total of 5,824 miles of wire.

Montreal, Que.—The work on the western section of the Grand Trunk Pacific is being carried on in British Columbia, from Rose Lake to Hutton—217 miles; in Sasktachewan, the Prince Albert branch—36 miles,—the Moose Jaw Northwest branch—19 miles,—the Weyburn branch, 20 miles; in Manitoba, the Brandon branch—26 miles. This means that in a few months this line will be a continuous unit; and the company has ordered additional equipment so as to commence an efficient and standard service.

Nelson, B.C.—The receipts of the Nelson Street Railway show a gratifying increase of $197.40 for the month of November, 1913, over the corresponding month of last year and an increase during the first week of December of $55.25 over the same period of last year. For the month of November the receipts amounted to $1,200.45, while for November, 1912, they amounted to $1,003.25. The first week of December the earnings of the company were $368.00, and for the corresponding week last year the earnings amounted to $312.75.

Montreal, Que.—The Calgary Power Company, for the 11 months ending November 30th, showed satisfactory increases over the corresponding period last year. For 1912 the gross earnings were $178,486; for 1913, $213,672. For 1912 the net earnings were $145,583; for 1913, $171,318. The fourth unit at Bow Falls is now practically completed and everything will be ready to commence generating power from this additional unit early in December. By the installation of the fourth unit the capacity of this plant is increased to 19,000 h.p.

Ottawa, Ont.—An increase in traffic on Canadian canals amounting to more than four million tons for the navigation season of 1913, which officially closed on November 30th, over the total tonnage of traffic recorded for the corresponding period of 1912 is shown in the report issued by A. W. Campbell, Deputy Minister of Railways and Canals. The total tonnage through Canadian canals for the past navigation season was 51,319,426 tons. Last year the total was 46,952,605 tons. The figures for the 1913 year, therefore, show an increase of 4,366,821 tons.

St. John, N.B.—The Quebec Railway Company, which has recently filed its petition before the State Railway Commissioners at Augusta for permission to construct 111 miles of track from Washburn westward to the Canadian boundary line of Maine, will, according to President Arthur Gould, ultimately form a continuous electric line between the tidewater at St. John and Quebec. The Canadian Pacific and the Aroostook Valley roads would combine with the new line to form the continuous chain between the two cities. The section of the road between Andover, N.B., and Washburn has already been built and is in operation.

Victoria, B.C.—Premier McBride has stated, in connection with President Wilson's recent message to Congress in

the United States concerning railway development in the north, that he believes the construction of a line of railway north and south through British Columbia providing access to the Atlin and the Yukon to be a national enterprise. He says that closely linked with such a possibility as the establishment of this line is the building of railways in Alaska and the eventual linking up of that district with the United States proper by means of steel running through the Yukon and province of British Columbia.

Fredericton, N.B.—Up to the month of December 72 miles of rails had been laid on the St. John Valley Railway, according to the report presented to the Provincial Government at the closing meeting of the December sessions. The estimates for work on the Valley Railway during the month of November amounted to about $100,000, while progress reports showed $142,000 of work done in October. Of the steel now laid, 25 miles is south of Fredericton and about an equal distance north and also south of Woodstock. Construction work will be carried along as much as practicable throughout the winter.

Toronto, Ont.—The construction of a new double circuit power line between Niagara Falls and the main transmission station at Dundas, the doubling of the present line between Dundas and St. Thomas by way of London, and the enlargement of half-a-dozen sub-stations, all to cope with the rapid expansion to the consumption of power, have been practically decided upon by the Ontario Hydro-Electric Commission. The construction of the Niagara Falls-Dundas line will necessitate the acquisition of a right-of-way and involve an expenditure of approximately half a million dollars; and the doubling of the Dundas-St. Thomas transmission line will mean another hundred thousand.

Ottawa, Ont.—It has been stated by Controller Nelson, of Ottawa, that this year over 5 miles of pavements have been laid at a total cost of $300,000, 13 miles of sidewalks at a cost of $70,000, and sidewalk repairs to the extent of practically two miles of new walks. However, Alderman McNeill has taken an active interest in traffic regulations this year, and states that next year Ottawa will have to devote more money and attention to roads. He claims that the money now allowed for maintenance is insufficient. There has been much repair needed which could not be undertaken this year, and holes in roadways should be repaired at once, not when they have become a menace to traffic.

Victoria, B.C.—Mr. Taylor, minister of public works, is reported as having declared that within the next year or two British Columbia will possess an up-to-date highway, extending from Kamloops to Tete Jaune Cache, and giving connection through to Edmonton. The provincial government has already established a good road for about 90 miles north of Kamloops along the north Thompson river, and it is to be extended later north to Tete Jaune Cache, where it will meet the highway built by the Grank Trunk Pacific contractors, east and west. It is probable that this road will be taken over by the province from Tete Jaune Cache to the provincial boundary line at Yellowhead pass; and already a fairly good railway contractors' road extends through the Rockies to the east along the Grand Trunk Pacific route to Edmonton.

Vancouver, B.C.—Ever since the new Coquitlam dam of the B.C.E.R. company was completed several months ago, water has been rising rapidly; and not long since poured for the first time over the spillway, proving the company's scheme to provide an adequate water supply for its power houses at Lake Buntzen to be a success. The water takes a drop of 73 feet from the top of the spillway to the bed of the river below. There is now stored behind the dam 8,000,000,000 cubic feet of water, or 50,000,000,000 imperial gallons. From Coquitlam Lake, as now enlarged, water is drawn off by means of the tunnel to the two power houses on the shore of the north arm of Burrard Inlet. The capacity of the spillway is three times the maximum flood into the lake and the dam has been constructed so that water will never pour over it.

Ottawa, Ont.—The proposed route of the All-Red Railway and Steamship Line, which is to seek incorporation at the next session of parliament, is from Cape St. Charles, on the coast of Labrador, north of Newfoundland, through northern Quebec to Winnipeg, and on to Dean Inlet, on the Pacific coast, running north, but parallel with the G.T.P., where it turns south to the coast. This route will reduce the time, it is claimed, between Winnipeg and Liverpool to four days. The route between the Atlantic coast and Winnipeg is through virgin country, which contains immense quantities of pulp. It is proposed to connect with the C.N.R. at Quebec. The time between New York and Liverpool by rail to Cape St. Charles, thence by steamer, will be reduced to three days and two nights. Owing to the shortening of the ocean trip it is thought very much traffic could be diverted from New York. As the road will follow the height of land, very little bridge building will be required.

Victoria, B.C.—The 50 arc light set and a spare transformer for the city light station are expected to arrive daily in the city, having been shipped from Peterboro. An installation of the lights on Ross Bay seawall driveway will be completed this month, the conduits having been put in when the street was paved some months ago. The "Park" type of fixed lights will be utilized, the light being attached to the standard, this rigid variety being considered the best, owing to the exposed position of Ross Bay. When this work is completed, the only portion of the waterfront from the city boundary to the outer wharf, unlit at night, will be the stretch of macadam across Beacon Hill Park. In order to rearrange the lodes for arc lighting, trunk connections are being installed through the city from Herald Street eastwards, and when the cables are in, the lode on circuits in the east and south-east portion of the city will be re-distributed. A number of new lights are being installed, and with the payment for the new equipment now on order, the loan of 1911 will about be used. City Electrician Hutchison believes that the future arc lighting extensions can be cared for out of revenue after the loan is expended.

Victoria, B.C.—Eight new bridges are now being constructed by the provincial board of works department, and three bridges are being renewed. Work on all of the structures is to be completed early next spring. Most important among those under construction is the bridge at Taghun, near Nelson, B.C., which will span the Kootenay river, and will cost about $90,000. It will comprise 3 steel spans with approaches, and will rest on steel cylinder piers filled with concrete. The bridge to be constructed across the North Thompson river at the mouth of the Barrier river, 40 miles north of Kamloops, will comprise one swing span and two fixed spans. Three bridges are being constructed across the Eagle river between Sicamous and Revelstoke; and two are being built over the Skeena river, one at Terrace, and the other at Smithers, this latter to have piled piers and Howe truss spans. The last of the eight new bridges is Clayton's bridge, to be built over the Bella Coola river. Those being renewed are one at Princeton, which will be a wooden truss structure on concrete piers, and will span the Tulameen river; one across the Okanagan river at Penticton, a swing-span bridge; and the third over Toby creek at Athalmar, in the Columbia district. Nothing definite has been done yet in connection with proceedings on the actual construction of the proposed Pit river bridge on the Dewdney trunk road.

Vancouver, B.C.—As far as the money available will allow, it is likely that the city will go ahead with the building of the causeway across Coal Harbor, and that the Park Board will move back the zoo and gradually improve the

surroundings of the harbor immediately. The work of building the causeway will be for the city works department, $155,000 having been appropriated for the preliminary expenses of the project. Ald. S. J. Crowe, chairman of the Civic Board of Works, declared recently that he was in favor of calling for tenders for the causeway immediately so that the city could go ahead with the work first thing in the spring, or as soon as money was available. Plans were passed some time ago by the Civic Bridges and Railways Committee, and they are said to have been drawn up with a view to conforming to the Mawson scheme. Chairman W. R. Owen, of the Park Board, said that the Board had asked for the approval of only the ground plan drawn up by Mr. T. H. Mawson, and that the work to be done, while gradual in effect, would conform to the general plan. In the meantime, the Park Board, he said, would trim up Coal Harbor and as soon as possible begin to fill in round the edges until the circular lake was formed. There was no intention in the plan of doing a great deal of expensive embankment work at once, but grassy slopes would likely be the scheme at first.

Montreal, Que.—Early in the morning of December 10th, at a point some 620 feet below the highest point of Mount Royal, the two headings of the Canadian Northern tunnel met almost exactly fifteen months after the first heading in the tunnel was commenced, and on the same day the first train ran through the tunnel from the west portal to the Dorchester Street shaft. Though the two heads started over three miles away from one another, when they were joined the grades were practically the same. Guests invited to make the first journey through the tunnel included Chief Justice Sir Charles Davidson, Acting Mayor Drummond, Controller Dupuis, Mr. Cowie, chief engineer of the Harbor Commission, J. E. Dalrymple, vice-persident of the Grand Trunk Railway, David McNicoll, vice-president of the C.P.R., Mr. Fairbairn, chief engineer of the C.P.R., Mr. Safford, chief engineer of the Grand Trunk Railway, Phelps Johnson, managing director of the Dominion Bridge Company, Prof. McLeod, secretary of the Canadian Society of Civil Engineers, G. H. Duggan, vice-president of the Dominion Bridge Company, and Professors Adams, Porter and Bancroft, of McGill University. This establishes a new record for deep tunnelling on the American continent and takes the record from the United States, while, with the exception of certain of the Swiss tunnels, where the headings are much smaller and the rocks softer, the achievement of the Canadian Northern engineers is a world's record.

PERSONAL.

W. D. L. HARVIE and M. A. REID have been elected public utilities commissioners for Lethbridge. ALEX. GRACE received the appointment of public works commissioner.

A. D. SMITH, for some time manager of the Western Electric Company at Fort William, Ont., has been appointed electrical inspector for that city, to assume duties January 1st.

J. K. SKAMMELL, District Engineer for the Department of Public Works at Fredericton, N.B., has been obliged to discontinue his services for the time being owing to severe accidental injury sustained recently.

HON. ADAM BECK, Chairman of the Hydro-Electric Power Commission of Ontario, who was in New York last week in an advisory capacity respecting the feasibility of power development, sailed for England on the 13th instant.

T. H. HOGG, B.A.Sc., has been appointed to succeed Mr. C. H. Mitchell, C.E., as one of the representatives of the graduate body of the Faculty of Applied Science on the Senate of the University of Toronto, Mr. Mitchell having recently resigned.

TH. SEIDL, Manager and Chief Engineer of Messrs. Escher, Wyss & Company, Montreal, started on a short trip to Switzerland on the 16th December. Mr. Seidl expects to be back in Montreal on 20th January. During his absence Mr. Withers will be in charge of the office.

ARTHUR H. BLANCHARD, M. Can. Soc. C.E., professor in charge of the graduate course in highway engineering at Columbia University, on December 6th delivered an illustrated lecture on "Modern Developments in Highway Engineering" before the Drexel Institute of Philadelphia.

J. T. BRECKON, hydraulic engineer, Vancouver, has been recommended to take charge of Vancouver waterworks system under Mr. F. L. Fellowes, Supervising City Engineer. Mr. Breckon is a native of Oakville, Ont. He has had twenty-five years' experience in Canada and the United States in connection with waterworks, power plants, water supply and sewage disposal systems. Since September, 1912, he has been in charge of the design and construction of the waterworks system for the Associated Cement Company at Bamberton, B.C.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, is minus the following issues: Feb. 19th, 1909; May 4th, 1911; May 11th, 1911; May 18th, 1911; May 25th, 1911; June 1st, 1911, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these numbers, and who do not care to keep them, kindly send them in to this office, and we will see to it that they are put into the hands of the party interested?

MANITOBA BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the annual meeting of the Canadian Society of Civil Engineers, held in Winnipeg on the 4th instant, Professor E. Brydone-Jack was elected chairman for the ensuing year, with Mr. G. E. Bell as Secretary-Treasurer. It will be remembered that Professor Brydone-Jack was secretary last year, while Mr. J. G. LeGrand was chairman. The new secretary may be communicated with at Box 2918, Winnipeg.

It is reported that on Dec. 2nd a mechanical section of the Canadian Society of Civil Engineers, Manitoba Branch, was organized. Mr. A. C. Frith was chosen chairman of this section; Mr. R. R. Neild, vice-chairman, and Mr. J. F. Tracey, secretary. The executive committee consists of Messrs. J. W. Dorsey, S. S. Kennedy, T. L. Roberts, W. J. Gilmore, W. Jardine, and R. Milne. The next meeting of the section will be held on the first Monday in January.

COMING MEETINGS.

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

MINING AND METALLURGICAL SOCIETY OF AMERICA.—Annual Meeting will be held in New York City, January 13th, 1914. Secretary, W. R. Ingalls, 505 Pearl Street, New York.

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

ORDERS OF THE RAILWAY COMMISSIONERS
OF CANADA

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

20939—December 2—Amending Order No. 10568, February 26th, 1910, to provide that crossing of Plymouth Road be protected by day and night watchmen; cost of maintaining gates be apportioned: 15 per cent. by town of Welland, 10 per cent. by Tp. Crowland, and remainder by M.C.R.R. Co.

20940—December 3—Approving location C.P.R. Swift Current North Westerly Branch from point in Sec. 16-23-20, W. 3 M., at mileage 111.17, to point in Sec. 12-5-3, W. 4 M., at mileage 134.38, and authorizing construction of said branch across 23 highways.

20941—December 5—Approving location C.P.R. Bassano Easterly Branch Line from point on East Boundary of N.E. ¼ Sec. 13-24-1, W. 4 M., at mileage 118.39 to point in Sec. 6-26-21, W. 3 M., at mileage 180.20. And authorizing construction of said line across 63 highways.

20942—December 1—Extending until July 1st, 1914, time for approval of C.P.R. tolls between points in Canada west of and including Sudbury, Ont., to and from points west of Sudbury, from, and to points east thereof, and east of and including Windsor, Ont., also included in said tariff; during such period C.P.R. is allowed to charge tolls it was authorized to charge under Acts 7-8, Edw. VII., Chapter 61.

20943—December 2—Authorizing, temporarily, until June 1st, 1914, C.L. and W. to operate trains over crossing of Oshawa Electric Ry., at mileage 158.85, at Prospect St., town of Oshawa, Ont., subject to condition that crossing be protected by flagman appointed and maintained by and at expense of Ry. Co.

20944—December 3—Approving location C.P.R. station at Willon, S.E. ¼ Sec. 10-14-28, W. P. M., Man., at mileage 26.5, on Virden-McAuley Branch.

20945—December 2—Authorizing C.P.R. to construct spur on parcel of land leased from Government, lying northeasterly of right-of-way of C.P.R. main line, and Dog Lake, in Tp. 46, Dist. Algoma, Ont., at mileage 58.8, Lake Superior Division.

20946—December 1—Extending, until July 1st, 1914, time limited by Sec. 4, Ch. 61, of Acts 7-8 Ed. VII., and extended until December 1st, 1913, by Order No. 19423, dated May 30th, 1913, for approval of G.N.W. Tel. Co.'s tolls between points in Canada west of North Bay, also to and from points west of North Bay and to points east thereof, and east of and including Windsor, Ont., also included in said tariff, during such period G.N.W. is allowed to charge tolls it was authorized to charge under Acts 7-8, Ed. VII., Ch. 61.

20947—December 1—Extending, until July 1st, 1914, time for approval of Can. Nor. Tel. Co.'s tolls for the transmission of telegraph messages between points in Canada; during such period C.N. Tel. Co. is allowed to charge tolls it was authorized to charge under Acts 7-8 Ed. VII., Ch. 61.

20948—December 3—Authorizing Can. Nor. Western Ry. Co. to construct across and connect with tracks of City Industrial Spurs in city of Medicine Hat, Alberta.

20949—December 2—Authorizing C.N.R. to construct spur for the Scott Fruit Co., city of Regina, Saskatchewan.

20950—December 1—Extending, until July 1st, 1914, time for approval of White Pass and Yukon Route tolls for transmission of telegraph messages between points in Canada; during such period company is allowed to charge tolls it was authorized to charge under Acts 7-8, Ed. VII., Chapter 61.

20951—December 1—Extending, until July 1st, 1914, time for approval of G.T.P. Tel. Co.'s tolls for transmission of telegraph messages between points in Canada, with exception of tolls of Co. between its local offices, on its Ottawa Division, in Provinces of Ontario and Quebec, and between them and Swanton, Vt., approved by Order No. 11153, dated July 12th, 1910; during such period Tel. Co. is allowed to charge tolls it was authorized to charge under Acts 7-8, Ed. VII., Chapter 61.

20952—December 4—Authorizing G.T.P. Ry. to construct Government Road Diversion across main line in S.W. ¼ Sec. 35-52-1, W. 5 M., at mileage 818-6 west of Winnipeg, Dist. North Alta., Alta.

20953—December 5—Authorizing C.P.R. to construct siding at Melba, across highway between N.W. ¼ Sec. 18-17-3, W. 3 M., and N.E. ¼ Sec. 13-17-4, W. 3 M., at mileage 41.9 from Moose Jaw, Sask.

20954—December 5—Relieving C.P.R. from providing further protection at crossing of First Avenue, village of Souris, Man., at mileage 16.6 on Estevan Subdivision, ¼ mile west of Souris Station.

20955—November 24—Directing that crossing at Broadway Street, town of Yorkton, Sask., be protected by a watchman, appointed by C.P.R., from 8.30 a.m. to 8 p.m., except during grain shipping season, when such crossing be protected night and day; wages of watchman be borne 60 per cent. by Ry. Co., and 40 per cent. by town of Yorkton.

20956—December 5—Extending, until May 15th, 1914, time within which C.P.R. complete spur for Canadian Metal Shelter Company, Winnipeg, Man., authorized under Order No. 19325.

20957—December 5—Authorizing C.P.R. to construct, by means of grade crossings, an additional track (double track) of main line, Sask. Division, Swift Current Subdivision, across five highways—M. 40. 8, N.W. ¼ Sec., 17-17-3, W. 3 M.; 2. M. 43 7, Sec. 23 and 26-17-4, W. 3 M.; 50.3, Secs. 25 and 26-17-5, W. 3 M.; 4. 51.3, Secs. 26 and 27-17-5, W. 3 M.; and 5, mileage 66.69, Secs. 22 and 21-17-7, W. 3 M., Ernfold, Sask.

20958—December 5—Amending Order No. 20502, by striking out figures "15" wherever they occur in recital and operative parts of Order and inserting in their place and stead figures "14," so as to make Order read, "and across Sec. 27, Tp. 18, R. 14, W. 2 M."

20959—December 5—Authorizing C.P.R. to use and operate Bridge No. 613 on Teeswater Subdivision, Ont. Division.

20960—December 3—Authorizing G.T.P. Branch Lines Company, to construct spur for Hamilton Brothers, village of Fort Qu'Appelle, Sask.

20961—December 4—Approving plan "B," dated November 25th, 1913, filed by G.T.R., and showing location of transfer track, town of Port Hope, Ont.

20962—December 3—Directing that, within 60 days from date of this Order, G.T.R., install automatic electric bell at crossing of highway, between Cons. 6 and 7, Tp. Otonabee, ½ mile west of Keane Station, Ont., 20 per cent. cost of installing bell paid out of Ry. Grade Crossing Fund, remainder by Ry. Company.

20963—December 5—Authorizing G.T.P. Branch Lines Company to operate trains over crossing of C.N.R., Maryfield Branch in N.W. ¼, Sec. 9-5-6, W. 2 M., Dist. Assiniboia, Sask., without their being brought to a stop.

20964—December 4—Directing that G.T.R., within 60 days from date of this Order, install improved type of automatic bell at crossing of public road west of Ste. Justine Station, Que.; 20 per cent. of cost of installing said bell be paid out of Railway Grade Crossing Fund, remainder by Ry. Company.

20965—December 4—Extending, for a period of 1 year from December 1st, 1913, Order No. 12723, dated December 6th, 1910, subject to condition that crossing be protected by gates, to be erected and operated by and at expense of applicant company (C.N.O.R.).

20966—December 9—Substituing plan No. 53515 as revised to December 5th, 1913, for plans approved under Order No. 20827, dated November 14th, 1913. 2. Openings be left in said bridge between piers 11 and 12 and piers 15 and 16, as shown on plan marked Plan "A."

20967—December 10—Approving proposed Supplement No. 2 to Canadian Freight Classification No. 16, as finally revised and submitted for approval by G. C. Ransom, Chairman, Can. Freight Association, by his letter dated Montreal, December 6th, 1913, effective not later than January 20th, 1913.

20968—December 6—Authorizing G.T.P. Ry. to construct highway between Secs. 32 and 33-51-20, W. 4 M., Alta., across its main line at mileage 763.7, west of Winnipeg.

20969—December 5—Approving revised location G.T.P. Ry. main line from East Line of Lot 5337 to West Line of Lot 5336, Cariboo District, B.C. Also approving location of station in Lot 5336, mileage 95, Yellowhead Pass West, B.C.

20970—December 6—Authorizing C.P.R. to reconstruct Bridge No. 2.0, Montreal Terminals, Eastern Division.

20971—December 10—Amending Order No. 20775, dated November 6th, 1913, by striking out figure "8" after words "Lot No.," in seventh line of operative part of Order, and substituting therefore figure "5."

20972—October 31—Establishing collection and delivery limits of Express Companies in Edmonton, Alta.: And rescinding Orders Nos. 14987 and 15759, dated respectively 11th September, 1911,, and 8th January, 1912.

20973—December 4—Establishing collection and delivery limits of Express Companies in city of Levis, Que.

20974—December 9—Authorizing city of Edmonton, Alta., to operate its Electric Street Ry., over G.T.P. Ry., at 27th Street, pending installation of half-interlocking plant required to be installed under Order No. 20793, subject to and upon conditions that crossing be protected by flagmen, appointed and maintained by and at expense of city; cars of city be stopped 100 feet from diamond; trains of G.T.P. Ry. to approach crossing under control, prepared to stop if electric railway is making crossing.

20975—December 9—Extending, until April 1st, 1914, time within which G.T.R. install gates at crossing of Wallace Avenue, Toronto, Ont.

20976—December 9—Authorizing Edmonton, Dunvegan and B.C. Ry. to construct bridge across Athabasca River, mileage 131, west of Edmonton, Alta.

20977—December 9—Authorizing Esquimalt and Nanaimo Ry. to consruct across Campbell Street, Nanaimo, to serve Nanaimo Pressed Brick and Terra Cotta Company.

20978—November 27—Authorizing C.L.O. and W. Ry. (C.P.R.) to operate trains, temporarily, until June 1st, 1914, over crossing of Toronto and Eastern Ry., at junction of Scugog and Wellington Streets, town of Bowmanville, mileage 149.2 from Glen Tay.

20979—December 9—Authorizing C.P.R. to construct spur for Imperial Oil Co., Limited, Montreal, Que.

20980—December 3—Approving and authorizing clearances as shown on plan of C.P.R. siding for Imperial Oil Company, Calgary, Alta., subject to condition that men keep off sides of cars while operating said siding.

20981—December 9—Extending, until April 1st, 1914, time within which G.T.R. commence construction of subway at crossing of Thompson Rd., Tp. Bertie, and directing work be completed within 4 months from that date; pending completion of subway, G.T.R. employ day and night watchmen at said crossing; wages of watchmen be paid—15 per cent. by P.M.R.R. Co., 30 per cent. by M.C.R.R., 47½ per cent. by G.T.R. and 7½ per cent. by Tp. Bertie. Rescinding Order No. 20921, dated November 20th, 1913.

20982—December 6—Authorizing G.T.R. to construct siding into premises of Frontenac Wall and Tile Company, part Lot 5, Con. west of Great Cataraqui River, Tp. Kingston, Co. Frontenac, Ont.

20983—December 9—Directing C.N.R. to dig a ditch 3 feet wide by 3 feet deep, from west end of British America Elevator, to connect with old ditch at east switch, to bridge just east of road allowance, Engelfeld, Sask. Ry. Co. grade driveway and aproaches to elevator and loading platform along south side of station grounds, and grade team-track driveway for distance of 300 feet from west side of Engelfeld Milling Company's building, work to be done by August 1st, 1914.

20984—December 10—Amending Order No. 20905, November 25th, 1913, by substituting words "tracks of the G.T.P. Branch Lines Company," for words "G.T.P. Railway," where they occur in Order.

20985—December 9—Authorizing C.P.R. to open for traffic its Virden McAuley Branch from mileage 13.5 to 36.0, Man.: Provided speed of trains be limited to rate not exceeding 20 miles an hour.

20986—December 10—Approving location C.N.O.R. station grounds at Coniston, Tp. Neelon, District Nipissing, Ont., at mileage 257 from Toronto.

20987—December 10—Approving location C.P.R. station at Broadacres, Sask., on S.W. ¼, Sec. 32-35-21, W. 3 M.; and rescinding Order No. 18915, dated April 14th, 1913, in so far as it approves location of station in Sec. 6-37-21, W. 3 M.

20988—December 10—Establishing collection and delivery limits of Express Companies in town of New Liskeard, Ont.

20989—December 9—Authorizing C.P.R. to construct proposed wye at Tregarva, Sask. Division, Colonsay Subdivision, across Railway Avenue Lane in Block 2 and Gregg Avenue, Tregarva, Sask.

20990—December 9—Authorizing C.P.R. to reconstruct Bridge No. 49.8 over Salmon River, Orford Subdivision, Eastern Division, near Kingsbury, Que.

20991—December 9—Authorizing C.P.R. to construct, at grade, Kootenay Central Ry., across four (4) highways in Lots 5033 and 4596 (Provincial Government Survey), East Kootenay District, B.C.

20992—December 10—Authorizing city of Fort William, Ont., to cross, at level, with its double track line of Street Ry., on Frederica Street, the tracks of G.T.P. Ry., where same cross Frederica Street, city of Fort William. Question of apportionment of cost of installation and maintenance of half-interlocking plant is reserved.

20993—December 9—Directing that C.N.R. divert road allowance from a point north of Ry., to farm crossing, thence to road allowance in Sec. 12-19-24, Man. Mun. provide necessary right-of-way upon payment by Ry. Co. of $200.

20994—December 9—Authorizing G.T.R. to construct spur across Montreal Street and the Port Arthur and Fort William Electric Street Ry., at West Fort William, Ont., for Canadian Car and Foundry Co., Limited.

20995—December 9—Approving plan showing details of superstructure of C.L.O. and W. Ry. (C.P.R.) bridge at Simcoe Street, town of Oshawa.

20996—December 12—Directing that crossing of tracks of Confederation Construction Company over G.T.R., be approved and authorized, for construction purposes only, subject to certain conditions. Temporary crossing be protected by an interlocking plant and derails be installed to satisfaction of Engineer of G.T.R.; Applicant Co., bear and pay entire cost of construction, maintenance and operation of crossing.

20997—December 11—Authorizing C.P.R. to open for traffic double track from mileage 76.8 to 84.2 on Moose Jaw Subdivision.

20998—December 11—Authorizing C.P.R. to open for traffic double track from Notman, mileage 95.1 to mileage 99.4, on Swift Current Subdivision.