PAGES

MISSING

Volume 26. Toronto, Feb. 19, 1914

Contents of this issue on page 349

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

MODERN CRANE EQUIPMENT

DESCRIPTION OF UP-TO-DATE APPARATUS FOR LOADING AND UNLOADING OF MATERIAL AND SUPPLIES WHEN SPEED OF OPERATION IS A VITAL FACTOR.

By C. F. KRUMBIEGEL,
Resident Engineer, Montreal, for Deutsche Maschinenfabrik, A.G., of Germany.

THE loading and unloading of material in bulk, such as coal, ore, slag, sand, gravel and the like is a matter of serious expense and consequently of great importance to mines, dealers, contractors, consumers, etc. There is no doubt that in many cases this matter is not given due attention and that the material is still handled in an out-of-date way by unnecessarily expensive labor from ships to cars or storage or from cars to storage or vice versa. One important consideration in this connection is the question of avoiding delays in despatch of vessels and cars and the consequent demurrage on same, as by modern methods a saving of days or weeks can usually be effected.

It is a proven fact that modern handling plant will in most cases pay for its first cost in a very short period by the saving in labor, demurrage and risk of accident. Besides these direct advantages there is the fact that such modern handling plants minimize any impairment in the material in the course of conveyance, especially in the case of coal, which, when handled by out-of-date methods, may be crushed and deteriorate in quality. Also, the trend of business and trade will always go to well-equipped plants, i.e., plants with the most favorable conditions for quick service and low prices. These loading and unloading equipments vary in their type and construction according to the purposes they are to be used for.

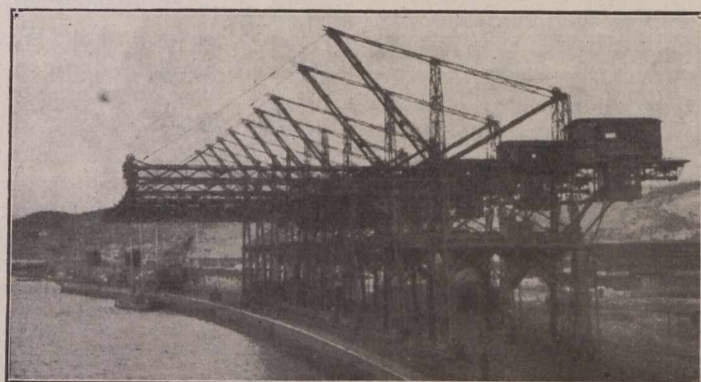


Fig. 1.—Loading Towers for Handling Large Quantities.

If the goods are simply to be loaded from boat into cars or vice versa, a slewing crane with grab bucket will be the correct equipment, especially if the boats are not too large or fitted with high masts. These cranes may be stationary or travelling, and driven by steam, as shown in Fig. 3, or by electricity where current can be easily supplied by wire or by a third rail. If it is necessary to clear one or more railroad tracks, the crane can be placed on a full or semi-portal and the jib can also be built to raise in order to clear the masts of the boats. (Fig. 4).

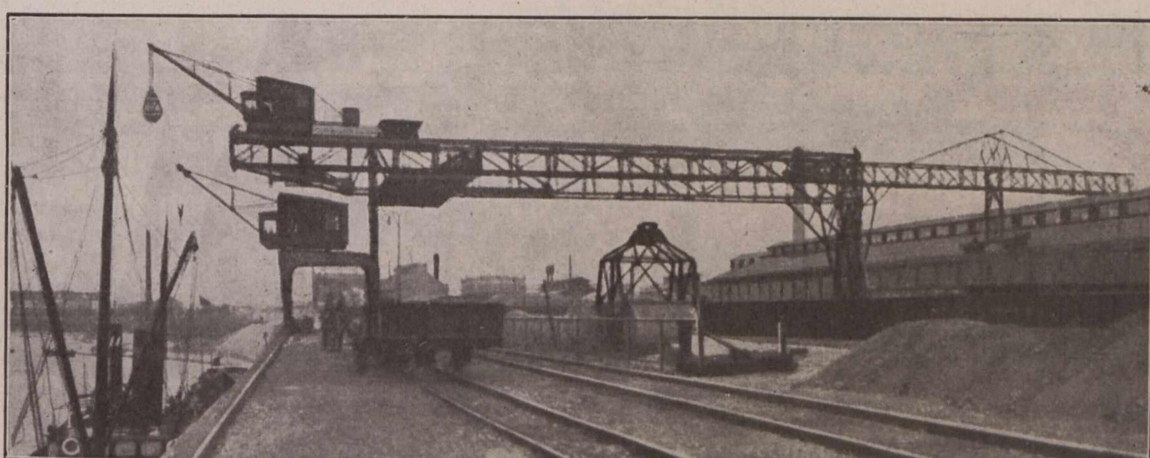


Fig. 2.—Travelling Slewing Crane Running on Bridge Girders.

The capacity of such slewing cranes runs from 4 to 15 tons, including weight of bucket. They may be also used with advantage for dumping the material into boats from special buckets, which are transported from mines or sand pits to quay by special bucket cars.

Instead of slewing cranes, loading towers operated by steam or electricity are supplied where larger quantities of material are to be handled expeditiously. Nine of such loading towers, shown in Fig. 1, are used for handling iron ore in the Imperial Steel Works of Japan. The hoisting apparatus for the trolley is placed on a small rear cantilever and the very light trolley runs with high speed from boat to the tower, where the ore is dumped into hoppers and from these into cars.

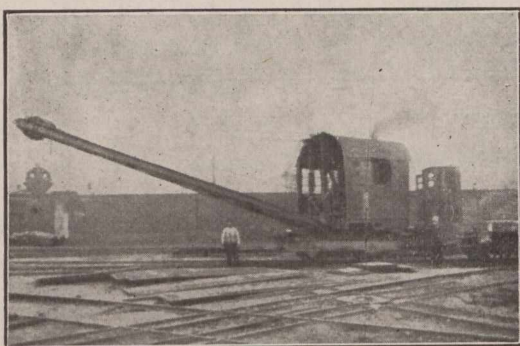


Fig. 3.—Steam-Driven Slewing Crane.

Such towers can be built up to an hourly capacity of 250 tons of coal and a weighing device may be adjusted if desired. In most other cases, where the material is to be stored in piles adjoining the quay, a loading bridge, supported by rigid legs, is the usual equipment. These bridges can be stationary or travelling, and are in most cases driven by electricity. A trolley with grab bucket running either on top or between the bridge girders with high speed, can reach from a waterside

This is a much better scheme than the scewing bridges where one portal can travel somewhat ahead of the other, which can only be done at the cost of the rigidness of the whole structure. If the waterside apron is not required very large, the jib connected with the trolley can take its part and serves as further extension of a short rigid cantilever. Instead of a trolley with slewing jib, a travelling slewing crane can be supplied, running on the tops of the bridge girders. With this type the structure of the bridge can be kept lower and lighter in construction, having the same advantage of

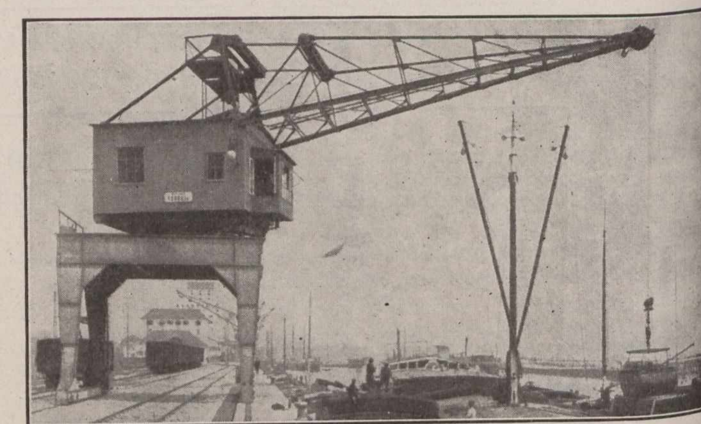


Fig. 4.—Arrangement of Crane to Clear Railroad Track and Vessels' Masts.

large working circle and avoiding the waterside apron for clearing the masts.

A bridge crane of this type is shown in Fig. 2. This crane is manufactured also with a trolley for reloading purposes. This bridge has the interesting feature that the second bridge, if needed as elongation, can

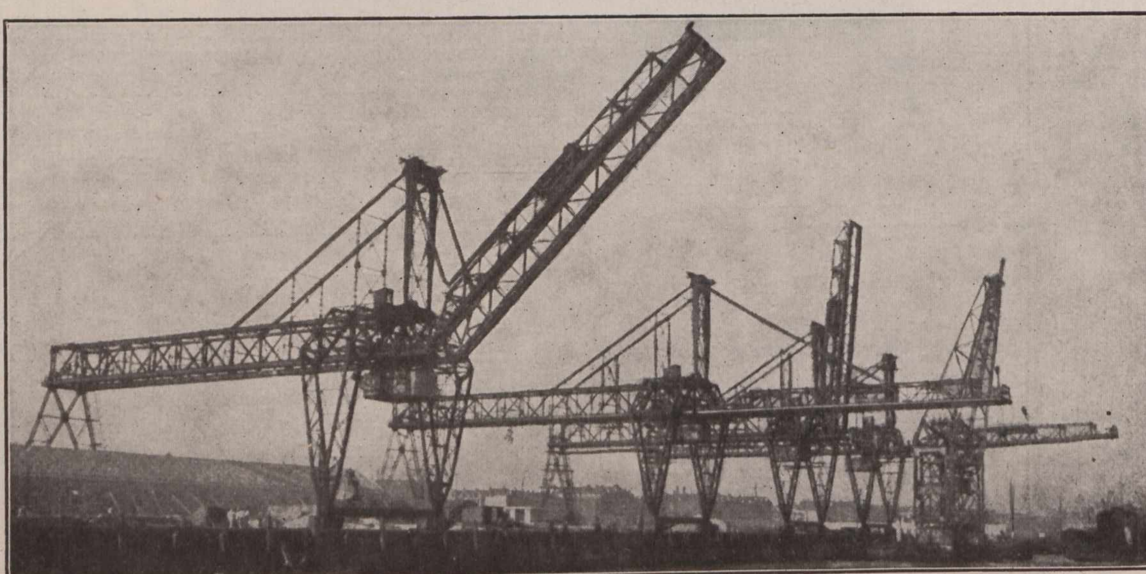


Fig. 5.—Loading Plant with Bridges of 160 ft. Span and 90 ft. Cantilever.

cantilever to the outmost hatch of the boat. This cantilever can have the form of an apron to clear the masts of the boats, as illustrated by Fig. 5. This loading plant is built in Rotterdam and consists of 4 bridges with 160 ft. span and 90 ft. cantilever. The trolleys have a capacity of 8 tons each and are equipped with a slewing cantilever of 23 ft., which makes it possible to reach a large part of the boat as well as the storage without moving the boat or travelling the crane.

be safely coupled to the main bridge in such a way that the trolley is able to run smoothly from one end to the other.

The writer is indebted to the Deutsche Maschinenfabrik, A.G., of Duisburg, Germany, for the photographs illustrating this article, the photographs showing a few of the many loading and unloading devices which have been built by their plants.

THE PETROLEUM INDUSTRY IN 1913.

The feature of chief interest in connection with the foreign petroleum industry in 1913 was the active prospecting for new oil deposits, according to a statement of David T. Day, issued by the United States Geological Survey. This prospecting extended to very remote regions, including South Africa, southern Chile, Patagonia, many islands of the Pacific, China, Japan, and the East Indies.

The prospecting of most interest to the United States was that in the West Indies, Central America, and South America, on account of the approaching completion of the Panama Canal. In Venezuela American capitalists were actively prospecting in many regions, chiefly along the northern border. More than 20 field parties were engaged in exploration with a view to the selection of the most promising oil fields that might be developed, working under a provisional concession from the Venezuelan Government. These capitalists and others were also actively and successfully developing oil concessions on the adjacent island of Trinidad.

In Colombia, English, American, and Canadian oil interests were concerned with concessions for the development of large areas where, though no large oil wells have been developed, the seepages of oil and asphalt are so significant as to lead to the hope of a large addition to the supply of fuel oil. The Cowdray interests withdrew from Colombia in the later part of the year.

There was a delay in developing the oil fields of Argentina, owing apparently to the desire of the Government to retain the oil as a national monopoly.

In Chile a governmental commission examined the oil and gas indications in the Magellan region and made a favorable report.

In Ecuador the Cowdray and other interests carried on a vigorous campaign for the acquirement and development of areas showing oil indications in the interior, as well as in the region of the old wells near the coast.

Interest was shown in the possibility of finding oil in Panama, Costa Rica, Nicaragua, and Honduras, but so recently that there has not yet been time for a significant result.

In the islands of the West Indies prospecting for petroleum was active in Haiti, where a small oil well was drilled near Azua. In Cuba drilling for oil was resumed near Havana, Cardenas, and Motembo. Explorations for oil were also active in Barbados.

In Mexico development work was remarkably active considering the unsettled condition of the country. It resulted in the development of several large wells in the neighborhood of the great gusher at Potrero del Llano. Another large gusher was obtained at Los Naranjos, on the shore of Tamiahua Lagoon, which indicated a considerable addition to the total oil supply. The importance of these additions cannot well be over-estimated, for in spite of the universal judgment that the Mexican fields are potentially very great the fact remains that so far as present supply is concerned Mexico has been practically limited to two or at best three large wells and not a very large number of smaller wells of most uncertain character. Of the large wells the American (Doheny) interests owned two and the English (Pearson) one. Even with the phenomenal energy of the exploration work it was questionable whether new wells would be found promptly enough, under the peculiar Mexican conditions, to maintain present shipments, let alone supply a combined fleet of about 40 large tank steamers. The supply is now ample. As an evidence of the peculiar character of petroleum commerce, it is probable that with this additional supply the price per barrel will increase, because the greater confidence in the supply will stimulate the adoption of Mexican oil for refining and for fuel.

The 8-in. pipe line of the Mexican Eagle Oil Company (Pearson interests) was completed from Potrero del Llano to Tampico. The refinery of this company between La Barra and Tampico, north of Panuco river, is nearing completion. Among many other interesting developments in Mexico was the continued interest in the Topila oil field, near Tampico, where, in spite of many wells going to salt water, the unusually large gushers occasionally obtained have stimulated continual drilling operations.

A feature of importance for the United States was the development of a large fleet of tank steamers for coastwise and trans-Atlantic trade. Imports of Mexican oil were extended to several refining centres of the United States.

The general interest in the development of new oil fields which characterized the year 1913 extended to Alberta and Saskatchewan, in Canada. Although explorations in Saskatchewan gave either natural gas or else entirely negative results, a well 27 miles southwest of Calgary, in Alberta, struck oil of very light gravity, causing much excitement, and a large territory in that region was taken up by prospectors for oil, probably much more than will be drilled within the next year. This oil excitement extended to the region north of Edmonton, in Alberta, where on Athabaska river and its tributaries, large bodies of so-called "tar sands" have been known for many years. These "tar sands" are in places 60 feet thick where exposed on the river banks and have been traced for considerable distances from the river. Seepages of oil are reported for as much as 400 miles to the north, and many thousands of acres of land have lately been taken up from the Canadian Government for oil development at some time in the future.

Work has continued in the development of the natural gas, petroleum, and oil-bearing shales of New Brunswick.

In Russia the production of oil declined significantly in the larger fields, but meanwhile the Ural-Caspian field was actively exploited. This field is reached by steamers to the north shore of the Caspian sea. There are no wharf facilities yet, landing being made in small boats through the shoal water. About 30 miles from the shore large oil wells have already been obtained, and pipe lines are being laid to the shore where barges can be loaded and towed up Volga river without the reloading necessary for shipments from Baku. Exploration in the Ural-Caspian field north of the present oil wells has been extended over many miles and has shown that the area, while very spotted, gives promise of further development. Exploration in this field is impracticable in winter, but in summer can be prosecuted with success in spite of the great lack of water, the available supply of which is derived principally from snow scraped up in the winter and conserved in pits. The inhabitants of the region are wandering tribes living in tents. They are peaceful and disposed to aid the exploration.

In Galicia deep boring is tending to check the decline in the oil supply and the exploitation has been actively carried forward in all regions where indications have been noted in the past. It is probable that the Government of Hungary will develop the gas wells in the region of Kisarmas.

In Roumania oil production continued active in spite of the very severe fire in the Moreni field. The chief contribution to the industry by the government was the development of a pipe-line system from the producing fields to Constanza, on the Black sea.

In Japan production was greatly helped by the introduction of the rotary system of drilling.

ELECTRIC RAILWAY SYSTEMS.

An article by Mr. C. E. Eveleth, based upon a lecture delivered by him in New York City, appears in the February number of the General Electric Review, and deals with the present magnitude of the application of electricity to transportation. The author sets down the factors to be considered in the choice, and traces the various features which influence the selection and affect the maintenance of systems. Mr. Eveleth, who is attached to the Railway and Traction Engineering Department of the General Electric Company, distinguishes between the "science" and the "art" of electric railroading in a very interesting way. His article is as follows:—

When considering the subject of electric railway systems it is well to bear in mind that only twenty-six years have passed since the first electric motors propelling street cars in Richmond startled the people by the terrifying flashes at the overhead collector and from the motor brushes. As in any radically new enterprise the pioneers were called upon to bear the brunt of development and to overcome what appeared to be almost insurmountable difficulties. The improvements made in the various elements were so rapid that soon the electric motors not only displaced horses as motive power, but also led to the extension of the field of city transportation. Then there followed the development of many thousands of miles of interurban electric lines, which have brought the outlying farms close to the cities in almost every locality east of the Mississippi river. This network is being steadily extended and will eventually cover the entire country as the density of population increases. The effect of the inter-communication so afforded is incalculable, both from an economic and sociological standpoint.

It is interesting to know, in these days when so much is heard about the increased cost of living, that such elements in our daily lives as are served by electricity have steadily decreased in cost, and to-day we ride farther for a nickel and have more electric light illumination for less money than ever before. Is it not significant to learn that the only divisions of one of our large eastern steam railroads where the net earnings per passenger car mile are holding their own are on the portions operated electrically, while on those divisions not so operated the net earnings are only a fraction of what they were seven or eight years ago and are decreasing at an alarming rate?

We sometimes ask: when will our railroads be operated electrically? In a recent lecture by Steinmetz, the statement was made that there is more aggregate horse-power in electric motors operating cars and locomotives to-day than the aggregate horse-power capacity of all of the steam passenger locomotives used for transportation in this country. Based upon this, we can fairly say that electrification is here now. The day has not yet arrived when the universal electrification of our steam railroads can be economically accomplished, but the decreasing cost of power and the lower cost of electric equipment for rolling stock is gradually extending the field where the application of electricity to transportation is justified and will eventually permit electricity to replace steam on all important railroad divisions.

At present we are using electricity to accomplish results unattainable with steam engines, notwithstanding the magnificent accomplishments which the steam engine designer has achieved with the Mallet locomotive, oil-fired boilers and the use of super-heated steam. Of all known agents, electricity is the most convenient means of distributing power and its application to transportation successfully overcomes widely different limiting conditions. On some railroad divisions about one-twentieth of the gross ton mileage is used for hauling the coal to supply the steam locomotives with fuel; on other sections, the speed on going up grade is limited by the boiler capacity of the engines. The operation in descending these same grades is frequently hazardous, owing to the possibility of the loss of air for the air brakes, or danger from overheated brake shoes and wheel tires. Applying electric locomotives to these conditions, in many instances, eliminates entirely the freight tonnage required to haul fuel. We are able to increase the speed of freight trains up grade to the maximum safe or economic limit, and by the use of regeneration we not only lessen the danger from failure of air for the brakes and the heating of tires and brake shoes, but are able to actually recover a material portion of the energy given up by a train descending a mountain and utilize this power for ascending trains. We are able to overcome the difficulties incident to bad water found in desert regions on one hand, and to more quickly transport the suburbanite on the other. Other limiting conditions which can only be met by electric traction are the elimination of smoke, the better utilization of space in city terminals by the use of differnet track levels, the elimination of round houses, turn tables and the saving of time required by steam locomotives while going for water and cleaning fires.

There are two broad divisions of the subject under consideration; one might be called the "Science of Electric Railroading," and the other the "Art of Electric Railroading.".

The "Science" has to do with all the fundamental details which enter into the present development and includes the work of improvements and invention, which are necessary to broaden the field of electric traction. This includes developments in insulation, designs of generating, transmission, conversion and rolling stock equipment parts, the solution of problems of current collection, the mechanical structure of locomotives for high speeds, and the many elements which go to make up a successful and economical system of control for the electric power from the prime movers to the train wheels. There are thousands of men employed in the development of the science of electric railroading, and it is to these men that we shall be indebted for the final victories of the electrification.

The "Art" of electric railroading includes the analysis of conditions and the selection and application of the available elements to a specific problem as well as the operation and maintenance of the finished system.

It is the problem of the electrical engineer to so select and balance all the elements of power generation, transmission, and consumption in such a manner as to deliver the desired quality and quantity of transportation with the greatest reliability and the lowest cost.

As set forth, the problem seems simple, but experience has indicated that very different conclusions are reached, both as to the methods which should be applied and the anticipated results. The problem is, in fact, extremely complex; so much so that it is almost impossible to retain in mind the many elements which must be simultaneously considered to reach a justifiable conclusion. Frequently one sees results cited, which, on analysis, are found to disregard entirely elements of the greatest importance.

A better comprehension of the situation can be obtained by outlining some of the elements which must be equated. We will assume that the problem as to schedules, train capacities, grades, etc., both for the present and future, has been accurately set forth. For conditions requiring the use of motor-car trains and locomotive operation, there are available for consideration direct current and single-phase equipments or possibly single-phase for the motor cars and split phase for the locomotives, with a further possibility of three-phase, if the problem involves the use of locomotives only. To reach the proper conclusion every element from the prime movers to the train wheels must be considered.

Power Supply.—In some sections of the country, in the Carolinas, Michigan, Montana, Washington, Oregon and California, for instance, we find networks of power distribution which range from five hundred to two or three thousand miles of transmission circuits in each system. Generally in such localities, it is more economical for a railroad to buy than to manufacture its own power, since this requires less capital expenditure, and the power companies which have the benefit of diversified load factor, can, generally, manufacture power for less cost. Where such conditions exist the frequency of the primary distribution is established by these systems. Where it is necessary for the railway to build its own power house, the question of frequency with its bearing on the power already available in the territory to be served and the demands of the particular rolling stock selected must be carefully investigated. Comparisons must be made between single-phase and three-phase power generation, due weight being given to the elements of initial cost, efficiency, power-factor and protective appliances. Some of the problems, such as the desirable size of power house units, their overload capacity, etc., is common to all unit systems.

Distribution System.—This is the simplest element in the chain and can generally be worked out on its economic merits as regards the selection of voltage, size of conductors and the character of installation to conform to the distance of transmissions and permissible line regulations for the various systems.

Secondary Distribution and Substations.—The location and capacity of substations must be considered jointly with the secondary power distributions to the trains. This involves the selection of voltage; the determination of the permissible potential drops; provisions for the mitigation of inductive interference with telephones and telegraphs for the single-phase and three-phase systems, or the consideration of the possibility of electrolytic difficulties in case of the direct current, both for normal operation and for conditions of short circuits; the selection of third rail or overhead trolley; the effect of atmospheric conditions, such as lightning, snow and sleet; examination of the reliability of the elements chosen and decisions regarding the amount of line to be incapacitated when local repairs must be made. The selection of substation apparatus will be different for each system, and will further vary with the frequency of power supply. The advisability of using transformers or auto-transformers with questions of capacity and regulation must be considered for the alternating-current systems; and with direct current, there are questions of the relative merits of motor-generator sets, rotary converters or motor converters with the determination of their normal and overload capacities and regulation. To make these different elements comparable, the selection of apparatus must be so balanced as to yield the same degree of insurance in case of the failure of individual elements or abnormal congestion of traffic, due to any cause.

Rolling Stock.—This item is by far the most important, as the proper selection of these elements is vital to the success of the system. Here we are at once confronted with the consideration of the inherent features and costs of the various kinds of apparatus available, and due consideration must be given the relative values of constant versus variable speed, features involving the starting characteristics, efficiency of motors, conversion devices, control and driving mechanisms, effects of inherent characteristics on power load factors, electrical power-factors, etc.; in addition, the desirability of regeneration and emergency braking require consideration, if mountain work is involved.

After having determined the first costs and rates of depreciation of each of the above elements, there remain two important items for consideration. The first is the analysis of power consumption, which can be carried through with reasonable accuracy for the particular conditions under consideration. The second is the problem of the determination of the operating and maintenance costs, which is more difficult. It is in these elements that the results of practice are most often lacking, and the value of an individual's judgment will depend on his general experience, and on his ability to deduce from available data information which can be applied, when properly modified, to meet the specific problem in hand.

General.—The assembly of these elements in the order of their relative merits is the problem before the engineer who is called upon to select a system for a particular application. It is not surprising that different results are reached by different investigators, due to the different weights assigned to the elements or difference in the degree of optimism towards some of the unproved features. Very often it is surprising to find how little difference there is in the initial costs of the various systems, as some of the elements tend to offset each other. For example: the high cost of single-phase rolling stock equipment frequently offsets the greater cost of direct-current substations, while the additional weight of the single-phase equipments offsets the greater conversion losses of the direct-current substations, resulting in both the cost and power consumptions of the two systems being almost identical. Consequently, with a greater quantity of rolling stock, the tendency is for the moderate voltage direct-current systems to be lowest in cost and cheapest to operate, while with few rolling stock elements the tendency is to relatively favor the higher voltage systems. For suburban electrifications a moderate direct-current voltage is generally the most economical, while for single-track infrequent service, higher voltages are desirable.

A discussion of electric railway systems would not be complete without consideration of the Standardization of Systems. There is no doubt but that standard third-rail and overhead trolley clearances are necessary to avoid serious interference with bridge girders, station platforms and various structures existing along main railway rights-of-way. About seven years ago, the Germanic countries, headed by Prussia, adopted certain arbitrary standards that all main railways should be equipped with fifteen thousand volt single-phase trolleys operated at sixteen and two-third cycles. At that time there was no experience available to justify such a selection, but it was believed by those in power to be desirable to have all efforts expended in one direction, and, furthermore, it was deemed necessary for military reasons. Since then, it has developed that the limitations imposed are very adverse to economical motor car operation, that inductive interference with telephones and telegraphs under certain conditions are extremely serious, and the low frequency involves difficult mechanical problems and practically bars out forever an economical design of induction motor for certain classes of service. These limitations are rousing some dissatisfaction in Germany; the

Italian engineers have decided that three-phase is better suited to their conditions, and the majority of engineers in England, Australia, Canada, France and Russia seem to favor direct current.

In this country we have done well to avoid a limitation such as an arbitrary standard system of electrification would impose, since it leaves us free to work in every direction, whether it be single-phase, three-phase, split phase, moderate or high voltage direct current, the mercury rectifier systems, or in any other direction which may be entirely unknown to us to-day. Arbitrary standardization of a system would mean limited development or stagnation.

Electrification of railways is desirable, not only from the standpoint of superior transportation, but on account of improvement in land values and the comfort and safety of travel. Although electrification is economically justified for many conditions, there are to-day no known systems sufficiently low in cost to permit universal use of electricity for railroads, and we must, therefore, have a free hand in order to achieve the ultimate general application which we believe will come.

WATER TOWER AT ST. VITAL, MAN.

THERE has recently been erected for the Agricultural College at St. Vital, Man., a water tank with a capacity of 125,000 Imperial gallons. The structure is mounted upon a tower, the total height being 160 ft. The weight is somewhat in excess of 100 tons. The cost, including foundations, was approximately $16,000. Fig. 1 shows the tower and tank completed.

Where such a means of water supply is resorted to in climates that are subject to severe freezing in winter time the main issue to contend with in the design and construction is to arrive at some feasible means to prevent freezing. To this end it will be noted that a riser pipe has been employed. It is built of steel, 6 ft. in diameter, the idea being that the diameter is sufficiently large to permit the formation of a natural frost jacket of ice about 3 inches thick on the interior of the riser pipe, protecting the balance of the cross-section from freezing. As an added precaution a 1½-inch steam coil, to the extent of about 100 ft. was placed in the bottom of the tank for the purpose of raising the temperature of the water.

On account of the excessive range in temperature, as well as owing to the great height of this tower, a second difficulty was encountered in attaching the riser pipe to the bottom of the tank. Obviously the variation in temperature from season to season is greater in the posts of the tower than in the riser, since the riser pipe maintains a more constant temperature than the outside air. Some provision had to be made necessarily to take up the difference in expansion and contraction between the posts and the riser pipe produced in this way.

It was deemed inadvisable to use the tank bottom as an expansion joint. To get over the existing difficulty the riser pipe was equipped with an expansion joint of large diameter at the point where it enters the tank proper. In this way the builders were able to retain the hemispherical bottom tank, which is claimed to be the strongest type in use. Another important point characteristic of this form is that the very steep slope of the bottom portion of the tank allows accumulating sediment to drain into a main drum, at the same time allowing the added advantage of the large steel riser pipe.

In order to insure a minimum of sediment and dirt in the water, the 12-inch inlet, which enters the large riser pipe at its base, has been carried up a distance of about 4 ft., thus forming in the bottom of the riser the mud drum, mentioned above, for the collection of sediment, etc., which may then be drained off. The extreme bottom of the riser pipe has been equipped with a quick opening flow-off valve so that this sediment can be carried away quickly and completely and the tank cleaned without emptying the structure.

There is also a valve chamber directly underneath the large riser pipe and below the surface of the ground, in which the pipes of the sewer system are so arranged that the water may be pumped directly into this system

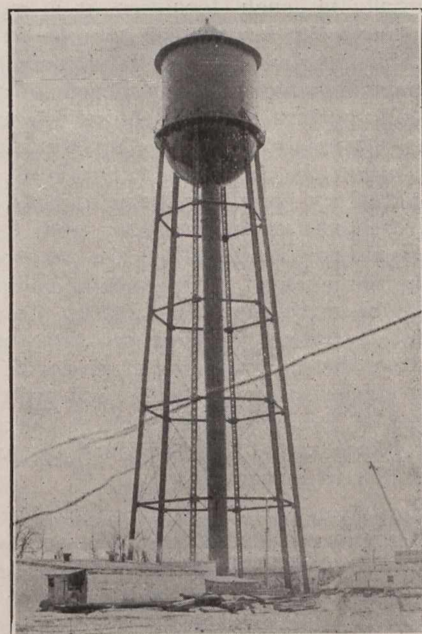


Fig. 1.—Tank and Tower Recently Erected at St. Vital, Manitoba.

without going through the tank, or may be pumped directly into the tank with the same inlet and outlet, using the tank as a pressure regulator, or the water may be pumped into the tank by one pipe and discharged in the mains by operating 3 valves in the valve chamber.

The Des Moines Bridge and Iron Co., Des Moines, Iowa, furnished and erected the structure.

WATERWORKS OF CANADA.

At the 5th annual meeting of the Commission of Conservation, held in Ottawa last month, it was announced by the chairman, Hon. Clifford Sifton, that a new edition of "Waterworks of Canada," by Leo G. Denis, B.Sc., Hydro-electric Engineer of the Commission, would probably be issued. The first edition had been much in demand, especially in the rapidly growing towns and cities of the west, where the necessity of installing waterworks systems was becoming more urgent year by year. The new report would bring up to date the previously published data, and would be much more extensive in its survey of existing systems as they are at present.

The 1912 edition contained a number of charts and tables, summarizing the information in the body of the work and emphasizing points of special interest, such as the growth of the principal systems, sources of supply, rates, cost, consumption, etc. This will be extended and made still more authoritative.

HIGHWAYS AND HIGHWAY SURVEYING

PRACTICAL SUGGESTIONS APPLICABLE TO PROBLEMS OF ROAD FINANCING AND ENGINEERING—OUTLINE OF SURVEY WORK, AND EXAMPLES OF ESTABLISHED METHODS.

By DANIEL J. HAUER
Construction Economist

EDUCATIONAL work among the public as to the value of good roads is about over. The humblest farmer now appreciates the fact that good roads mean better living for him and easier methods of obtaining it. The questions now before both laymen and engineers are "What to do and how to obtain better highways at a reasonable cost?"

Road Financing.—The greatest mileage of roads on the American continent consists of the unimproved dirt roads, the so-called farm roads, leading from the farm to the nearest towns and villages, or to the main travelled highways. The roads surrounding our large towns and cities can be easily improved, for it is not a difficult matter to raise the money to rebuild these highways. But it is a serious problem to obtain money enough to make passable the thousands of miles of dirt roads.

There are two methods in common use, namely, direct taxation, and the issuing of bonds. There must be a limit to direct taxation and especially in small communities; so most road enthusiasts turn to bond issues to obtain the necessary money. Bonds must be redeemed at maturity, if the credit of any province, county or town is to be maintained. This, together with the limitations set by law, must govern the issuing of bonds. Thus it becomes evident that long-term bonds should not be issued for road building and improvements. For building reservoirs, sewers, canals and other structures that last for many decades they are justifiable and economic, but for street and road work, the term of the bonds should not exceed the life of the road. Few road and street surfaces last more than a decade, so it is a mistake that will finally bring disaster to the community that sells long-term bonds for roads and streets. Many cities and counties are suffering now from this indiscretion.

The Highway Engineer a Necessity.—This and many other considerations, to be mentioned, may not seem germane to the title of this article, but nevertheless such considerations affect highway engineering and surveying, and the highway engineer must keep them in mind. It part of his duty to guide the public, as he alone, of public men, is fitted to prevent the taxpayer and our lawmakers from making these economic blunders. This is plainly shown by the waste of money made by those communities that have not had the advice of engineers or have acted contrary to such advice.

A common blunder made in the past, and still being made, is the general belief among public officials and the general public, that any intelligent man can build and maintain roads. This one thing has been the cause of wasting many thousands of dollars. In Eastern Canada, where the writer is familiar with the conditions, he does not hesitate to say that on the common country roads, one-half of the money now being expended is being wasted due to inexperience and a lack of knowledge of road engineering and construction. Road building and maintenance is a profession, and if the taxpayers are to obtain the best possible results for their money, they must see to it that only competent men with the requisite knowledge are employed for highway work.

At present, this is the most difficult task in road construction, due to the fact that we have such road laws that prevent obtaining competent men, and even if some are placed in charge of such work, the system under which they must labor prevents them from obtaining a dollar's worth for a dollar.

Need for Revised Legislation.—Those interested in better highways must first see to it that our road laws are changed. Small towns and rural communities are not capable of looking after their own highways. They neither have the money to employ competent men nor to purchase the necessary plant to build and maintain our highways. Hand work is too expensive to be tolerated any longer on roads. The need of conserving the available money to obtain all the improvement possible is too great to allow of obsolete methods being used.

The system of small communities looking after their roads dates back to feudal times in England. Each castle and mural town was cut off from others by vast forests infested by robbers, making communication hazardous and difficult; so that each community was compelled to build and maintain its own roads. Thus the local roads were kept in fair condition, while those through the forest were nothing more than muddy tracks. As the forest highwaymen were driven out the work on the town roads was carried into the forest and these roads made passable; but the old system continued, was brought to America, and in many sections is still in vogue.

There should be no smaller unit for road building and maintenance than a county. Thus a province or state and the general government, in giving road aid, can deal with one community rather than with 50 to 100 small units.

With the road tax paid into the county treasury, each county can have an expert highway engineer and under him can be competent assistant engineers and road supervisors. The proper machinery can be purchased, or the work can be let at contract, so that the most economical methods can be used. With this system the proper field and office work can and will be done.

Engineering is essential, no matter under what system highway work is done, or whether it be new construction, reconstruction, or maintenance. Thus highway surveys must be made. Almost any surveyor can run a line, but this is not surveying. For highway work it is essential that surveys be made with judgment and that they be complete in every detail, both as to surface of the ground and sub-surface. This brings us to the real consideration of highway surveying.

Establishment of Road System.—If only a single road is to be improved the survey can be started at once, but if a system of roads for a county or province is to be devised, then before the surveys are made a tentative road system must be laid down on a map, subject to changes that will be found expedient to make after the surveys are to be made. Money may not be available for improving the entire system at the outset, but this should not prevent preliminary work from being done; for it is evident that if a comprehensive system is devised at the start, it is possible to expend the money for years to come with a definite policy in view and to obtain the best possible highway. Slight changes in roads and in policy may be deemed expedient, as the work progresses, but changes of administration and of officials need not affect the general policy or system of highways without this office planning (to the public seemingly time and money wasted) each administration will inaugurate new schemes, change methods and money will be wasted as it has been in the past.

In laying down a system of highways there are many considerations to be kept in mind. First, should be the farming and commercial interests. It is hardly necessary to consider the automobile. Although we owe much to the automobile interests, in as much as they have wised the public to the need of good roads, and by their concerted action and labors have made better roads possible, yet build a good road and the automobilist will find it. A few miles of extra distance means little to him, and, after traversing all the roads, he will select the scenic ones for his touring and joy rides. However, in deciding upon the road surface the automobile must be kept in mind for, next to water, the rapid moving car is the greatest destroyer of road surfaces.

The Most Needful Roads.—Those roads serving the greatest number of people should be laid down first, carrying merchandise and produce from the towns and railroad stations to the farming, mining and manufacturing centres, and vice versa. The fact that such roads may be longer than the more direct routes should be ignored, for, to be of value, the roads must go to the people. It is wrong to build a road through a country rather than in it. There may not be money available at the outset to build the long system of roads, as against a short and more direct system, but this is not a valid reason against planning the system, for ultimately the money will be provided and the sooner the proper officials and public know what is needed the sooner the financial arrangements can be made. Population and valuation must be considered in this connection which precludes roads from being built on air lines through undeveloped country. These last roads are an after-consideration.

To call a system of country roads "trunk lines" is a misnomer, and frequently injures the work being done and the raising of money for roads, in the eyes of the public. A trunk line is a through road, meant for quick communication between central points. Roads should be named from the source of deriving the money to build and maintain them. Thus the various systems should be known as County Highways, Provincial or State Highways, National Highways, etc. After these systems are built to serve every hamlet and farming district, then direct routes can be selected and re-built, to be designated as trunk lines. These should embrace those roads having the heaviest traffic and, if necessary, short-cuts and new air lines should be laid out.

A further need of improving the roads that lead to the farm is the high cost of hauling produce per ton-mile, which is paid directly by the consumer, and the high cost of hauling farm supplies, which is paid indirectly by the consumer of farm products. Then, too, improved roads tend to keep the young country boy at work on the farm, which is necessary to-day, as our rural communities are being rapidly depleted of the choicest of their young manhood.

In planning a system of highways, the various roads or lines can be designated by letters and numbers and also by towns as, Highway A, Highway No. 10, Section No. 20, and the Charlotte-Mecklenburg Highway.

Engineering Staff Organization.—A tentative system of roads once devised, the work of surveys can be commenced. For this there must first be an organization that will allow thorough work to be done, but will be flexible, being able to curtail it as circumstances warrant it and being enlarged as the amount of work increases.

A chief engineer is the first requisite. He may be the commissioner of roads himself or he may be an official of such a commissioner or commission. Under him there should be an office assistant, an engineer, who remains in the office, acting for and under the direction of the chief; an office draughtsman; a filing clerk, and a stenographer. This force can be increased as the amount of work warrants it. There can be principal assistant engineers, assistants, district engineers, chief draughtsman and assistants, and other engineers and clerks. Or, with only a limited amount of work, the office assistant can do all the necessary drawing, and the filing can be done by the stenographer. It may even be possible to combine all four positions in one.

The system of roads, if too large to be looked after personally by the chief engineer, should be divided into districts and over each district should be an engineer-in-charge. If his district is large he may need an office assistant, who should be a draughtsman, and a stenographer; but for a small district, he should be able to look after this work himself. Under the district engineer should come the field parties.

If there are more than two or three field parties, assistant district engineers should be used, each man having charge of two or three parties. These district engineers and their assistants should be the resident engineers of their district, so as to be in touch at all times with their work. It is an expensive policy to have an engineer in charge of each field party. This resident engineer is not necessary as the district engineer can visit each field party several times a week, spending such time with them as is necessary to guide the work of surveys and decide on all doubtful points. A chief of each party means extra salary and expenses, and the results obtained are not commensurate with the money expended.

The transitman can be the chief of the party. Under him should be the levelman, who runs the level and, if necessary, substitutes at the transit. The level rodman completes the level party. In the transit party there should be a head and back chainman, a rodman and a stakeman. These last two can run the back rod, make stakes and hubs, drive and number them, and carry the extra equipment. The back rodman can be dispensed with if absolutely necessary, but as his wages are small and as the increased work that can be done through his help more than offsets his salary, it is the part of wisdom to employ him. With this extra man it also becomes possible to have the transitman go ahead at times to lay out the work for a mile or so, while the head chainman runs the transit and the others chain and place the stakes. The writer prefers to employ a back rodman rather than an engineer-in-charge for each field party. As previously explained, one man can look after several parties.

The Plotting of Field Notes.—It is a common practice to-day in some sections to employ a field draughtsman. This, the writer believes, is unnecessary. Notes should be plotted in the field, rather than in the office of the chief engineer, and it is seldom necessary to employ a special draughtsman for this purpose. If notes are plotted in the field the party, seeing what is done each day, is able to work more intelligently, and to make more complete surveys. If anything is overlooked it can be taken up before the party has gotten too far ahead.

Each day the levelman, with the assistance of his rodman, should work up his field notes and plot the profile, especially of the transit line. The cross-sections and side elevations can be plotted on rainy or stormy days. The transitman, with the assistance of the head chainman, can plot the alignment each night, and on stormy days houses can be plotted on the map and other side notes completed. It is not a great hardship on the men to do this work and they derive benefit from it, as it makes them more careful, besides learning to do much that will be the means of bettering their positions. This, too, means the saving of a field draughtsman's salary, which could be added to the pay of those already employed, or effect a clear saving.

If notes are sent to headquarters they are always slow in being plotted. The notes may be inaccurate and incomplete, and with the field parties disbanded the results may be exceedingly unsatisfactory. From notes made in the field tracings can be made and sent to headquarters. On these, new locations and grades can be placed, from which notes and blue prints can be made and sent back to the surveying parties to be used. This makes a complete organization for surveys.

Alignment.—On the actual work of surveying, the first thing to be considered is the alignment. A complete survey should be made of the present roads. This is best done by running a transit line as near the centre of the road as possible. It is a very easy matter to say to keep in the centre of the road, and it can be done with long, straight stretches, but on very crooked roads with sharp, abrupt turns, it is quite a difficult task to do, and at the same time make a fair rate of speed in the surveys. It is evident that if the road is to be re-built on exactly the same line, then it is money saved to take the time and trouble to get the transit line exactly in the centre, as then the preliminary line answers for the location. But if improvements are to be made in the alignment, then it matters little if the transit line is not always in the centre; for a line must later be located on the ground at the proposed centre, the only difference being that in running levels fewer are needed if the transit line is in the centre of the road.

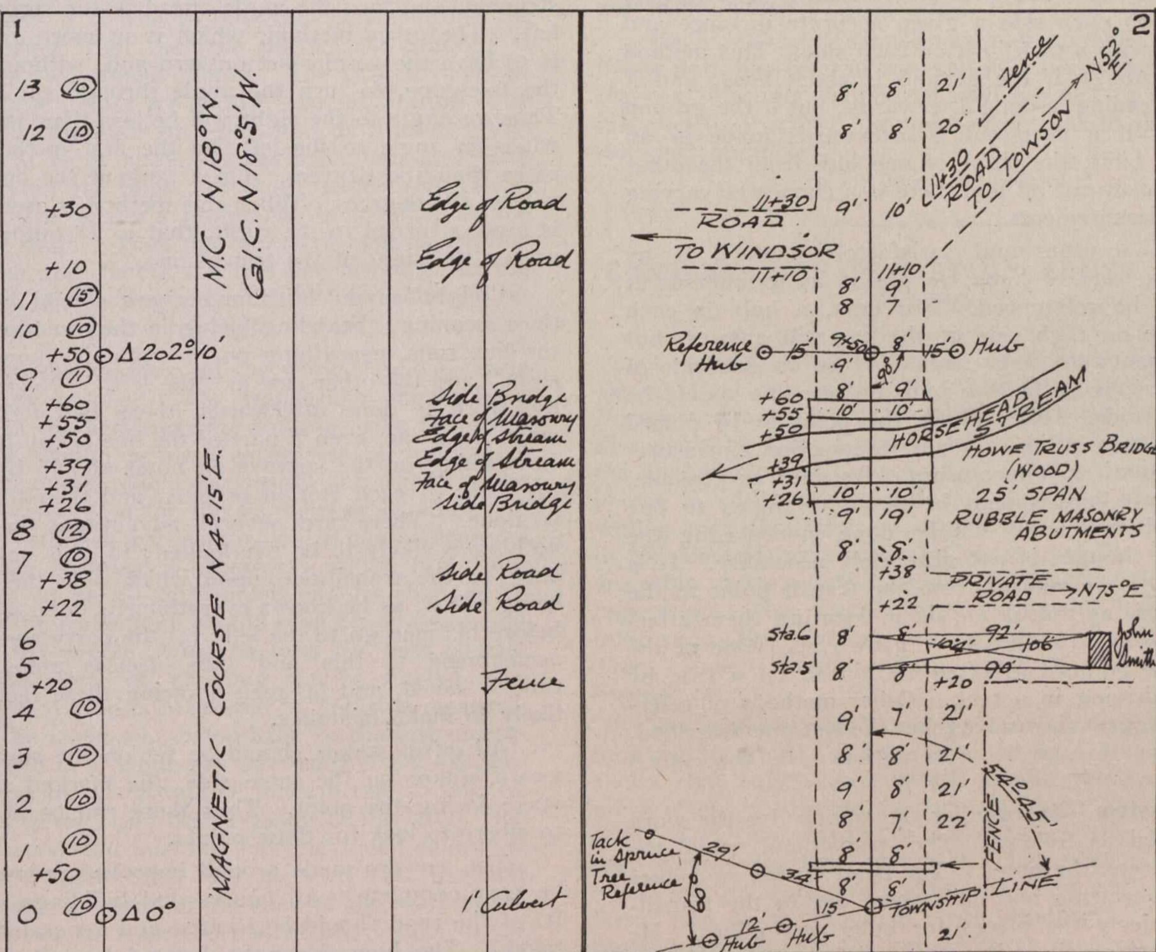


Fig. 1.—Sample Page of Transitman's Note Book.

Establishing Reference Points.—To start the survey, a point is selected at any definite place, as at the intersection of two roads, a town line, an established meridian, etc. It is not possible to drive wooden hubs into the roadway, as they will be destroyed by the traffic. A better plan is to use spikes for transit points. An 8 or 9-in. spike will give a good mark. A boat spike is preferable, as it does not bend as easily and has a good head on it, but a wire spike will answer the purpose.

Then the transit line should be projected straight along the road in the direction in which the survey is to run to the first turn or top of the first hill. To tie this line in, an angle should be turned between the projected line and that already established, at the intersecting road, town line, or meridian. Then a magnetic course should be read on each line. The point established thus, becomes zero, the angle and magnetic courses give the location of this point, and the work of chaining is ready to commence.

A station is made every hundred feet. At each station the distance is measured to each side of the road, to the fences, if any, on each side, and to other features that may be found. The plus stations of all culverts, pipes, etc., are taken, and the measurements to each end from the transit line, all being recorded in the note book. Before moving the instrument ahead, each transit point should be referenced.

The easiest way of referencing a transit point is to turn a right angle to the transit line (this should always be to the back line, and not to the newly projected line; uniformity in this will prevent mistakes afterwards); measure off on each side a given accurate distance and put in a hub with a tack in it on each side. This method is accurate enough if the ground is about level, and if little if any grading is done afterwards; but if the ground is rough, or if a deep cut is afterwards made or an embankment built, the sight of one hub from the other may be obviously cut off and there is a chance of varying in making measurements.

A more accurate and satisfactory method is by means of two sets of hubs, so placed as to interset at the point to be referenced. For cuts, a hub on each reference line on each side of the cut will answer, but for embankments the hubs should all be on one side of the road, or at least the two hubs on one line should be on the same side. This allows the point to be placed back on the transit line by an intersection, measurements being entirely unnecessary. As near as possible, these reference lines should be at right angles to one another, as better work can be done in replacing the point. This, though, is not absolutely necessary. It is well to make measurement from the transit point to the reference hubs, as this is an aid in locating them afterwards, especially if bushes have grown up. One of the two reference points can often be placed on a tree by blazing and driving in a tack. Other methods of referencing will suggest themselves, but the last one described, with variations to suit local conditions, is the safest and best.

Party System.—In running the transit line the work can be divided as follows: The transitman runs the transit and keeps the notes. The head chainman makes all the measurements and calls them out to the transitman. He selects the places for hubs and spikes. He runs the front transit rod or flag, giving all foresights. Under his direction the rest of the party works. The back chainman holds the back end of the chain, assisting in making measurements, calls out the last station number, and carries along any extra stakes. While the transitman is moving up the back chainman assists in making hubs and stakes, or in cutting away bushes and trees that may be in the way. The head chainman should be ready at all times to set up the instrument for the transitman, should the latter need the time to make record of notes.

The axeman makes the stakes and hubs, carries a supply along with him, marks the stakes, calling back the numbers to the back chainman. He also drives the stakes and hubs, and assists the head chainman in making side measurements. The back flagman gives a back sight whenever needed, makes stakes and hubs in his spare time, and, if necessary, helps cut out bushes and trees. He carries along any extra baggage. Every man in the party should be provided with a piece of keel or marking crayon, so that time be not wasted in marking or re-marking stakes.

Features of Importance in Transit Work.—In placing the spikes or hubs, the latter should be used whenever possible, i.e., when the points come on the sides of the roads, as they will on sharp turns; they should be placed at some foot mark, or, if possible, at a station or plus 50, as this makes plotting easier and more accurate. Generally speaking, every transit point means that there is an angle in the line. A few may be points on long tangents, but these can be treated in a manner similar to those that have angles.

There are two methods of turning angles in highway surveying. The first is to take a back sight with the vernier set on zero, then reverse the telescope of the instrument and turn the angle ahead to the right or to the left. The other method, which is in more general use, is to have the vernier set on zero and, without changing the telescope, to turn the angle through the entire arc. Thus an angle to the right will be less than 180 degrees, while an angle to the left, by the first method, will be more than 180 degrees. On a tangent the angle turned will be 180 degrees. When this method is used the angle is always turned to the right, that is, through the entire arc on the right of the transit line.

"Right" and "left" in surveys should have a distinct meaning. Standing facing in the direction in which the line runs, everything on the right is known as "the right" and the other side as "the left." No matter how the work is done afterwards, these two terms always mean the same, even if part of the line is run backwards. In working on the surveys all notes should be taken on the right at each station or plus, and then the left side is done. There are several advantages in this: (1) nothing is likely to be overlooked; (2) this saves calling back to the transitman upon which side the notes are being taken, as he knows everything is done on the right before his men go to the left; (3) the party soon becomes accustomed to this and thus useless steps are and time is saved, and (4) men knowing these facts are less likely to make mistakes.

All offset stakes should be set on the right, and all guard stakes on the same side, the marked side of the stake facing the point. Thus there can be no doubt as to where to look for these points.

The surveys made around improved property should be very complete. All houses and buildings within 100 ft. of the road should be located and general dimensions taken. The houses can be located from two stations, taking a measurement from each station or plus to each corner of the building, making four measurements in all. All private and public roads or cross roads touching the highway should be located on the centre line and the magnetic course of them taken. They should be measured to the house or for at least a distance of 200 ft. The width of such roads should be taken, or other important features noted.

For bridges, the plus of each side, the direction of the flow of the stream, the span of the bridge, and the width of the stream, if it varies from that of the bridge, should all be taken.

The notes for all of these should be recorded in the transit book. Extensive road improvements generally cover a period of many years, as the laws or acts furnishing the money frequently provide that a stated sum shall be expended annually, for a given term of years. This means that many changes are bound to be made in the engineering corps, so it is absolutely necessary that all notes and records should be made in a manner that will not be confusing or difficult to understand.

Fig. 1 shows the two pages of a transit book, Station (Zero) O starting at a township line. The width of the road, i.e., the beaten track of travel, is shown at each station, and the distance from the centre line to the fences. A culvert is shown at Station 0+50 and a bridge at 8+26. A farm house with a private driveway alongside is shown between Stations 5 and 6. At Station 11+10 are shown cross roads. Magnetic courses are taken on all lines and roads, as shown in the notes. On the transit line the magnetic course is taken and from it and the angles calculated courses are recorded. If the road-building is to be done at once this is all that is necessary, but if the work is to last over a number of years it is well to take into consideration the magnetic bearing from the true north. At Stations O and 9+50 are two transit points. The two methods of referencing these points are shown, viz., at Station O by two lines with two hubs on each, and at Station 9+50 by two hubs at right angles to the back tangent. The notes are run up the page, although some prefer them downwards. The writer's preference is to start at the bottom of the page. Then the notes are kept as the line is run and the man facing the line has his notes in the same position, preventing mistakes being made in recording measurements on the right and left.

In making the surveys, all the work should be done in a systematic manner. The transitman should keep his notes up in the field, leaving nothing to be put down at night. He should, as soon as he sets up his instrument on a new point, take a back sight and reference the point. This gives time for the flagman or chainman to go ahead and establish a foresight, which can be changed to suit the men chaining if necessary, as the first point may be found to be 9+42.6 which can be changed to 9+50. Then the transitman should read his angle, meanwhile letting his needle swing to take the new course. This done, the work of chaining can be started once more. As each station is measured in, the side measurements should be made and called back to the instrumentman, or recorded in a temporary note book if the distance is too great to call. It should be made a rule to take all measurements to the right before going to the left. This prevents confusion and mistakes, saving much calling of names, as at Station 13 it will be seen that the first measurement, 8 ft., means to the edge of the road on the right, the next 21 ft. from the transit line means to the fence on the right, then 8 ft. on the left means the edge of the road, and with the chainman going ahead the transitman knows there are no other notes to be taken. Men can work several thousand feet in front of the instrument in this manner without confusion or error.

It is not possible to drive stakes on the transit line, except when the line is run on the side of the road or for a trial line. Then the stakes should be driven at each station, with the marked side facing the instrument or zero point. When the stake cannot be put at the measured station, it should be offset to the right-hand side of the road, always on the same side, and at right angles, as near as possible, to the transit line. The marked side of the stake should face the station point and the offset in feet should be marked on the stake below the station number, with a circle around it. This same offset should be recorded in the transit book at each station with a circle around it, as shown in Fig. 1. This allows of the stake being found easily if it is broken off, and is a help afterwards. To save time these offsets can be marked in the book on a rainy day or as the party is going over the line later.

At hubs or spikes the guard stakes should always be set to the right with the marked side facing the point. Uniformity in this is a great help afterwards. At all pluses, references, etc., it is well to mark the station number on the stake, as well as the plus or reference. Then, if the stakes are pulled up there can be no question as to where they belong. This means the saving of much time afterwards. At all transit points the guard stake should first be marked to denote that this is a hub or transit point. In marking stakes, space should be left at the top to mark a letter, as this line may afterwards be given a letter to denote it, or an "L" may be placed on it to show it is a located line upon which improvements are to be made.

Each night the transitman plots up his notes, and if any data has been overlooked it is taken the first thing the next morning. It is not well for him to use ink on his map until it is to be finished or sent to the office of the chief engineer.

(To be continued.)

CONSERVATION REPORT ON TRENT WATERSHED.

A report, entitled "Trent Watershed Survey," by Dr. C. D. Howe and J. H. White, of the Faculty of Forestry, University of Toronto, with an introductory discussion by Dean Fernow, will shortly be published by the Commission of Conservation. The area investigated is one in which the conditions are typical of those prevailing over thousands of square miles of cut-over lands in the Eastern provinces of Canada and for which it is desirable to formulate a policy of reconstruction and recuperation. The Dominion Government has a special interest in this region, as the capital invested in the Trent Valley Canal system amounts to upward of $10,000,000.

The report covers farming, forest, industrial, mining and tourist traffic conditions in the area considered. It shows that only 15,000 people inhabit the 2,100 square miles of the watershed (a decrease since 1901 of 15 per cent.), and that hardly 10 per cent. of the region has been cleared for farm purposes. The soil is altogether unsuitable for agriculture, and run-down and abandoned farms are to be found in large numbers. Nearly 200 farms were for sale for unpaid taxes in 1911 at 6 cents per acre.

Practically all the pine has been removed. The whole area has been burned over at least once. Almost one-half the area is covered with young and second-growth trees of the poplar-birch type, the result of fires.

It was found, however, that enough hardwood and wood of the poplar-birch type remain to warrant the adoption of a policy of conservation, and Dominion, Provincial or municipal ownership of the territory in question is suggested by the Commission as an initial step in that direction. Other recommendations are: the re-possessing by the Province of the licensed lands which have practically ceased to produce the quantity of logs contemplated under original licenses; the imposing of restrictions on existing limit holders, tending to protect the forest growth; the appointment of a forester charged with the surveillance of the region; the perfecting of a fire-protection organization, building of look-out stations and watch towers, and appointment of the game-wardens as fire-wardens.

NOTES ON SAND, STONE AND GRAVEL FOR SALT WATER CEMENT.*

By Harrison S. Taft, Seattle, Washington.

THE success to be attained by placing concrete structures in sea water depends upon, first, the possibility of using cement in salt water, and, second, an economical design. Without doubt a great many prominent engineers hesitate to recommend the placing of concrete structures in sea water more from a chemical point of view perhaps than from a structural one. If the material out of which the structure is to be built cannot be depended upon to maintain its integrity when exposed to the elements, the very best design will not solve the problem.

Therefore, the chemistry and manufacturing side of the cement industry becomes a question of prime and vital importance as regards cement to be used in sea water structures. The next question is that of impermeability; otherwise the concrete might slowly deteriorate under the action of the chemicals in sea water, since perhaps it is impossible to reduce such actions to a negative quantity. In freezing climates this question of impermeability becomes a very serious one, due to the destructive action of alternate freezing and thawing.

Cement.—The first and chief difficulty that has to be overcome in using concrete in sea water is "the peculiar chemical disintegrating action of the magnesium and other sulphate contents of ocean water upon the alumina compounds in the cement," followed "by the abrasive action of the water of the ever-restless sea" upon the chemically affected and softened concrete.

To overcome the chemical action of the sea water upon concrete the Germans have placed upon the market a brand of cement called "iron ore cement," wherein the alumina content of a cement is partly replaced for fluxing purposes by iron which is not affected deleteriously by the magnesium and other sulphates of the salt water; thus inoculating the concrete, as it were, against attack. The world-famed Teil Cement Works does not allow more than 2 per cent. alumina and absolutely no free lime in the cement which they manufacture for use in concrete structures standing in sea water.

Another German product called Puzzolan-Portland Cement, especially devised for use in sea water, has been on the market some 16 to 18 years. This product is a mixture of Portland cement and a natural puzzolan (a volcanic ash), or of a Portland cement and an artificial puzzolan (blast furnace slag of a certain chemical composition), the mixture being 30 to 60 per cent. puzzolan and 50 to 70 per cent. Portland cement.

The chemical action in hardening results in a Puzzolan-Portland hydraulic cement invulnerable to sea water. Although the mixing can be done on the job, it is far preferable to pulverize the two ingredients together in the mill at the cement factory.

A set of extensive tests made by the German government shows higher strength for Puzzolan-Portland cement concrete both in tension and compression than for pure Portland cement concrete. It has also been demonstrated that the former resists salt water far better than the latter. From an economic point of view in producing resistance to the action of sea water a barrel of Puzzolan-Portland cement has been found to be equal to two barrels of pure Portland cement.

From information obtained in regard to these two German cement products, concrete made of them and placed in salt water has been giving the best and most satisfactory results. Thus a vast amount of salt water concrete construction is being carried on in Germany and other foreign countries, due no doubt to their overcoming the action between salt water and the cement.

Though there have been a number of disastrous disintegrations in using American Portland cements in salt water, on the whole American Portland cement seems to have worked quite satisfactorily in sea water.

Such cement "has the power of armoring itself against the action of the magnesium sulphates of the sea water by the formation on its exposed surfaces of a film of lime carbonate." This film appears to serve as an effective protection to the concrete structure in comparatively still waters, but where the waters are greatly agitated this film has no opportunity to form. Hence "the calcium hydrate set free by the decomposition incident to the hardening of the Portland cement is washed away," leaving the concrete structure unprotected against "further inroads of the deleterious chemicals contained in the sea water."

To reduce the question of the chemistry of sea water cement to a more technical form, Mr. J. M. O'Hara, in a report to the Southern Pacific Railway, states: "The magnesium sulphate present in sea water acts upon the calcium hydrate of the cement, forming calcium sulphate, and further, this calcium sulphate combines with the alumina of the cement, forming calcium sulpho-aluminate, which last compound gives rise to the swelling and cracking of the concrete."

Mr. O'Hara also states that though it may seem that a cement in which the alumina has been replaced by iron is desirable, it would be impracticable, however, to replace *all* the alumina in a cement by iron oxide, as "a product resulting from the burning of ferric oxide and calcium carbonate does not possess hydraulic properties." He further says that whereas it seems to be universally accepted by engineers and others that a dense concrete is impermeable to sea water, the results of tests made by him do not seem to bear out this theory, unless the cement used has the inherent qualities to resist the disintegrating action of the sea water.

In discussing the subject of mass concrete in block form for breakwater purposes, William Matthews, a prominent English engineer, says:

"In a tideway, where mass concrete is used, it is of the utmost importance that the relative sizes and proportions of the aggregate should be such as to produce an absolutely watertight material. The infiltration of sea water into green or unset concrete and its subsequent exudation due to tidal action causes the magnesium salts in the sea water to withdraw a portion of the lime of the cement in the form of calcium salts, leaving a deposit of magnesia in its place. It is this magnesia, derived from sea water, either alone or mixed with lime from the cement, which constitutes the white substance deposited in the interstices of porous concrete between high and low water. Concrete so affected possesses but little strength and its failure is only a question of time."

As the result of his research upon the use of cement for sea water purposes, the eminent Dutch chemist, V. I. P. de Blocq van Kuffeler, Hoorn, in a paper read before International Association for Testing Materials, New York, September, 1912, states "that the decomposi-

*From Metallurgical and Chemical Engineering, January, 1914.

tion of the concrete is caused by the salts contained in sea water; the sulphates are the most to be feared owing to their action on the unstable compounds of lime which are formed during the very long period taken by the cement for hardening. Evidently it is during the first part of this period that the action of sea water is the most detrimental, i.e., when the compounds are least stable. Actual experience has confirmed this theory."

He also says that "when such material as trass or puzzolanes are added to the cement, one part of the lime forms compounds with silicates, the other compounds mentioned becoming more stable and the influence of sea water is less to be feared"; that "fine trass increases the impermeability of the mortar"; and "if the concrete has been hardened in a damp atmosphere the influence of the trass is still more marked."

Irrespective of the brand, a cement to be successfully used in salt water must be of the very best quality, of a fine pulverization, and thoroughly analyzed and tested for its chemical properties. Every means should be taken to avoid too much alumina in a cement that is to be used in salt water. The per cent. of alumina should be low, that of silica high. The cement should also be as free as possible from gypsum.

A cement of the slow hardening order should be avoided. Distinction between "setting" and "hardening" of cement should be kept in mind. A slow setting but quick hardening cement is the proper kind to use in salt water.

Not only must the cement manufacturers provide the engineer and the contractor with a cement of the proper chemical constituents, but the concrete made from said cement must be dense in order to fulfil all the requirements of a salt water concrete. This apparently is what the Germans have been doing, and it explains why they are able to get such excellent results in concrete work in Germany as well as in other foreign countries. It is an exceedingly important question for domestic cement manufacturers to consider.

As considerable stress has been laid above on the German method of manufacturing cement for sea water purposes it is fitting to still further consider what Herr Blocq van Kuffeler says upon the question of using cement in concrete placed in salt water. He states that the following points should be most strictly adhered to in using concrete in salt water:

(a) Artificial (slow-setting Portland) cement of first-class quality and hardening very uniformly should be used to the exclusion of all others.

(b) The mixing of the material and the ramming of the concrete in strong and tight casings must be performed with the greatest possible care.

(c) The use of trass (or puzzolanes) is recommended.

(d) The concrete must be compact and the composition of the mortar should not be below 1 part cement, ½ trass and 3 sand, or 1 part cement, 1½ sand.

(e) Allowing the concrete to set in a damp atmosphere before placing "in situ" greatly increases its resistance to attack by sea water and is recommended where possible. When the concrete is exposed to the infiltrations of sea water immediately after manufacturing its composition should be richer.

In conclusion he says a carefully considered composition, most careful manufacture, the use of excellent cement with trass (or puzzolan) and hardening in a damp atmosphere are the most efficient means of satisfactorily ensuing the preservation of reinforced concrete in maritime works.

Laboratory or Similar Tests.—For several years past the United States Government has been carrying on a set of tests at Atlantic City and elsewhere to determine the exact fact as regards the use of cement in sea water. A preliminary report of these tests has recently been issued by the government. Although three years is a comparatively short time for determining the absolute facts under actual conditions, the results of these tests so far published seem to indicate that the success of using concrete in sea water depends in a large degree upon careful and proper working of the material rather than upon the special brand of the cement itself. It is true that some cement works better than others in sea water, those with a low percentage of alumina giving the most satisfactory results, but with an impermeable structure as the prime factor in all cases.

Although these government tests will no doubt in time give the concrete engineer the absolute facts as regards the situation, the engineers of this country already have the actual experience of some 18 years of foreign practice by which to guide themselves. No doubt the final results of these United States government tests will simply substantiate what has already been learned regarding the use of cement in sea water by foreign chemists, viz., an impermeable mass with a low per cent. of alumina in the cement used.

In the early part of 1909 twenty-four test pieces were made of concrete and hung from one of the wharves at the Charlestown Navy Yard, Boston Harbor. These test pieces were 16 feet long, 16 inches square and made with a core for part of their length so as to provide a means of determining their permeability. Several different kinds of cement were used in making these pieces and the concrete mixed in various proportions; some of the pieces being made dense, others porous. These pieces were hung from the pier in such a way as to have their lower ends always in water, while the tops were seldom submerged. At the end of the first two years of immersion one of these test pieces showed marked signs of deterioration, while others were in good condition. Later reports go to substantiate the truism mentioned above, since the pieces made of a porous nature have deteriorated somewhat with those of a dense nature are in the same perfect condition as the day they were made.

Though these laboratory tests will go a long way in revealing the true facts and actual conditions it is necessary to guard against in the use of cement in sea water, "it must ever be kept in mind that the phenomena, both physical and chemical, in the sea cannot be reproduced exactly in laboratories on land." Consequently laboratory tests will never give the real truths of using cement, and hence concrete, in sea water as will actual experience. Thus the actual experience of foreign engineers in the use of concrete in sea water structures and the modes pursued by them are far more valuable to the American engineer than any short time test made in this country.

Admitting that laboratory tests are absolutely necessary and that the world cannot get along without them, such tests must be considered hand in hand with actual experience and as supplementary thereto. The fact that local conditions and local material will seriously alter cases brings home to the engineer the truth that he must not judge foreign experience by home conditions, and vice versa, until the actual conditions covering each are known and is used as the complement of the other.

Waterproofing Compounds.—In view of the claims made by waterproofing experts as respects the excellency of their product, it is proper to quote from an article entitled "Test of Water-Proofing Material," U.S. Bureau of Standards, No. 3, August 22, 1911: "Portland cement mortar and concrete can be made practically water-tight or impermeable (as defined below) to any hydrostatic head up to 40 feet, without the use of any so-called 'integral' waterproofing material; but in order to obtain such impermeable mortar or concrete, considerable care should be exercised in selecting good material and aggregate, and proportioning them in such a manner as to obtain a dense mixture. The consistency of the mixture should be wet enough so that it can be puddled, the particles flowing into position without tamping. The mixture should be well spaded against the forms when placed so as to avoid a formation of pockets on the surface.

"The addition of so-called 'integral' waterproofing compounds will not compensate for lean mixtures, nor for poor material, nor for poor workmanship in the fabrication of the concrete. Since in practice the inert integral compounds (acting simply as void filling material or in the nature of a lubricating material) are added in such small quantities, they have little or no effect on the permeability of the concrete. If the same care is taken to make the concrete impermeable, without the addition of waterproofing material, as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained."

In connection with this part of the subject it may not be out of place to speak of "oiled concrete" for waterproofing certain classes of concrete structures. It is of such recent development that sufficient opportunity has not been given to determine its real merits for universal waterproofing purposes especially as regard concrete structures standing in sea water. So far as known there are no records "of any such tests ever having been made" and some chemists have positively stated that it will be impossible to make oiled concrete a success foı sea water purposes.

On the other hand, I. Hiroi, a civil engineer of Japan, has stated: "Of more than 12,000 concrete blocks of all sizes and of different compositions, used by the writer in harbor works during the past ten years, there has not been the slightest indication of failure. On the contrary, the protection given by coatings of animal, vegetable and mineral origin to the surfaces of the blocks has rendered them almost impregnable against the incessant action of the sea. The protection thus afforded by nature, which would render a comparatively weak artificial stone, when properly made, as lasting as the natural stone used as its ingredient, is unknown in laboratory experiments."

Sand, Gravel, Stone.—The sand used in concrete placed in sea water must be clean, sharp and free from all foreign material. The stone must also be clean and sound. Gravel, if used, must likewise be clean and of proper size. The chemical composition and mineral structure of the stone, sand and gravel for use in proposed sea water concrete structures, should be known absolutely beyond all doubt. Since it is of great importance that concrete used in sea water should have the maximum density, the mechanical composition of sand and gravel should be known and modified, if necessary, by adding screened material.

For the same reason that an igneous rock or material is far better in the construction of a fireproof concrete structure, it is absolutely necessary in salt water concrete to use aggregates that will not disintegrate or fail when exposed to the elements of the salt water and the action of the sea.

Mr. John R. Freeman has called the attention of engineers to the fact that "here and there are banks of sand and gravel which, upon ordinary inspection, appear ideally perfect for making mortar and concrete, but which are nevertheless dangerous in the extreme, and all because of some ultra-microscopic content, probably similar to tannic acid (in a colloidal film around the sand grain), which works in some mysterious way to prevent the union between the cement and the sand grains."

Mr. Freeman cites an occasion where he found at the site of a proposed structure what promised to be a most economical resource in a shape of excellent sand and gravel; but upon being tested some of the samples of 1:3 mix, six days in water, hardly maintained their integrity while being placed in the clamps and before any load was applied. The cement was of a brand that had given excellent results with other aggregates.

E. E. Free, an investigator, engaged upon physical and chemical investigations for the Bureau of Soils, has noticed analogous phenomena in studying the relative fertility of different soils. Mr. Free states that:

"In popular terms the situation can perhaps best be explained by considering that an extremely thin film of a complex form of tannic acid surrounds each grain of the troublesome sand and prevents its attachment to the cement. These complex organic acids have a strong tendency to spread themselves thinly and strongly adherent over the outside of the siliceous material. The reason why one particular brand of cement is able to break through this filmy barrier so as to get a firm grip upon the sand grain is because of its containing a small quantity of some form of alkali that unites with this acid film or somehow changes its colloidal state."

It is admitted that these defective sands are the exception rather than the rule. Though some engineers and contractors may think the whole investigation a highly interesting laboratory amusement, of no value whatsoever to practical construction, the fact remains that there are sands whose availability for concrete aggregate cannot be predicted under any of the ordinary methods now in vogue, and that ever so often one of these sands gets into a structure to its detriment and perhaps failure if the structure stands in sea water. Therefore the sand and stone should be tested as carefully as the cement for salt water purposes.

Of equal importance is the utmost care that must be taken in mixing and placing the concrete, in order to obtain an impermeable mass throughout. Superintendents and concrete foremen should also be careful to see that injurious acids do not get into the sand, gravel and stone of concrete to be placed in sea water by the working force urinating upon the material. Great care should likewise be taken to exclude from all material entering into the manufacture of concrete such things as scraps from lunches, tobacco and spittle of those chewing tobacco. It is known that an amount of sugar, even as small as ¼ per cent. will entirely prevent a batch of cement from hardening. Since the extract from chewing tobacco contains sugar or glucose, any such extract that enters into the concrete will prevent the cement from setting. There are other organic compounds whose presence in the concrete will have a marked effect on the hardening of the cement, and the utmost means should be taken to exclude such detrimental material from all concrete to be placed in sea water.

Mixture.—In connection with the concrete dock work of the Thames River the practice seems to have been to use "a gravel of moderate size combined with two-thirds of its bulk of sand mixed with one part of cement to every two parts of sand," viz., 1:2:3 mixture. It is stated that with such a mixture there will be no fear of the results if the concrete is properly mixed and handled. The concrete is also given a grout coating after it has set and hardened.

In building concrete breakwaters in Holland it has been found that mass concrete blocks made of 1 part Portland cement, ½ part trass (the trass being a Puzzoland which is found near Andernach on the Rhine), 3 parts sand and 5 parts Rhine gravel, enabled the blocks to resist the corroding action of the sea water. Of more recent date they have been using a cement-trass-concrete of 1 part cement, ⅓ part trass, 2 parts sand and 3⅔ parts gravel.

In Germany a mixture of 1 part cement, ½ part trass, 3 parts sand, 4 parts gravel, is very often used.

During recent years a very rich mixture, viz., 1:1½:3, has been used in nearly all the important sea water concrete structures built in England and France.

In the harbor development of Otaru, Japan, a proportion of 1 part cement to 2 parts sand for the mortar gave superior results; the average concrete mixture used being "1 cement, 2 sand, 2 gravel and 2 broken stone, before the tuff was put in, the ratio equivalent by weight of the cement to the tuff being, 1 cement to ½ tuff." By volume this combination reduces to:

1.0 cement; 0.8 tuff; 3.2 sand; 6.4 ballast.

In the Netherlands Portland cement concrete with the addition of trass has been used almost exclusively. Though Herr Blocq van Kuffeler recommends a mortar of 1 part cement, ½ part trass and 3 parts sand mixture for sea water structures, he states that concrete of the above composition will remain in a perfect state of preservation "provided it has been hardened in a damp atmosphere before placing *in situ*, but is apt to give disappointment if the concrete is exposed to the infiltration of the sea water immediately following manufacture." Under the latter conditions he recommends a richer composition—at least 1 part cement, ½ part trass, 2½ parts sand. When no trass is used he says a mixture of 1 part cement, 1½ parts sand should be used. He also says that whereas mortars of 1 cement, 1½ sand and of 1 cement, 1½ trass, 3 sand can be used with safety in marine concrete work, the latter will create a saving in cost of considerable extent. It is also of great importance that the cement and the trass should be thoroughly mixed before the sand is added.

As respects the use of salt water in the manufacture of concrete, the same eminent chemist states that since the amount of salts introduced into concrete by diffusion when the concrete is exposed to sea water is vastly in excess of any salts that might be introduced into the concrete "by the small quantity of water used in its manufacture—the use of salt water in the making of concrete is in all probability prejudicial to only a slight extent."

As in ordinary reinforcement work, when the reinforcement is complicated, a smaller size gravel should be used with their homogeneity increased, a size of not over .116 cubic inch being recommended by a leading authority for marine reinforced concrete.

Mr. I. W. Sandeman, in his paper upon "Action of Salt Water Upon Concrete," states that for salt water purposes the maximum proportion of the sand in the mortar must not be more than twice that of the cement, and the mortar must exceed the voids in the aggregate. The exact grade of the sand mixed with the cement plays an important part in obtaining impermeable concrete, a hard, coarse sand giving the best results. It was the knowledge of this important point and a thorough investigation of it that enabled the noted Italian engineer, Com. Luigi Luiggi, to construct a dry dock at Bahia Blanca, in 1902, that resulted in a perfectly watertight job. The utmost care was taken in the construction of this dock, with special attention to the bonding of old concrete to the new.

As respects the advantages of using crushed stone over gravel, Mr. Staniford, chief engineer of the New York Dock and Ferry Department, states that his department does not find gravel a suitable material to use in mass concrete when subject to the action of the sea water, and that the broken, hard trap rock, so commonly used in New York City and vicinity, gives far better results in such kinds of concrete than are obtained with gravel. From the author's own experience with broken stone and gravel, he prefers stone, especially if it is trap rock.

Conclusion.—In the final analysis, the successful use of cement in concrete structures standing in sea water boils down to the use of an impermeable concrete made of a cement low in alumina and otherwise suitable for salt water purposes. The former is the problem of the concrete and construction engineer; the latter the problem of the chemist and cement manufacturer. To obtain an impermeable concrete a very rich mixture must be used, the exact proportion between the finer and coarser material being dependent upon the per cent. of voids.

If possible the concrete should be hardened in a damp atmosphere in order to assist the chemical reaction of setting before being placed *in situ*, or before being subject to the action of the sea water, especially so if the sections are small.

The mixing and placing should be closely watched and done with the greatest care, far more so than in the ordinary building work, in order to ensure that each particle of the sand and coarser material is well covered with cement and mortar respectively. A concrete of a medium or plastic consistency will ensure far better results than a wet or dry mixture.

"In the Netherlands experience has furnished conclusive examples as a guide for future construction, with a sufficient degree of safety, as to justify the further application of reinforced concrete in marine structures, which after all are only the work of mortals and not destined to last for eternity."

Mr. W. C. Phelan of the United States Geological Survey, states in a report upon the aluminum industry that the year 1912 was marked by a notable increase in the use of that metal, more than 65,000,000 pounds being consumed, compared with 46,125,000 pounds in the preceding year. Not only was there an increase in the domestic production, but there was a decided growth in the imports of the metal. The domestic production of bauxite during 1912 was 159,865 long tons, valued at $768,932. Compared with the output in the preceding year, these figures represent an increase in quantity of 4,247 long tons, and in value of $18,283. It is significant, however, that the importation of metallic aluminum of different grades increased enormously in 1912, a fact which may possibly account for the small increase in the production and the decrease in the imports of bauxite.

PROTECTION AGAINST FOREST FIRES ALONG CANADIAN RAILWAYS.

SINCE forest protection is the first essential to the development of forestry practice, and since fire has always been the chief enemy of the forest, with the railways as one of the principal agencies responsible for destruction, it is proper to emphasize the remarkable improvement which has taken place in the railway fire situation during the past year. The Commission of Conservation was instrumental in securing legislation which empowered the Board of Railway Commissioners to make regulations for fire protection along the railway lines. Under date of May 22nd, 1912, the Board, by Order No. 16570, covered the railway fire situation very fully, and placed upon the railway companies, subject to the jurisdiction of the Board, the responsibility for taking all measures necessary to the prevention and control of fires due to railway operation. As was reported at the annual meeting of the Commission in January, 1913, the Chief Forester for the Commission was also appointed Chief Fire Inspector for the Board of Railway Commissioners.

During 1912, the railway fire protection work was organized only in the West. In 1913, the organization has so far as possible been extended to the East. As announced by Hon. Clifford Sifton, chairman of the Commission, at the annual meeting in January, 1914, the plan has been consistently followed throughout of building up an inspection staff through co-operation with the existing fire-protective organizations of the Dominion and Provincial Governments, within the territory already covered by the jurisdiction and organization of each. Thus, the Railway Commission has appointed as officers of the Fire Inspection Department, a very considerable number of the officials of the Dominion Forestry Branch, Dominion Parks Branch, British Columbia Forest Branch, Department of Lands, Forest and Mines of Ontario, Forest Protection Branch of Quebec, and Crown Lands Department of New Brunswick. The principal work of these officials for the Board has been in connection with enforcing the requirements as to the patrol work and right-of-way clearing by the railways, though there has been a considerable amount of inspection of fire protective appliances on locomotives, in co-operation with the Operating Department of the Board. It will be seen that in this way the fire-protection work of the Board operates in complete control with the existing fire-protective organizations of the Dominion and Provincial Governments, and all unnecessary duplication is avoided.

In Nova Scotia, the proposed plan of co-operation has not yet been put into effect, pending the appointment of a Provincial Forester, who, according to the law enacted last spring, following the report by Dr. Fernow, on forest conditions in that province, will handle forestry work for the Provincial Government, as well as supervise the work of fire-protection in general.

To handle fire guard inspection in the prairie provinces, plans of co-operation have been developed whereby the Chief Fire Guardian of Alberta and the Fire Commissioner of Saskatchewan have been appointed officers of the Board. As to Manitoba, negotiations are now under way which, it is hoped, will result in a similar arrangement for co-operation by the Fire Commissioner of that Province.

The results which have been secured as a result of the co-operative handling of the railway fire-protection work have been admirable. The occurrence and spread of railway fires has been greatly reduced. The efficiency of the work is in direct ratio to the sufficiency and efficiency of the inspection staff made available by the various co-operating agencies. In the West, practically no criticism could be made on this score. The eastern provinces are somewhat more conservative, and the completion of the organization comes more slowly. However, assurances have already been received which will mean a very much more satisfactory organization in the east during 1914, and, as the work justifies itself by its results, further extensions may confidently be expected. For the most part, the railways have shown a decided appreciation of the work, and have endeavored to comply honestly with the various requirements. There is every reason to believe that henceforth the railways will be found among the minor—instead of the major—agencies responsible for damage by forest fires.

In order to bring this prediction fully into effect, further action is necessary respecting two classes of railways not under the jurisdiction of the Railway Commission. These are the various provincially chartered railways and the Government railways.

As to the first class, action in the form of new legislation is needed in the Provinces of Nova Scotia, New Brunswick and Alberta that railways chartered by these Governments may be required to observe the same precautions that are now required of Dominion chartered lines. These matters have already been taken up with the Governments concerned. In Ontario, existing legislation may possibly be adequate, but there does not seem to be sufficient provision for enforcement.

The situation as to fire protection along the Government railways has shown marked improvement during the past year. Following representations made last spring by the Commission of Conservation and by the Government of New Brunswick, a system of special fire patrols was established along the National Transcontinental Railway between Moncton and Edmundston, N.B., and special instructions were also issued to all employees in regard to reporting and extinguishing fires along the railway line. Much, however, still remains to be done before the system of fire-protection on Government railways will be as intensive as that now required on lines subject to the Railway Commission. Along both the Transcontinental and Intercolonial, there is very much to be done in the way of removing inflammable matter from the right-of-way. This situation is especially serious on the Transcontinental, and will mean a very serious fire risk until the debris is destroyed. It is also necessary that provision be made for special patrols on both lines through forest sections, and that special instructions be issued to all employees, similar to those issued on the New Brunswick Division of the National Transcontinental. Reports also indicate that a closer degree of inspection of fire-protective appliances on locomotives is needed, especially as to those running on portions of the Transcontinental not yet regularly opened for traffic. These various matters have for some time been the subject of discussion between our officers and the Department of Railways and Canals.

The suggestion has now been made to the Minister of Railways that all of the Government Railways should be placed under the operation of the regulations issued by the Board of Railway Commissioners. There can be no doubt that uniform regulations and a uniform inspection would be in the highest degree desirable and would conduce to effective fire-protection. The suggestion is at present under the consideration of the Minister of Railways.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of CIVIL, STRUCTURAL, RAILROAD, MINING, MECHANICAL, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

PRESENT TERMS OF SUBSCRIPTION
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00	$1.75	$1.00

ADVERTISING RATES ON REQUEST.

JAMES J. SALMOND—MANAGING DIRECTOR.
HYNDMAN IRWIN, B.A.Sc., EDITOR.
A. E. JENNINGS, BUSINESS MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont.
Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."
Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 1008, McArthur Building. Phone Main 2914. G. W. Goodall, Western Manager.
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor.
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

SUBSCRIBERS PLEASE NOTE:
When changing your mailing instructions be sure to state fully *both* your old and your new address.

Published by the Monetary Times Printing Company of Canada, Limited, Toronto, Ontario.

Vol. 26. TORONTO, CANADA, FEB. 19, 1914. No. 8

CONTENTS OF THIS ISSUE.

HIGHWAY SURVEYING.

The attention of our readers is directed to the article entitled "Highways and Highway Surveying," beginning on another page of this issue. The writer, Mr. Hauer, has had numerous requests during the past few years from both young and old engineers to write an article of this nature, whereby any civil engineer in taking up the practice of road work could undertake the special survey work connected with it intelligently and without the necessity of waiting to gain experience that he might deem necessary in order to do it properly.

The subject of road engineering is one of greatest importance in every province in Canada at the present time. Besides the opening of new highways, many communities that have borne expense and inconvenience for years in the upkeep of inadequate roads are awakening to the measure of economy which attends better facilities for transportation. The result is that more attention will be given during the next few years than ever before to the economics and location of country roads and to their construction and maintenance. The advent of motor-driven traffic has precipitated a complexity of shortcomings in previous practice that necessitate placing the care of such roads in the hands of engineers so that the scientific principles involved may be properly applied.

The article referred to has been specially written for *The Canadian Engineer*. The author's broad experience in construction work has equipped him with a knowledge of those details which determine success or failure, and how to achieve the one and evade the other. There is added to this the fact that the first article Mr. Hauer has ever written for any Canadian paper is the one on highway surveying, which he has prepared specially for this journal.

RESPONSIBILITY IN CONTRACT WORK.

Engineers cannot always throw the entire responsibility for the success of the construction of every job upon the shoulders of the contractor. It may be a comparatively easy matter, especially with the assistance of an able solicitor, to prepare a specification by which a municipality runs no risk whatever, but such a specification cannot always be enforced.

To begin with, it is a difficult matter to take away the contractor's right to appeal to the courts, should the specification mean probable confiscation of the work under certain conditions. Even though an iron-bound specification be prepared, such that allows the contractor no resource to the law, and that the engineer is the sole arbitrator of the value of the work done under the specification, the latter cannot always force the acceptance of the terms of the specification. This is especially true where the work is so large that it requires a bonding company's security. If this company believes the specification to be so rigorous as to be unfair to the contractor it will refuse to issue a bond; whereupon the engineer will then have to accept a bid without the bond, or modify his specification to the reasonable wording in which it should have been first written.

A notable case in point is the specification for the Toronto mechanical filtration plant, for which tenders were received a couple of weeks ago. The Department of Works was so anxious to safeguard the city in every possible way that a feeling was created among the bonding companies that the specifications prepared by the Department were entirely too arbitrary. We understand, unofficially, that as a result not one of the four tenders received was accompanied by the required bond. Moreover, it is believed that some, if not all, of the tenders were submitted with the condition imposed that certain modifications be made in the specifications.

Nothing but praise is due the Toronto Department of Works for its over-anxiety to protect the city's interests; but the case again calls attention to the fact that there are certain kinds of risk in every contract that must be shared by both parties to the contract. Toronto cannot reasonably expect its filtration plant to be an exception to the rule.

THE CONSERVATION COMMISSION AND ITS PUBLIC HEALTH MEASURES.

Several useful publications in the interests of public health were issued during 1913 by the Commission of Conservation under the direction of its medical adviser, Dr. Chas. H. Hodgetts. A compilation of the public health laws of the Dominion, as suggested at the Conference of Health Officers in 1912, a work which was urgently required and which is very much in demand, was one of them. A report was also compiled for the special committee of the House of Commons having under consideration two bills regarding the prevention of pollution of waterways. An illustrated pamphlet was prepared and printed in both English and French, and 150,000 copies distributed, having reference to the collection and disposal of garbage in cities and towns.

The question of sewage disposal as practised in England and Germany has been carefully studied by Dr. Hodgetts, and a report thereon is now in preparation.

Perhaps the most important development in connection with the subject of public health has been the determination of the Commission to take up more actively the question of Housing and Town-Planning. It will be remembered that some attention was given to this subject in the early stages of the Commission's work, and public addresses were delivered with the object of stimulating action by municipalities throughout the Dominion.

Gratifying results have followed from this movement, a great deal of attention having been given to the subject in various places, the most practical work that has been done up to the present time having taken place in the city of Toronto.

At the fifth annual meeting in January last, the chairman announced that with the object of strengthening and advancing the movement in favor of more scientific town-planning and more vigorous attention to the housing requirements of the population, the Commission had determined to act as the host of the National City Planning Conference, which will be held in the City of Toronto this spring. Arrangements are now in progress for the holding of that conference. It is intended, if possible, to make it the means of exciting more direct and effective attention to the subject throughout Canada; and also to procure, if possible, a body of substantive legislation which will enable those who are desirous of promoting progress in this important department of social welfare to act under the sanction of law.

For this purpose there has been appointed a special committee, of which Colonel Jeffrey H. Burland is chairman, having for its duty the preparation of draft legislation. It is the intention to have the recommendations of this committee submitted to the various Governments of the Dominion, and after receiving suggestions from them, to submit the whole matter to a Committee of the National City Planning Conference, with the object of getting a thoroughly digested measure. When this has been done an effort will be made to secure the enactment of the proposed legislation in the different Provinces of Canada.

LETTER TO THE EDITOR.

Billings Bridge, Ottawa, Ont.

Sir,—While appreciating the criticism concerning the floor slab on above bridge given in your issue of February 5th, the writer (the designer of the bridge) would take issue with "Bridge Engineer" as to the strength of this slab.

At the outset, let me say that $4\frac{1}{2}$ in. was the effective depth of slab, the stringers being spaced for roadway at $3\frac{1}{2}$ ft. As the span of slab is less than the width of roller, the roller load of 16,000 lbs. can be reduced to $\frac{3\frac{1}{2}}{4}$ of 16,000 lbs. = 14,000 lbs. This load was assumed to be distributed over an area of 1.16 ft. perpendicular to, and an area of 3.5 sq. ft. parallel to, the axis of the roller. This gives a load of 3,450 lbs. per sq. ft., and is about the worst condition of loading.

This gives a bending moment of 3,500 ft.-pds. using the formula $\frac{w\,l^2}{12}$ for continuous slabs. Dividing this by the moment of resistance of the steel gives the sectional area required per foot of width as 0.6 sq. in.

From this is derived a ratio of reinforcement of about 0.01%, and I fail to see where it is in any way disastrous.

To follow out the motor truck loading as mentioned, let us assume a concentrated load of 8,000 lbs. with a 12-in. wheel base. This will distribute the load over an area equal to 1.16 ft. x 1.83 ft., or 2.12 sq. ft., which gives a concentrated load per foot of width of 3,800 lbs. or, say, 4,000 lbs.

Using the ordinary bending moment formula for concentrated load, $\frac{W\,l}{4}$, gives a moment of 3,500 ft.-pds. and from it is deduced a sectional area per foot of width of 0.6 sq. in., or the same ratio of reinforcement as in the former case and this with a bending moment formula for a simply supported beam.

The figures for the distributing area are obtained in this latter case by assuming an actual wheel contact in a longitudinal direction of 4 in. passing at 45° through the 4-in. wood block and 1-in. sand cushion, and in a transverse direction by the 12-in. wheel base, passing down in the same way.

Expanded metal will be used for reinforcing.

ROBERT HENHAM,
Bridge Engineer.

Ottawa, Ont., February 13, 1914.

ONTARIO GOOD ROADS ASSOCIATION.

The annual convention of the Ontario Good Roads Association will be held in the County Council chambers on Adelaide Street on February 24th, 25th and 26th. The program as arranged provides for the reading and discussion of a number of papers on road construction and maintenance, having particular regard to conditions in Ontario. In view of the highway improvement proposals of the Provincial Government, this is expected to be an important gathering.

SEWER-PIPE AND ROOFING-TILE TESTS OF WESTERN CANADA CLAYS.

THE second part of a report on the clay and shale deposits of Western Canada has just been issued by the Geological Survey, Department of Mines. The first publication covered the results of a reconnaissance, carried out in 1910, of the formations in the region between Winnipeg and the Pacific Coast, which were likely to yield clay or shale deposits that might be of value in the ceramic arts. The report pointed out that there were not only extensive clay and shale formations but that some of them were of excellent quality and adapted to a variety of uses.

The new report deals with more extended investigation of this nature, and presents it on a formational rather than a geographical basis. It covers also the performance of a special series of tests on certain promising clays to determine their value for the manufacture of sewer-pipe and roofing-tile. (In addition, Mr. Keele made a somewhat detailed investigation of the preheating treatment as applied to Western Canada clays. This was outlined in *The Canadian Engineer* for February 12, 1914—page 311.) The sewer-pipe tests were carried out as follows:—

Samples were selected for special tests of those shales or clays which seemed to be of promise for pipe manufacture. These were moulded up to a very plastic mass and then pressed out through an annular die, giving a pipe whose outside diameter was 3 in., and internal diameter 2.5 in. Only those clays were used which flowed smoothly through the die, and these were cut up into 6-in. lengths.

After moulding, the pipes were dried and burned to cone 010, after which they were placed in the kiln of a sewer-pipe works, firing to cone 4.

It was to be expected that all of the samples tested might not yield the best results, as some would no doubt give better glazes when burned at a slightly different cone.

The clays used, together with the results obtained, were as follows:—

No. 1747.—Mixture of two parts Pierre shale from La-Rivière, and one part Niobrara shale from Leary, Man. This took a bright salt glaze, but not an exceptionally smooth one. This was undoubtedly due to the fact that the mixture was not ground fine enough, and that cone 4 is a trifle too high for these clays.

No. 1754.—Fireproofing clay from Coleridge, Alta. The salt glaze on this was fair, but the clay is hardly fire-resisting enough for successful salt glazing, even if its other physical properties were favorable to its use in sewer-pipe manufacture.

No. 1765.—Shale from Tofield, Alta., used in the proportions of 75% raw clay and 25% calcined clay, plus 2% salt to prevent cracking in air drying. This at cone 4 was much overfired, and it is doubtful if it would stand the heat required for salt glazing. If softened so at cone 4, that it was not stiff enough to hold its shape.

No. 1762.—Upper 7 ft. of shale from south bank of Lobstick River near Entwistle, Alta. The salt glaze on this was poor, and the clay itself is hardly refractory enough for making sewer-pipe.

Nos. 1805, 1806, and 1807.—Mixture of equal parts of these three clays, from the Dirt Hills, Sask. This mixture gave excellent results at cone 4. The pipe was straight, nicely vitrified, and the glaze smooth. The mixture should undoubtedly make a good sewer-pipe. The unglazed pieces showed some soluble salts, but not enough to interfere with the salt glaze.

No. 1817.—Mixture of two parts of top shale and one part under clay from Walton's mine, Minto, N.B. This took a good salt glaze, although cone 4 seemed a little too high, and better results would no doubt be obtained at cone 3. Care should be taken to grind this shale fine.

No. 1824.—Shale overlying sandstone, at Stonehaven, N.B. Like the preceding this developed a good salt glaze at cone 4, but was a trifle overfired. Cone 3 would be a better burning temperature for it. The clay should also be finely ground.

Roofing-Tile Tests.—A clay, in order to be useful for roofing-tile, should conform to certain requirements. These might be enumerated as follows: (1) suitable plasticity; (2) moderate shrinkage; (3) sufficient strength; (4) wide vitrification range; (5) development of preferably a red color in burning, which should be maintained without change over a range of several cones; (6) freedom from cracking and twisting in burning; (7) slow and slight warpage if burned unsupported.

It may not be difficult to find a clay which shows the proper development of some of these properties, but materials which are eminently desirable in all respects are more difficult to obtain.

In the manufacture of flat shingle tile and normal Spanish tile these slabs can be made by forcing a ribbon of clay through a slit-like die, and then cutting the ribbon up into proper lengths.

More complicated shapes, such as interlocking tile, are made by forcing a bar of clay through the die of a stiff-mud machine, this bar being then cut up into slabs which are given the proper shape by re-pressing in a plastic or steel mould.

One of the tests that may be applied to a roofing-tile clay in the laboratory, is the warpage test. This consists in moulding the clay or mixture of clays into thin strips 13 in. long, 1¼ in. wide, and ½ in. thick.

These are carefully dried, and then placed in the kiln resting on sharp edged fireclay supports, with a 10-in. span between the edges.

In the experiments these were burned at cones 010, 03, 05, and 1. The names of the clays tested and the results obtained in each case are given below.

In the testing of roofing tiles it has been advocated by some that their transverse strength when air dried should be determined,[1] but as shown by others,[2] the transverse strength of an air-dried clay stands in direct relation to its tensile strength, consequently it seems sufficient in describing these tests to give the latter.

Niobrara Shale from Leary, Man. (1636).—To this was added 25% of grog, consisting of calcined shale, to improve its working qualities. The bars had an average air shrinkage of 5.5%, and dried well without warping. The average tensile strength was 243 pds. per sq. in.

At cone 08 the fire shrinkage was 5.1, the sag 0.35 in., and absorption 12.2%. At cone 05 the fire shrinkage was 6%, the sag 0.58 in., and absorption 10.2%. At cone 1 the clay had sagged so as to give a deflection of 3½ in., and is to be regarded as over-fired. The clay is nearly steel hard at cone 08.

Clay from Dirt Hills, Alta.—This a grey shale lying at base of section in hill No. 2 (1647). The clay bars had an average air shrinkage of 7%, and an average tensile strength of 334 pds. per sq. in. It warped very slightly in drying.

At cone 08 the fire shrinkage was 1%, the sag was 0.08 in., and absorption, 15.5%. At cone 05 the fire

[1] Orton and Worcester, Ohio Geol. Surv.

[2] Ries and Allen, Trans. Amer. Ceram. Soc., vol. XII.

shrinkage was 2%, the sag 0.09 in., and absorption 14.7%. At cone 1 the fire shrinkage was 8%, the sag 1.37 in., and absorption 3.2%. The clay burns light red up to cone 05, but deepens considerably at cone 1.

Shale from Kilgard.—(1738).—The strips of this shale dried perfectly and had an air shrinkage of 4%. The average tensile strength was 114 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the sag 0.08 in., and absorption 22.6%. At cone 05 the fire shrinkage was 1%, the sag 0.09 in., and absorption 17.3%. At cone 1 the fire shrinkage was 6.5%, the sag was 1.14 in., and absorption 7.3%. At cone 3 the fire shrinkage was 7%, the sag 1.57 in., and absorption 9%. The color after burning was a soft drab.

Shale over Coal at Minto, N.B.—(1817).—The shale dried well without warping. Its air shrinkage was 3.5%, and tensile strength 68 pds. per sq. in. At cone 08 the fire shrinkage was 2.5% and sag 0.28 in., with an absorption of 9%. At cone 05 the fire shrinkage was 4.5%, and the sag 0.60 in., with an absorption of 6.2%. The shale burns red, but the color is somewhat dull.

Surface Clay from Merritt, B.C.—With 25% sand added (1779A), the mixture dried without warping and had an air shrinkage of 7.5%, the tensile strength being 318 pds. per sq. in. At cone 08 the fire shrinkage was 9.5%, the sag zero, and absorption 13.2%. At cone 05 the fire shrinkage was 0.5, and the sag still zero, with an absorption of 13.2. The clay burned red but showed a tendency to scum, although this could be prevented.

Mixture of 3 Parts of Grey, Sandy Clay from Camrose, Alta., and 1 Part Shale from Gwynne, Alta.—(1801A).—This clay showed a tendency to buckle in drying, and its air shrinkage was 8%. The tensile strength of the mixture was 166 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the sag 0.13 in., and absorption 17%. At cone 05, fire shrinkage still 0%, sag 0.16 in., and absorption 10.2%. The clay burns to a good red color.

Clay from Brickyard Site, Taber, Alta.—(1791).—This Clay dried without appreciable warping and had an air shrinkage of 8.6%. Its average tensile strength was 135 pds. per sq. in. At cone 08, the fire shrinkage was 2%, the total sag 0.14 in., and absorption 15.4%. At cone 05, the sag was 0.17 in., and the absorption 14.4%.

Lower Shale, South Side of Lobstick River, Near Entwistle.—(1763).—This shale dried well without warping, and had an air shrinkage of 6.0%. The average tensile strength was 114 pds. per sq. in. At cone 08, the shale had a fire shrinkage of 2.5%, a total sag of 0.18 in., and an absorption of 13.6%. At cone 05 the fire shrinkage was 3%, the total sag 0.24 in., and absorption 12%. At cone 1, the fire shrinkage was slightly greater, being 5%, the total sag 2.55 in., and absorption 0%. The shale burns to a light red color at the first two cones but is much darker at cone 1. It became steel hard at cone 05.

Sewer-pipe Shale East of Brickburn, Alta.—(1759).—This shale showed no distortion in drying, and had an air shrinkage of 6%, and the average tensile strength of 60 pds. per sq. in. At cone 08, it had a fire shrinkage of 1%, the total sag 0.09 in., and the absorption 12.3%. At cone 05, its fire shrinkage was 1.5%, total sag 0.16 in., and absorption 11.7%. At cone 1 the fire shrinkage was 6.5%, with a total sag of 1.42 in., and an absorption of 4.5%. The clay was steel hard at this last cone.

Shale from Valley of Bull's Head Creek, Alta.—(1757).—This warped slightly in drying and had an air shrinkage of 7%. Its tensile strength was probably high. At cone 08 the fire shrinkage amounted to 0.5%, with a total sag of 0.12 in., and an absorption of 10%. At cone 05 the fire shrinkage was 0.5%, the maximum sag, 0.18 in., and the absorption 9%. Its absorption at cone 1 was 2%. The clay burns red.

Fireproofing Clay, Coleridge, Alta.—(1754).—In drying this clay showed no tendency to warp. The air shrinkage was 4.6. The average tensile strength was 284 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the total sag 0.06 in., and absorption 15.6%. At cone 05 the fire shrinkage was still 0, the total sag 0.07 in., and absorption 15.5%. At cone 1 it sags still more, but the exact amount was not measured.

Surface Clay from Hazel Brae, Clayburn, B.C.—(1741).—This clay dried well without warping, and had an air shrinkage of 6%. The average tensile strength was probably good, but was not tested. At cone 08 the fire shrinkage was 1%, the sag 0.08 in., and absorption 16%. At cone 05, the fire shrinkage was 1%, the sag 0.13 in., and absorption 16.4%. At cone 1 the clay was past vitrification, and had sagged badly. The clay burns to a good red color at the first two cones.

For convenience of comparison these properties are given in tabulated form in Table I.

Table I.—Summary of Roofing Tile Tests.

				Cone 08.			Cone 05.			Cone 1.			Cone 3.			
Laboratory No.	Per cent. water required.	Tensile strength pounds per square inch	Per cent. air shrinkage.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	Per cent. fire shrinkage.	Sag in inches.	Per c nt. absorption.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	Per cent fire shrinkage.	Sag in inches.	Per cent. absorption.	
1636..	32	243	5.5	5.1	0.35	12.2	6	0.58	10.2	...	3½	...	...	...	...	red
1647..	30	334	7	1	0.08	15.5	2	0.09	14.7	8	1.37	3.2	...	...	...	red
1738..	18	114	4	0	0.08	22	1	0.09	17.3	6.5	1.14	7.3	7	1.57	9	drab
1817..	..	68	3.5	2.5	0.28	9	4.5	0.6	6.2	...	...	...	...	...	...	red
1779A.	..	318	7.5	0.5	0	13.2	0.5	0	13.2	...	...	...	...	...	...	red
1801A.	24	166	8	0	0.13	17	0	0.16	10.2	...	...	...	...	...	...	red
1791..	26	135	8.6	2	0.14	15.4	5.3	0.17	14.4	...	...	...	...	...	...	red
1763..	22	114	6	2.5	0.18	13.6	3	0.24	12	5	2.55	0	...	...	...	red
1759..	18	60	6	1	0.09	12.3	1.5	0.16	11.7	6.5	1.42	4.5	...	...	...	red
1757..	21	—	7	0.5	0.12	10	0.5	0.18	9	...	...	2	...	...	...	red
1754..	20	284	4.6	0	0.06	15.6	0	0.07	15.5	...	...	...	...	...	...	red
1741..	30	—	6	1	0.08	16	1	0.13	16.4	...	...	...	...	...	...	red

RAINFALL, EVAPORATION AND RUNOFF IN MANITOBA.*

Two main factors enter into the investigation of any possible power development—the head and flow available. While the first of these is obtainable through field survey and a knowledge of the extreme and average stages of river level, yet the second comprises an extensive study of the flow which, dependent on natural conditions, varies not only with the season and year, but also with the topography and character of the drainage area. Primarily all waters carried by rivers come from the rainfall or the melting of snow which has been precipitated during the winter months. Of this rainfall a portion evaporates, a portion enters the soil and is either absorbed by plant growth or by ground flow reaches the rivers or lakes, while the third portion finds its way into streams as surface flow or runoff.

Rainfall.—While the record of the runoff from a drainage area is of first importance in the question of power development, yet the rainfall or precipitation is also of extreme value, in that these latter records, if of a more extensive period than those of the runoff, would indicate the high and low range of flow which might be expected. In a like manner rainfall records in a drainage basin in which no discharge measurements are available can be used for the estimation of the flow based on the rainfall and runoff records of an adjacent area.

Throughout the southern portion of the province of Manitoba, rainfall records have been obtained by the Meteorological Bureau of the Marine and Fisheries Department of Canada, and these records are tabulated for the various stations in Fig. 1.

It is well known that the precipitation not only shows a variation from season to season, but also that a record extending over a short period of years is not sufficient to give the mean annual rainfall, but rather that for this means a period or cycle of long term should be considered. As the stations throughout the province at which long-term records have been obtained are not numerous, it is necessary to carry out some system of compensation for the shorter records of the adjacent stations. As is shown on the curves on Figs. 2 and 3, the records of the rainfall at the long-term stations shown separately for the eastern and western portions of the province have the same general features from period to period. Assuming that the intermediate stations of shorter terms will also range in a like manner from periods of heavy to those of light precipitation in the same years as at the long-term stations, the probable ratio of these short-term records to that of a long-term for the same station, has been based on the ratio of the precipitation at an adjacent long-term station during similar years, to the precipitation of the total period of the long-term station. As shown, the precipitation, together with the duration of the record, are given for various stations throughout the province. The ratio of all short-term records has been computed from the nearest long-term station as tabulated in the table, and a compensated annual mean for the station has been calculated. From these compensated results, the location of lines of equal precipitation has been determined. In the preparation of an isohyetal map of this district it has been necessary to use several records of very short period, but in the main, these records have been found to verify the lines of equal rainfall between the long-term stations.

*Extracted from a report on the water powers of Manitoba, prepared by the Department of the Interior, Ottawa, for the Public Utilities Commission of Manitoba.

Evaporation.—Of the tremendous losses due to evaporation from the ground surface very little is known. It is impossible to arrive as such losses by taking the difference between rainfall and runoff, as in this there would also be included the losses due to absorption by the soil and by vegetation, and again the rate of runoff does not depend altogether upon the rainfall. It is known, however, that a variation does occur in the evaporation depending upon many factors in which are comprised atmospheric conditions, geological and topographical features of drainage basin, together with the extent of forestration and vegetation.

STATION	ELEVATION	DURATION OF RECORD	YEARS	ANNUAL MEAN INS.	LONG TERM MEAN BASED ON RECORD AT.	PROBABLE RATIO OF RAINFALL IN THIS PERIOD TO LONG TERM MEAN	COMPENSATED ANNUAL MEAN FOR THIS STATION.
						Per Cent.	
Almasippi		1903 – 1912	10	20·90	Winnipeg	100	20·9
Asessippi		1886	1	13·52	Minnedosa	65	18·3
Adelphi		1888 – 1912	1	12·25	Bottineau N.Dak.	86	14·0
Brandon.	1176	1885 – 1912	21	17·16		100	17·2
Birtle	1703	1884	1	25·40	Hillview	130	17·8
Barnardo		1891 – 1905	9	16·80	Hillview	122	13·1
Berens River	710	1908 – 1912	5	21·22			
Beausejour		1886 – 1888	3	15·09	Winnipeg	52	22·3
Burnside		1886 – 1890	4	14·95	Stony Mountain	70	19·4
Craigilea		1888	1	15·05	Winnipeg	78	18·4
Channel Island		1890 – 1905	15	17·10	Stony Mountain	73	21·7
Cartwright	1533	1884 – 1912	15	19·82	Bottineau	123	15·3
Clarkleigh		1886 – 1888	3	18·10	Stony Mountain	86	20·6
Carberry	1258	1909 – 1911	3	17·07	Minnedosa	90	18·8
Clandeboye		1884 – 1888	4	16·72	Stony Mountain	72	21·4
Elkhorn		1895 – 1901	4	17·81	Hillview	115	15·1
Emerson		1894 – 1898	3	21·67	Pembina N.Dak.	106	20·4
Eden		1884 – 1887	4	17·14	Minnedosa	74	21·6
Fort Ellice		1885 – 1891	7	15·25	Hillview.	99	15·4
Gretna	760	1903 – 1910	8	18·67	Pembina N.Dak.	94	19·8
Gilrad		1904 – 1905	2	11·77	Bottineau.	93	12·6
Hillview	1400	1891 – 1912	20	20·00	Minnedosa	114	17·2
Minnedosa	1690	1881 – 1912	32	17·82		100	17·8
Morden	978	1888 – 1912	17	19·69	Pembina N.Dak	93	21·1
Norquay	798	1888 – 1912	16	19·00	Winnipeg	85	21·9
Oakbank	740	1886 – 1912	22	21·04		100	21·0
Oakdale Park	740	1905	1	18·48	Minnedosa	110	16·6
Portage la Prairie	830	1884 – 1908	14	17·00	Winnipeg	93	18·2
Pilot Mound	1547	1887 – 1898	4	18·74	Pembina	93	20·1
Rapid City	1180	1882 – 1912	15	17·65	Minnedosa	91	18·2
Russell		1884 – 1904	9	15·18	Hillview	89	16·8
St. Albans.	1060	1885 – 1912	25	17·66		100	17·7
Swan River		1901 – 1910	4	20·85			
Shell River		1884 – 1890	6	15·37	Minnedosa	89	16·9
Stony Mountain	803	1878 – 1909	22	17·64	Winnipeg	83	20·6
Turtle Mountain	2150	1884 – 1904	12	21·92	Bottineau.	141	12·9
Treherne	1212	1910 – 1912	3	18·28	Winnipeg	93	19·6
Winnipeg	760	1873 – 1912	40	21·55		100	21·6
Kenora (Ont)		1886 – 1912	9	22·41	Winnipeg. Port Arthur	93	24·0
Norway House		1896 – 1904	8	18·90			
York Factory		1875 – 1882	3	20·38			
Moosomin (Sask)		1901 – 1905	3	17·39	Hillview	113	15·1
Saltcoats (Sask)		1900 – 1903	4	15·69	Hillview.	122	12·2
Port Arthur (Ont)		1886 – 1912	27	23·08			

Fig. 1.—Manitoba Rainfall Records.
(Assumption, 10 in. snow = 1 in. rainfall.)

A more complete study has been made of the evaporation from the water surface of lakes and rivers, the greatest use of such studies being in the investigation of storage and the losses which are likely to occur on such reservoirs through evaporation. That the losses on lake areas are very great and often of greater extent than precipitation is well known.

In connection with the investigation of the water-powers on the Winnipeg River, and with the view to maximum efficiency in the development of powers thereon, it has been found necessary to consider and investigate the possibilities of conserving the flood waters. Accordingly, very complete studies are being made of the storage possibilities of the immense lake areas of the the Lake of the Woods district. These studies have naturally included the securing of data with respect to evaporation, and on May 1st, 1913, an evaporation station, together with numerous instruments for the recording of all atmospheric phenomena which affect the extent of evaporation, was established on the Lake of the Woods in the vicinity of Keewatin, Ont.

Runoff.—It is readily seen that the extent of runoff or stream flow depends principally upon the depth of rainfall and the area of the basin drained, yet many other factors entering therein and of extreme importance comprise such as the geological formation and topographic features of the drainage area, whether of sloping land tending to give a rapid runoff, or of low-lying, swampy areas from which the flow is more or less uniform, and also dependent upon the extent of the growth of timber and vegetation together with numerous other factors.

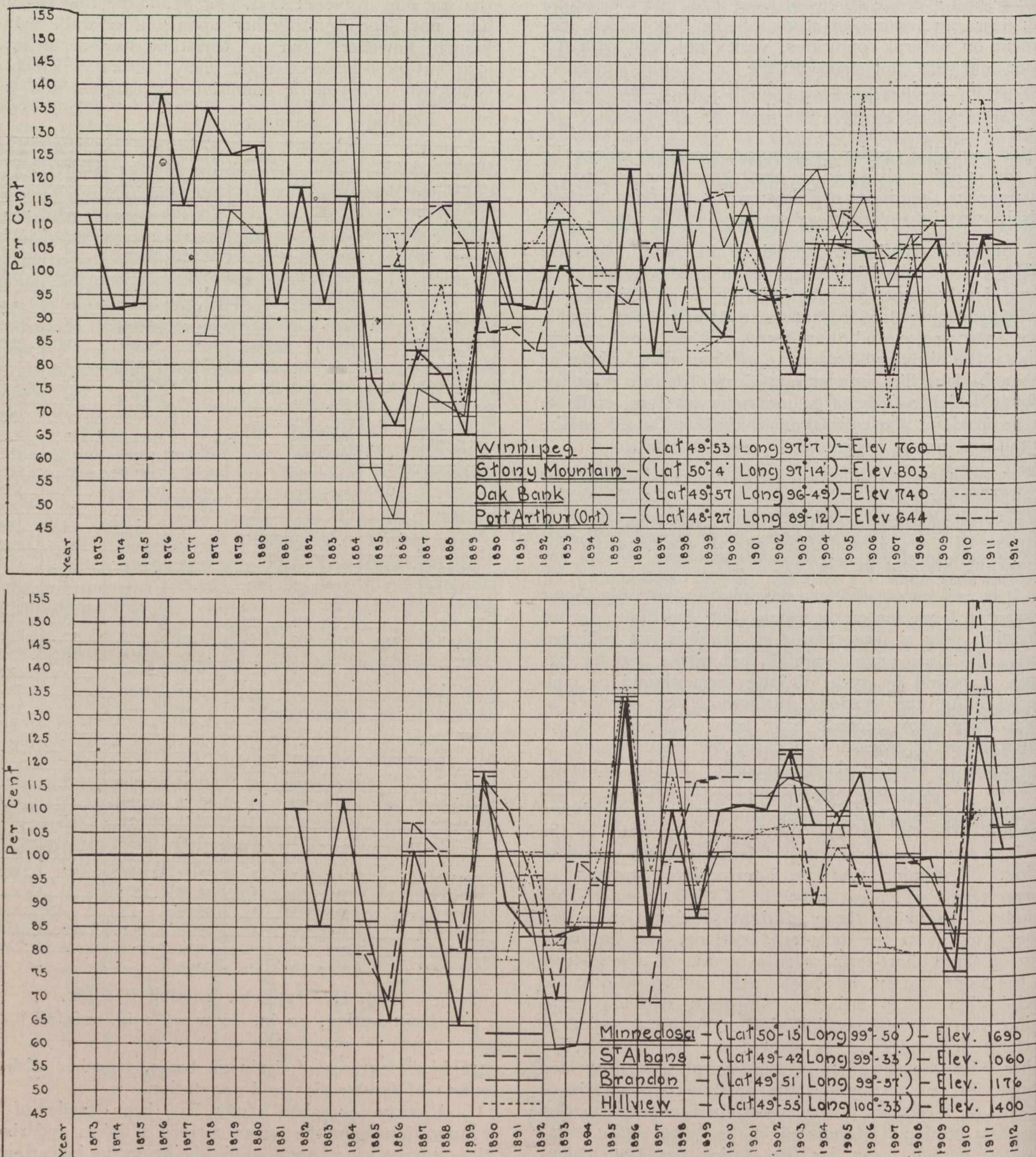


Fig. 2.—Curves Showing Relation of Precipitation at Long-term Stations in Manitoba.

While much can be gained from the studies of rainfall and evaporation and the physical features of a drainage area, yet the most accurate and reliable data with regard to runoff or stream flow is obtained by a systematic gauging and metering of the flow of the stream to secure the continuous runoff and extending over sufficient time to obtain the extreme fluctuation. The runoff of any stream varies not only from season to season, but also to such an extent from year to year that the same conditions are not likely to occur on a river on any two successive years. Records for a cycle of at least seven years are, as a rule, necessary to cover the yearly variation to be anticipated.

Not only is the study of the runoff of streams of extreme importance in the investigations of power possibilities, but it is also of extreme value in the investigation of possible reclamation of low lands through drainage, or the reclamation of arid lands through irrigation. Such a study is also necessitated on many rivers where schemes for the betterment of navigation are proposed.

Manitoba Hydrographic Survey.—Previous to the year 1911, there had been no systematic or reliable gathering of data relating to the flow of the rivers in the province of Manitoba. Some few scattered discharge measurements had been made throughout the province, but not of sufficient extent to give information as to the continuous flow of any river as extending over various stages of their discharge. In the above year a systematic study of the power possibilities of the Winnipeg River was inaugurated by Mr. J. B. Challies, Superintendent of Water Power Branch, Department of the Interior of Canada. The field work, of which Mr. D. L. McLean was in charge, consisted of a detailed survey of the river and its power possibilities in Manitoba, and also included the establishment and maintenance of gauging stations on the river. This work, in the spring of 1912, was further enlarged so as to embrace a systematic study of the flow and power possibilities of all rivers throughout the province. For this extensive work, the Manitoba Hydrographic Survey was organized, with the appointment of Mr. D. L. McLean as Chief Engineer, the work still being carried on under the supervision of the Water Power Branch. Numerous gauging stations were established on the rivers and streams throughout the province, and since that time the gathering and compiling of the data has been vigorously carried on.

NORTHERN MANITOBA WATER POWERS.

During the year a report will likely be issued by the Commission of Conservation regarding water-powers in the three prairie provinces of the Dominion. Mr. L. G. Denis, one of the engineers of the Commission, has practically all the data in hand.

During the past year he spent 4 months on a reconnaissance trip through northern Manitoba. From Norway House his party descended the Hayes river to York Factory on Hudson Bay. He then ascended the Nelson river back to Norway House and thence to the mouth of the Berens river, on Lake Winnipeg. This river was investigated to the head of Little Grand rapids, after which the Pigeon river was descended, thereby returning to lake Winnipeg. The Dauphin river was likewise investigated.

The work entailed the taking of levels and discharge measurements, together with notes of the power possibilities along the rivers travelled. This information, added to that which had been previously collected on water-power resources of Saskatchewan, Alberta and southern Manitoba will constitute the substance of the new report.

TEST OF REINFORCED BRICKWORK

By Chas. H. Edmonds,
General Manager, The Reinforced Brickwork Company, Limited, Winnipeg, Man.

A NOTABLE test was conducted at Exhibition Park, Toronto, last fall to determine the maximum uniformly distributed load that could be supported without complete failure:—

1. By a cantilever.
2. By a beam built between two piers.

A solid 9-in. wall was built 3 ft. high, and supported by two brick piers so as to form a simple beam with 10 ft. clear span, and a cantilever beam 5 ft. clear length. The distance from the ground to the bottom of the wall was 3 ft. The two piers were 18 in. square, and were carried on a stone footing 3 x 3 x ½ ft. The vertical joints of every second course of the cantilever brickwork were built right at the pier. The cement mortar was a 3:1 mixture.

The reinforcing used was "HB," as supplied by the Reinforced Brickwork Company, Ltd., Winnipeg, two 2½-in. strips being used per course, (as the wall was 9-in. thick), and was run straight through beam, pier, and cantilever.

The work was allowed to dry out from the date of construction, August 20th, 1913, until October 9th, 1913, during which period the weather was dry and warm.

In order to obtain a uniformly distributed load, pig-iron was piled on the cantilever and beam, care being taken to keep the load built up squarely at the ends, and also to keep the top of the pile level, so that uneven loading conditions might be avoided. The idea followed out was to first load the cantilever to destruction. In order to give a fairly balanced condition, the beam was also loaded at the same time.

The first load was placed on the beam and cantilever on October 9th, 1913, the loading being applied until the beam carried 7,197 lbs., and the cantilever carried 2,519 lbs. On the following day the loading was continued. The following are total loads when work ceased at noon, Oct. 10th:—

Beam, 14,927 lbs.—Deflection, .07 inch.
Cantilever, 6,337 lbs.—Deflection, nil.

When loading was recommenced and had reached 13,063 lbs. the cantilever sheared off at the pier. Outside of a small hair crack on the tension side of the cantilever, and a very slight opening of about half a brick length of a mortar joint, the cantilever was intact. The bricks were broken across, no failure taking place horizontally along the mortar joints at the pier; or in other words, the bricks did not pull out on the tension side, or crush on the compression side of the cantilever. The vertical joints of every second course of the cantilever brickwork were built right at the pier. Had there been no vertical joints immediately at the pier, the ultimate load would undoubtedly have been greater.

Just after the cantilever failed, a slight fracture was noticed on the upper side of the beam. There is no doubt that, because of the cantilever shearing off at the pier, and the whole load falling vertically, the footing of the pier must have been given a severe shock. This, and the sudden releasing of the stress due to the cantilever being continuous, would naturally tend to produce fracture in the beam.

The beam was then further loaded until it was supporting a load of 36,190 lbs., and when this load was reached, it was noticed that the pile, having reached a considerable height, had a tendency to waver sideways. It was felt, in consequence, that further loading would be carried on under rather dangerous conditions for the workmen. Loading was, therefore, stopped, and seven men were instructed to use a 2 x 12-in. plank, 15 ft. long, as a ram, and to deliver blows on the lower side of the beam at the centre. Seventeen blows were given, the result being a bad fracture, although the beam still held, and showed no inclination to fracture completely. The next blow, aimed at the central portion of the fractured material, caused ultimate failure.

Deflections.—Deflection readings were taken during part of the test. At failure, the cantilever showed a deflection of 0.125 in. The deflection of the beam, loaded with 16,561 lbs., and just after failure of the cantilever, was 0.101 in. Just previous to the load of 18,540 lbs. on the beam, the deflection was .115. At this load, a fracture occurred in the beam as explained above, and deflection readings were discontinued, as the fracture was thought to be more serious than subsequent loading proved.

Similar successful tests have been conducted in Calgary, Vancouver, and Winnipeg, and have a tendency to indicate that a modification of existing ideas with respect to the thickness of brick walls is needed. Building by-laws call for stated thicknesses, but in the cities of Montreal, Winnipeg, and Calgary, it has been conceded that owners and builders should be permitted to take advantage of such improved methods of construction, and the building by-laws have been amended whereby one may reduce the thickness of their walls by 4 in. to 9 in. by the adoption of a proper wire mesh reinforcement. Not only is there a saving of from 10 to 16 per cent. in the first cost, but the builder has the advantage of an additional amount of floor space which is of considerable yearly value to him.

To effectively reinforce a wall, there are certain conditions which must be fulfilled. If a strip of hoop iron is placed in the centre of a joint, and the wall subjected to lateral pressure, the position of the steel coincides with that of the neutral axis of the wall, and the steel will not become stressed. The greatest tension occurs at the outer edge, furtherest from the load, and in this case is carried by the joint—the steel only comes into action when the outer fibres of the mortar joint have failed, and the bond being destroyed, the steel is no longer protected from the weather.

In practice it is found, if using two strips of hoop iron placed near the edge of the wall, that failure will take place by shearing long before the full safe working stress of the steel is reached, partly because there is no connection between the compressive and tensile reinforcements, or no provision for shear, and partly because the metal is not sufficiently surrounded by the mortar to obtain proper adhesion. Consequently, for an effective system there are three fundamental points to be observed:—

(1) The reinforcement must be such that there are sufficient tensional members to take up the tension.

(2) Sufficient members to take up the shear.

(3) Reinforcement must be such that it is completely and easily surrounded by the mortar, both as regards adhesion and protection from weather and moisture.

The action of this new form of reinforcement is as follows:—

The reinforcement is firmly bedded in the mortar joint, and the tensional wires running the entire length and over the joints of support, form a continuous bond, and give to the mortar a power to resist tensional stresses which it does not ordinarily possess. The stresses in a wall, whether lateral or in the form of a load, tend to elongate these tensional members, and this is where the cross or lacing wires come into action. They form, with the tensional wires, a series of triangles which are surrounded and filled with the mortar of the joint. Any tendency towards elongation by the tensional wires would result in a closing action of these triangles, and, consequently, of the mortar inside them, but the mortar, being strong in compression, resists this closing action, and absorbs the stresses of the wire, with the final result that a compound force, much greater than the sum of the individual strengths of both mortar and steel, is developed. Practical tests have shown that the mortar joint is as strong as the brick, and the result is a brick wall which is a monolithic structure, not requiring continuous foundation, and immensely stronger than plain brickwork.

TRANSCONTINENTAL RAILWAY STEAMER FOR ST. LAWRENCE RIVER FERRY.

A CANADIAN car ferry and ice-breaking steamer, built by Cammell Laird, of Birkenhead, for the Transcontinental Railway Company of Canada, was launched on January 17th last. It is intended for service on the River St. Lawrence, between Quebec and Levis, and is a very interesting specimen of naval architecture. Its principal dimensions are, length 326 ft., beam 65 ft., with a draft of about 15 ft. The propelling machinery consists of 2 sets of triple expansion condensing engines, steam being supplied by 8 single-ended cylindrical boilers working under natural draught. An ice propeller of nickel steel, driven by a compound condensing engine, is fitted at the forward end of the vessel, which is built to Lloyds' special survey, and is arranged for the carriage of passenger and freight trains at all seasons of the year.

The trains are carried on a tidal deck, arranged above the main deck of the vessel, on three lengths of track, the length of each track being about 272 ft. The tidal deck rests on castings working up and down on 10 vertical lifting screws on each side, supported on columns, the columns being stayed by lattice buttresses against longitudinal transverse thrusts. The lifting screws are hung on ball bearings from the top, and are manipulated by means of worm-wheels, driven from horizontal shafting, which runs the length of the vessel on each side. The horizontal shafting is worked by bevel gearing from a four-cylinder, high-pressure engine of special design situated below the main deck. The gearing is arranged to lift the tidal deck, fully loaded with a train and locomotive weighing about 1,400 tons, at a rate of one foot per minute, to a height of about 20 ft., which enables the ferry to be loaded or unloaded at any state of tide. At each end of the tidal deck an adjustable hinged gangway is suspended, which allows for any change of trim or heel of ship due to unequal distribution of weights while taking the coaches, etc., on or off the vessel. Above the highest position of carriages on the tidal deck a promenade is arranged all round the vessel, with a bridge platform forward, from which all the operations of steering and manœuvring are directed. The boiler-rooms are arranged in wing compartments amidships, with the coal bunkers and the tidal deck engine-room between them. The main propelling engines are situated abaft the boiler-rooms, and the engine for the ice propeller is placed in the hold just abaft the fore peak bulkhead.

The vessel is fitted with electric light throughout, and electric gear is provided for raising and lowering the end gangways and for hauling the railway carriages on or off. Special arrangements are made for heating the carriages during transit. Double windlasses are fitted, one on each side, with slip-drum for mooring.

CONCRETE IN HIGHWAY WORK.

THE following remarks on the subject of concrete roads were made by Major W. W. Crosby, Chief Engineer of the Maryland Geological and Economic Survey, in the course of a discussion following a paper* read by Mr. Frank F. Rogers, State Highway Commissioner of Michigan, at the Philadelphia convention of the American Road Builders' Association:

While at present there seems to be a sort of a stampede, ably assisted, perhaps, by certain interests, toward the use of concrete for roads and streets, the speaker wishes to utilize this opportunity to express the opinion that the selection of concrete for such work may well be considered as divided into two main questions of great importance for proper determination.

The first of these questions is that of a necessity for rich concrete, or even for a concrete base itself, for the pavement or wearing surface itself—a condition by no means always existing or likely to exist during the life of the wearing surface. Many mistakes, it seems to the speaker, have been, and are being, made by the use of any concrete base or foundation where equal satisfaction at least and great economy would have been had by its omission or the substitution of a cheaper but, under the local conditions, an equally efficient foundation. It is to be understood here that the speaker believes that the use of concrete for the wearing surface itself, except in a few cases under peculiar conditions, is already proved impracticable, but for the sake of brevity the reasons for this conclusion will not be again expressed here.

The second of the questions referred to is made up of the old questions as to (a) the character of the wearing surface to be supplied on top of the concrete base or foundation, and (b) the thickness of such wearing surface.

As to (a) the character of the wearing surface to be built, little need be said at this moment for the purposes of the speaker.

The point which the speaker wishes to make at this time is under (b) the thickness of the wearing surface when the latter is bituminous in composition. Wearing surfaces composed of pitch compounds (bituminous materials, such as asphalts, tars, and oils) mixed either previously or *in situ* with sand, gravel or stone chips, have almost invariably proved unsatisfactory as carpets on concrete unless these carpets have been of more than a minimum thickness, dependent for expression in figures on local conditions, while those of sufficient thickness have proved satisfactory where their construction was proper under all the conditions.

The speaker thinks a reason for this difference in results between carpets identical except in thickness and for the failure of many too thin carpets comes from the fact that the thin carpets do not sufficiently absorb the shocks of traffic to prevent the disintegration and pulverization to a greater or less degree by such shocks of the surface of the concrete to which the carpet is applied. Hence, such carpets, lacking sufficient coherency in themselves and the preservation of a proper surface to which to maintain their adhesion, soon break up and disappear, first in spots and then altogether.

The surface of the concrete base naturally contains a great deal of mortar—an extremely friable substance, readily disintegrated under horses' feet and hard tires. If the effect of these is permitted to pass through the carpet and to reach the mortar, the latter soon becomes broken up and the adhesion of the carpet to a stable surface destroyed.

The same phenomena have been noticed by the speaker in the cases of macadam built of a soft, friable sandstone covered with a thin carpet, and their failure to occur has been equally noticeable where the thickness and character of the carpet has been sufficient to absorb the shocks referred to and to prevent disintegration of the friable materials underneath.

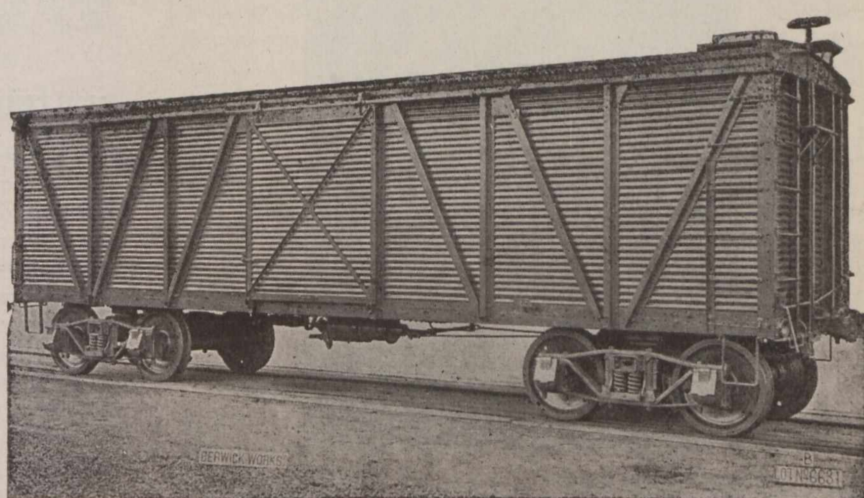
The speaker realizes the difficulties of thick carpets, but he feels they can be solved by proper methods, such as have been used in the case of a familiar form of carpet for city streets—the sheet asphalt pavement. He believes that further solution of the problem of adapting this pavement to country roads—by the substitution of a "paint coat" for the "binder course," for instance—is in sight.

*Published in *The Canadian Engineer* for November 13th, 1913.

ALL-METAL BOX CARS.

The illustration herewith shows an all-metal box car made by the American Car and Foundry Co. at Berwick, Pa., for use on the Central Railroad of Brazil, South America.

Owing to the conditions existing in that section it is necessary to use metal which would be anti-corrosive as the railroad alternates from a high altitude in mountains to very moist condition in the valleys and the extremes of altitude



and temperature are very conducive to corrosion. Toncan metal anti-corrosive sheets were used in corrugated form for the roof sides and ends. It is claimed that such a construction makes a perfectly fire-proof box car and in addition that the majority of methods whereby the car may be broken into and the contents molested are removed. A combination of corrugating and stamping was necessary in order to have the ends of the sheets flat at the corners of the car so that the heavy angle section could be riveted close up, thus preventing any leakage of contents. We are indebted to the Pedlar People of Oshawa, who are the Canadian agents for Toncan metal, for these interesting particulars of a new form of construction.

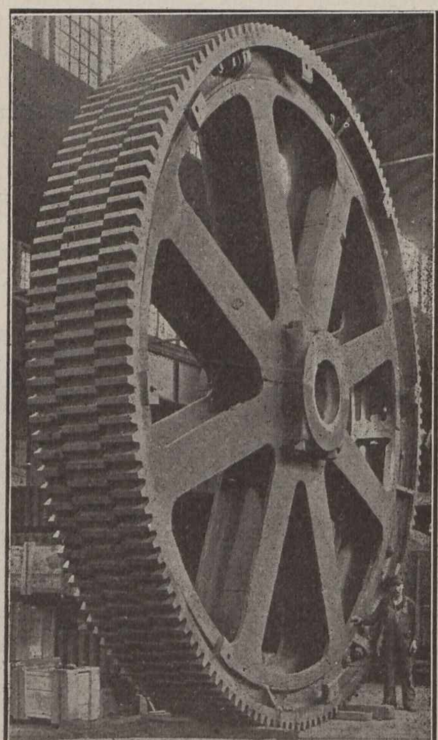
The Newfoundland Railway and Train Ferry Syndicate, Limited, a private company, has recently been granted authority to construct, equip, and operate a line of railway from the south-west arm of Green Bay to Humber Mouth, Bay of Islands.

A GIGANTIC STEEL GEAR.

A steel gear that is very unusual, and probably the largest of its kind ever manufactured, is being installed by the Inland Steel Company, of Chicago, to be used for driving a sheet mill. By the use of this gear and pinion a single-stage speed reduction is obtained from the motor to the mill.

This gear is 22 ft. 8 in. in diameter, with a 38-in. face and 5⅜-in. circular pitch. The mating pinion is 2 ft. 11 in. in diameter. There are 154 teeth in the gear and 20 teeth in the pinion.

The design varies from ordinary practice, because the teeth are staggered in three sections, as shown in the accompanying figure. On account of the axial motion to which the drive is subjected it was necessary to use a spur gear. Herringbone gears were not considered because of the unequal pressure that would be exerted on the side of the tooth face. The gears travel at the speed of 2,000 ft. per min. To meet the action of this high speed the gears were very carefully cut, the teeth staggered and the drive arranged to run in an oil bath.



An Unusually Large Triple-staggered Toothed Steel Gear.

The machining of the gear is very interesting. All the teeth of the gear were cut on a planer, specially designed and built by the Mesta Machine Company, Pittsburg, the manufacturers of the gear. For large work they found the old-style crank-operated tools too yielding, and, consequently, originated their own planer. In this machine the tool is driven directly by a heavy lead screw, which in turn is operated by a variable-speed reversing motor.

The gear itself is built up of six parts. The gear centre, including the arms, etc., carries the central rim segments of teeth. The two halves of the gear are bolted together and the separate rims fastened to this by bolts running through the side of the central casting.

Starting with the rough casting, the operation of making such a gear will be followed. After annealing of the casting the joints at the hub and rim of the central portion of the gear were planed. These joints were then drilled, reamed, and the two halves bolted together. The wheel was then placed in the pit lathe, the gear centre turned down to the correct diameter, and the surface machined where the rim segments were to rest. The main gear was then taken from the lathe and the rim segments machined. Lugs were cast on these segments to aid in holding the work on the face-plate. One segment was bolted on the face plate and turned up. It was then reversed and the other side machined to size, and the segment turned to correct diameter. The surface of the segment to rest on the main gear was machined at this time.

The rims were next bolted securely to the main gear centre, with all the teeth in a line across the face of the gear, as shown in Fig. 2. The teeth were then planed, through the centre section and both side sections at the same time. The final cut was taken on the gear without removing the tool during the entire operation of cutting.

The mating pinion was machined in a way similar to that of the large gear. After the teeth were cut the bolts were taken out and the two side sections shifted on the centre section to give the proper stagger. This was done by using an indicating micrometer, so that the slightest variation from exact dimensions could be eliminated. After the stagger of the teeth of the pinion was set, the teeth of the large gear were set to match the pinion.

Holes were then drilled through both rims and the centre of the gear. These holes were reamed and machined bolts inserted.

The gear was then taken apart and shipped. Since the gear is built up of six parts, together with the fact that the parts were fitted together at the plant with machined bolts, before shipping, the installation will be very simple. It will not be necessary to disturb machinery already installed.

UNITED STATES COAL MINING INDUSTRY.

A production between 565,000,000 and 575,000,000 short tons of coal in the United States during 1913 is the official estimate of the United States Geological Survey, an increase over the record-breaking production of 1912 of 30,000,000 to 40,000,000 tons. These figures are given out by Edward W. Parker, coal statistician of the Survey, with the statement, however, that the coal mining industry in 1913 lacked any spectacular features, the increase, in other words, being normal and an index of the general industrial activity of the country. Of this increase about 4,500,000 tons was in the production of anthracite and the rest in the output of the bituminous coal mines.

The coal production in 1912 was 534,466,580 short tons, and the output in 1913 would probably have been somewhat in excess of 575,000,000 tons except for the general shortage of labor in the larger coal-producing states. This deficient labor supply was an important factor, however, in enabling operators to maintain prices, and it prevented an output in excess of market requirements, which would have added one more to numerous preceding years when prices were demoralized by an excessive supply. As it was, there was a slight advance in prices, compared with 1912.

The total coal production in 1900 was 269,684,000 tons.

Experiments described in the *Zeitschift des Vereines deutscher Ingenieure* on the flow of water indicate that a decrease in the flow in ascending pipes, and a low efficiency of certain types of pumps are due to the presence of air bubbles in the water. The velocity of the air bubbles increases with the amount of air flowing, and the relative velocity of the air with respect to the velocity of the water increases with the size of the bubbles.

COAST TO COAST.

London, Ont.—It has been announced that the Toronto-Windsor line of the C.P.R. is not to be double-tracked past London.

Toronto, Ont.—The station of the Marconi Wireless Telegraph Company, recently located at Toronto, is in operation.

New Hamburg, Ont.—The Boards of Trade of New Hamburg and Baden have appointed committees to act for those municipalities in the matter of hydro-radial service.

Winnipeg, Man.—The cash receipts of the Winnipeg light and power department in January will attain a record amount of between $85,000 and $90,000, according to the statement of Manager J. G. Glassco.

Yorkton, Sask.—When the new municipal electric power house is complete, and the two new 500 h.p. Diesel units have been installed, Yorkton's plant will have a capacity of 1,150 h.p. The lighting of the town also is to be extended, its main portion to be lighted by 5-light standards.

Moose Jaw, Sask.—Work on the C.N.R. bridge over the Moose Jaw Creek, the proposed entrance of the railway company into Moose Jaw, has ceased; and it is believed that this entrance will be abandoned in favor of running rights over the G.T.P. track into the city.

Vancouver, B.C.—The Imperial Oil Company has secured about 100 acres on Burrard Inlet, and will expend more than $500,000 in an oil-refining plant. Immediate work is to commence, it is understood. Plans for the improvement of the property include a wharf from 700 to 800 feet long.

Victoria, B.C.—The engineering branch of the Victoria civic service has at present in consideration the proposition of a civic-owned paving plant. The city engineer is securing information relative to cost, etc., pending the decision of the Canadian Mineral Rubber Company in connection with the completion of its paving contracts.

Toronto, Ont.—The recent statement of the Hon. Adam Beck shows construction plans for the Hydro-Electric Commission for 1914 entailing an expenditure of between two and three million dollars, and which, by the end of the year, will make the consumption of power considerably in excess of 80,000 h.p. The present monthly load is close to 55,000 h.p.

Granby, B.C.—During the week ending January 14, Granby smelter treated 22,480 tons of ore, 22,094 tons being from the Granby mines and 386 tons from other properties. The copper shipments amounted to 457,000 pounds. During the two weeks ending December 14, a total of 45,318 tons of ore were smelted and 773,000 pounds of blister copper were shipped.

Winnipeg, Man.—J. P. Gordon, assistant chief engineer for the Hudson Bay Railway, has reported that all the roads have been cut through as far as Manitou Rapids by the sub-contractors, McMillan Bros., and they expect to reach Kelly Rapids, within 100 miles of Nelson, before spring. The embankment of the road has been graded as far as mile 150 north of Le Pas.

Winnipeg, Man.—The construction of a steel bridge across the C.P.R. tracks at Salter Street, Winnipeg, instead of the proposed subway, is a proposal which is gaining favor among civic officials. It is believed that in a few years other passages connecting the north and south sections of the city will be necessary; and a system of bridges is considered preferable to subways, owing to the enormous cost of the latter.

Sarnia, Ont.—It is stated that Sarnia's new waterworks plant on the shore of Lake Huron, just above Point Edward, will be completed in July, 1914. It will have a capacity of 6,000,000 gallons daily, and will have cost about $250,000. A feature of the system is that the current of the lake, which runs from 6 to 8 miles an hour at the point at which the plant is located, washes continuously the sand and germs of the filtration basin.

Saskatoon, Sask.—The operating railway mileage in the Province of Saskatchewan at the end of 1913, totalled 4,651 miles, an increase of 897 miles over 1912. This is almost double that of the province of Manitoba, whose railways were extended by 473 miles during 1913. In the Maritime Provinces the increase is merely twelve miles, i.e.:—2 miles in Nova Scotia and 10 miles in Prince Edward Island. New Brunswick remained stationary.

Vancouver, B.C.—The expenditure up to date upon the Point Grey partnership water main from Capilano has exceeded greatly the original estimate of cost. However, that estimate, which was $302,820 for the entire work, was made about five years ago. Up to the end of 1913, there had been expended $379,266 upon the construction; and it is believed that an expenditure of $50,000 will be necessary to complete the work.

Winnipeg, Man.—The gross earnings of the Winnipeg Electric Railway Company for 1913 were $4,078,694, as compared with $3,765,384 in 1912. Net quarterly dividends of $1,070,043, or a rate of 12 per cent. per annum, were paid, leaving a surplus of $185,461 to be added to the profit and loss account. This account at the end of 1913 attained the sum of $2,276,679; and the directors decided to place $1,000,000 of this to the credit of a reserve account; $375,000 in a suspense account; $901,679 remaining in the profit and loss account.

Victoria, B.C.—The award for tenders for piers Nos. 2 and 3, in connection with the Victoria breakwater and harbor works, is being watched for daily by local contractors. The date for reception of tenders was extended to admit of offers from old country firms. Pier No. 2 will be 1,000 feet on one side and 800 feet on the other, and will be 250 feet wide. Pier No. 3, which will be located 300 feet west of pier No. 2, will be 800 feet in length on either side and 250 feet in width.

Toronto, Ont.—A survey for an extension of the Temiskaming and Northern Ontario Railway has finally been made, which is considered feasible by the Provincial Government; and it is expected that construction will commence as early in the spring as the weather will allow. The survey extends from Elk Lake to Gowganda, and will connect by a continuous line of railway Sudbury, Gowganda, and Cochrane. It will make possible the construction of the line at but half the cost involved by the least expensive of the former routes surveyed.

Regina, Sask.—In addition to $160,000, which will be expended on Regina's light and power distribution system in 1914, there is provided $244,000 as capital expenditure on the new power house. Among the larger items which are included in this amount are $72,000 to complete the building, $11,000 to provide for the removal of 1,000 h.p. of boilers from the old power plant to the new, $22,000 for main switchboard and feeder regulator, two 125 k.w. exciters costing $12,000, machine shop equipment costing $6,500, oil filters and storage tanks costing $3,200, and lighting for plant costing $7,000.

St. Thomas, Ont.—The largest steel water structure of its kind has recently been completed at St. Thomas. It is a water tower to be used in connection with the city waterworks system to equalize the pressure and to afford a means of water supply, should a break occur in the pumps or mains. It forms an integral portion of the improvements at present being carried out at the St. Thomas plant at a total cost of $100,000. The tower itself has been erected at a cost of $25,916, has a capacity of 500,000 gallons, a height of 144 feet, and is not only the largest in Canada, but the second largest in America.

Fredericton, N.B.—The adoption of the Fredericton Gaslight Company's proposition to supply electric power for the lighting of the city streets is likely to be accepted by the civic authorities. The company's proposal is to supply power at 3½ cents per kilowatt hour. The latest figures available show the consumption of current for running the street lighting service to be 105,000 kilowatts per annum, which at the quotation named would make the cost of power about $3,500 per annum. This would mean a considerable saving on the present expense of maintaining a civic plant; and would admit, it is considered, of extending the street lighting service, an improvement urgently needed.

Hamilton, Ont.—The entire plant of the Canada Steel Company, which was partly destroyed by fire in August, 1913, has been reconstructed and is ready for operation. The additions and parts rebuilt, including new machinery, have cost approximately $100,000. The company has erected a new brick and reinforced concrete roll and machine shop, 60 x 120 feet, completely equipped with all necessary tools for doing its own repair work; and a new shipping end to the plant, 60 x 250 feet, with crane runway the entire length, which handles all the finished material directly from the shears into the cars. It has also rebuilt the main mill building, has erected a new power house, installing a new 500 horse-power motor; and also an 8-inch mill.

Victoria, B.C.—Mr. H. E. Beasley, general superintendent of the E. and N. Railway Company, has reported that the Canada Bridge Company has completed the Big Qualicum steel span on the East Coast extension of the railway, and has removed its plant and men to Arbutus Canyon, which overlooks the Saanich Inlet. Since the concrete foundations have been ready for months, and some weeks ago the steel for this bridge was placed in readiness for putting together, it is expected that this structure will soon be erected. The E. and N. line will then have replaced all its timber trestles of any importance between Victoria and Wellington, with steel structures of splendid type.

Port Coquitlam, B.C.—The first ocean-going vessel built on the Fraser or Pitt rivers was successfully launched from the ways of the Coquitlam Shipbuilding and Marine Railway Company at the confluence of those rivers on January 31st. The schooner cost $70,000; and all the lumber which was used, except that of the keel and the spars, was logged off St. Mary's Heights, Coquitlam. She is 216 feet in length over all, with 41 feet beam, 14 feet depth of hold, 17 feet draught of water, 900 tons registered tonnage; and she has a lumber capacity of about 1,000,000 feet. She is iron-kneed and copper-fastened throughout, and all her iron work is galvanized. A shaft tunnel and engine-bed have been provided in case auxiliary engines are installed in the vessel.

Regina, Sask.—While other estimates still remain to be considered, up to date the Utilities and Works Committee of the Regina city council has authorized an expenditure of over $2,000,000 for civic works in 1914. An undertaking of great importance is the construction of a 5,000,000-gallon water storage basin at a cost of $140,000. This will be supplemented by two new pumps which are to be purchased, and together these will insure a water supply of 10,000,000 gallons for ordinary purposes and 10,000,000 gallons for fire purposes. Also this year, 12 miles of water mains and a similar mileage of domestic sewer mains will be laid; while the program of works and estimates also provides for sewage disposal, street railway extensions, construction of pavements and sidewalks, and electric light and power extension.

Fredericton, N.B.—A report has been furnished to the provincial government by Messrs. A. R. Gould and Ross Thompson, of the St. John and Quebec Railway Company, upon the progress made during the winter on the railway's bridge construction. Bridges have been completed at Centreville and Shogomoc; and at present a trestle is being erected at Eel River. From Centreville to Gagetown, all the bridges will have been built before spring, with the exception of one at Pokiok, which is in a small zone where steel is not laid. Material for all the structures is in process of manufacture and will be available as soon as required. The trestles still to be built are three below Fredericton, at Hartt Lake, Swan Creek, and Oromocto; and five above Fredericton, at Kelly's Creek, Long's Creek, Garden Creek, the Meduxuekeag, and the C.P.R. crossing at Woodstock.

New Westminster, B.C.—Mr. J. R. Freeman, consulting engineer for the Dominion Government, furnished recently a report to Mr. J. B. Challis, superintendent of the water power department, upon the Coquitlam dam, which has been built by the Vancouver Power Company, and especially upon the water supply of New Westminster, which is taken from above the dam. Mr. Freeman states that the present and prospective needs of New Westminster for water supply are amply provided for by the new intake tower and by the conduit leading from the tower to a point safely down stream from the limits of the dam; and that the work of the Vancouver Power Company has been of such a nature and scope as to tend to improve the quality of the water conveyed from Coquitlam lake to the city, as a result of the removal of stumps and decaying logs from the swampy margins at the lower end of Coquitlam lake, and also the very thorough work of felling, removing and burning the timber and brush within the range of the increased height of flowage by the new dam. Mr. Freeman concludes his observations on the purity of the water supply in the following words: "I know of no natural surface supply of water in the world that is superior to Coquitlam lake as a source for domestic supply, and I find that the company's work in dam-building has been so carried out as to conserve and improve this excellent quality."

Granby Bay, B.C.—One of the largest smelting plants in the Pacific northwest has been completed by the Granby Smelting Company, which has its headquarters at Grand Forks, B.C. The entire construction includes the smelter hydro-electric power plant, machine shops, and an electric railway system. It is located at Hidden Creek in the wilds of northern British Columbia, and has been erected at an approximate cost of $2,500,000. The purpose of the company, primarily, is to handle the output of its Hidden Creek copper mines, which have at present about 8,000,000 tons of ore in reserve, containing from 3 to 5 per cent. copper; but ores from properties owned by other companies and individuals will also be handled. The Granby Company has recently taken over the Midas group of claims and several other copper properties; but the plant, which will have a daily capacity of 2,000 tons, is expected to handle ore from all of these with facility. Operating expenses, also, will be greatly reduced by the proximity of the mines to the smelter. A connection afforded by 1½ miles of electric railway reduces transportation costs on the ore almost to a minimum. The report on the construction which has been furnished by Superintendent Williams, who is in charge of the construction states that there are 16 inches of snow at Hidden Creek, but that the buildings were all enclosed and roofed before the storms came, making possible completion of the work on schedule, the original estimate providing for blowing in the smelter furnaces between January 1 and February 1, 1914.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice. THE CANADIAN ENGINEER publishes, on page 94, a directory of such societies and their chief officials.

CANADIAN MEMBERS, INTERNATIONAL ELECTRICAL CONGRESS.

In connection with the International Electrical Congress to be held September 15th-18th, 1915, at San Francisco, Cal., U.S.A., during the Panama-Pacific Exposition, the following Canadian engineers have been appointed honorary members of the International committee on Congress organization: Dr. L. A. Herdt, (Vice-President I.E.C. and Local Honorary Secretary), McGill University, Montreal; Mr. Ormond Higman, Ottawa, Ont.; Mr. A. B. Lambe, Ottawa, Ont.; Prof. L. W. Gill, Queen's University, Kingston, Ont.

The proceedings of the International Electrical Congress will be divided into twelve sections, relating to the principal branches of electrical engineering, and it is expected that about 250 papers will be presented covering a wide range of topics. The San Francisco congress of 1915 will be held under the auspices of the American Institute of Electrical Engineers, and is authorized by the International Electrotechnical Commission and the Turin Electrical Congress of 1911. The International Electrotechnical Commission will meet at San Francisco during the week preceding the electrical congress.

TORONTO BRANCH, CAN. SOC. C.E.

The first of a series of monthly luncheons, inaugurated by the Toronto Branch of the Canadian Society of Civil Engineers, was held on February 11th, 1914. Over 75 of the local members were in attendance.

In the absence of Mr. A. F. Stewart, chairman of the branch, Major C. H. Mitchell presided. Among the speakers were Dean Galbraith, Mr. J. M. Clark, K.C., and Prof. C. R. Young.

Mr. Young, on behalf of the library committee of the branch, outlined the plans of that committee for the improvement and extension of the usefulness of the library. It was the ideal of the committee, as it is of the Engineers' Club of Toronto, to bring about a unification of the four separate libraries, now in the Club's rooms, into a large and valuable central technical library, accessible to any one who is a member of at least one of the technical societies contributing to it. Unfortunately, the energies of the Engineers' Club directorate were so much taken up with the problem of securing new quarters at the present time that little could be expected of it in the matter of library improvement for a year or two. However, the Canadian Society of Civil Engineers could do a great deal independently that would in no way interfere with what the Club might do, but would be complementary to it.

The policy of the library committee with respect to immediate extension was, first of all, to put on the shelves bound volumes of indispensable periodicals, especially the proceedings and transactions of the great engineering societies; and, secondly, a selection of the books most useful to the practising engineer. Duplication would, in general, be avoided, but might in a few cases be found desirable. In order to make the best possible choice of books, the opinions of many members of the Branch were being sought.

Several schemes for entending the usefulness of the library were outlined by the speaker. A monthly bulletin was suggested as a means of rousing the interest of the members; the privilege of keeping books out for a limited period appealed to the committee; engineering students in the University of Toronto would find the library of value, and the pointing out of this would be a service to them as well as an advantage to the Society through the incoming of many Student members; and, finally, the obtaining of exchange privileges with libraries in other cities would be a desirable arrangement for the members.

VANCOUVER BRANCH, CAN. SOC. C.E.

As announced in last week's issue, a paper, dealing with the construction of the section of the Canadian Northern transcontinental line between Yellowhead Pass and Vancouver, was read by Mr. J. V. Nimmo, before the Vancouver branch of the Canadian Society of Civil Engineers, on February 3rd. The paper was accompanied by 100 lantern views.

Mr. Nimmo, who has had an extended experience on railway work in India as well as on railway location and construction work in many provinces of the Dominion, dwelt upon his subject with detail, and in explaining the various passes across the several mountain chains and intervening valleys, he showed clearly the advantages attained by the Canadian Northern Railway in its route through the Yellowhead and down to the North Thompson via the Albreda Summit. In his remarks he paid tribute to the sagacity and foresight displayed by Sir Sanford Fleming, whose work in the '70's disclosed the desirability of the Yellowhead Pass. He went into details of grades and other technical features of interest to the engineering profession, indicating what the construction department had to contend with and what the completed railways would have to offer in advantages to the operating department.

Regarding construction, he said that the heaviest work was in the Fraser Canyon, where the heaviest mile cost $326,000, up to the point where it was ready for steel. Other portions of the canyon averaged $252,000 a mile in cost. Four years from the beginning of surveys would see the work completed.

In dealing with the locating and other engineering work, he referred to many of the difficulties encountered, and in the views shown indicated some of the perilous places where the engineers had to work, crawling along the faces of escarpments and overhanging cliffs. Notwithstanding this, only one engineer had lost his life in the work.

AMERICAN ROAD BUILDERS' ASSOCIATION—ANNUAL MEETING.

The annual meeting of the American Road Builders' Association for the election of officers was held at New York, Feb. 6th. At this meeting the following officers were elected:—

President—W. A. McLean, Toronto, Ont.
First Vice-President—Geo. W. Tillson, Brooklyn, N.Y.
Second Vice-President—A. W. Dean, Boston, Mass.
Third Vice-President—A. B. Fletcher, Sacramento, Cal.
Secretary—E. L. Powers, New York, N.Y.
Treasurer—W. W. Crosby, Baltimore, Md.

The following directors were appointed for three years:—

Samuel Hill, Seattle, Wash.; Paul D. Sargent, Augusta, Me.; A. H. Blanchard, New York; R. H. Gillespie, New York; Harold Parker, Worcester, Mass.; Fred. E. Ellis, Peabody, Mass.

The reports of the executive committee and the secretary showed a large gain in the active membership of the Association.

ASSOCIATION OF ONTARIO LAND SURVEYORS.

The following constitutes the list of successful candidates at the recent examinations for Ontario Land Surveyors:—

Preliminary—T. N. Enright, Toronto; John F. LaPlant, Simcoe; William W. Perrie, Hamilton; Matthew Rae, Unionville; Henry W. Richardson, Hamilton; Leopold Wright, Toronto.

With supplemental—R. A. Cox, Collingwood; T. K. DeMorest, Ottawa; H. C. Mathers, Lambton Mills; W. R. Peck, Toronto.

Final examination—F. H. Muckleston, Toronto; N. B. MacRostie, Ottawa; S. G. McDougall, Ottawa; G. L. Berkeley, Toronto; Milton E. Crouch, Toronto; Karl Huffman, Toronto; P. A. Jackson, West Toronto; R. S. Kirkup, Fort William.

With supplemental—F. A. Bell, St. Thomas; J. H. McKnight, Simcoe; S. J. Pepler, Toronto; J. M. Riddell, Thessalon; J. R. Wood, Welland.

PERSONAL.

C. H. TOPP has been appointed engineer for the municipality of Esquimalt, B.C., to succeed W. E. Casey, resigned.

E. R. BINGHAM, O.L.S., has been appointed Corporation Surveyor for the city of Port Arthur, to succeed A. L. Russell, resigned.

E. H. VERNER, until recently engineer for the municipality of Coquitlam, B.C., has just been appointed city engineer of Port Coquitlam.

V. J. ELMONT, A. M. Can. Soc. C.E., of Montreal, is attending the annual meeting of the American Concrete Institute and the Cement Show in Chicago.

J. ANTONISEN, C.E., formerly City Engineer of Port Arthur and of Moose Jaw, has tendered his resignation to the Brandon Street Railway Company, for which he has acted as superintendent during the past year.

R. J. MACKENZIE, son of Sir William Mackenzie, will shortly assume the responsibilities of being active head of the lines of the Canadian Northern Railway between Lake Superior and the Pacific coast. He was recently appointed second vice-president.

H. W. DURHAM, M. Am. Soc. C.E., Chief Engineer in charge of highways, Borough of Manhattan, New York City, on February 9th delivered an illustrated lecture on "The Highways of Panama" before the Graduate Students in Highway Engineering at Columbia University.

ROBT. P. WEIR has recently been appointed district representative, with offices in the Traders Bank Building, Toronto, for the Cutter Company, of Philadelphia, Pa. Mr. Weir, a graduate in engineering of the University of Toronto, was previously with the Toronto Power Company, and also with the Toronto Hydro-Electric System.

GEORGE T. CLARK, former City Engineer of Saskatoon from 1909-1913, has been appointed construction manager for Western Pavers, Limited, having purchased considerable stock in the company. He will assume charge on March 1st. Chas. Curtis is president and sales manager of the company and Henry J. Keith is secretary-treasurer.

R. W. MILLS has been appointed head of a new branch of work in the Observatory at Toronto. This service is to supply rural communities with information respecting coming weather and its probable effect on crops, etc. The step was strongly advocated last fall by Mr. R. T. Stupart, Director of the Meteorological Service of Canada. Mr. Mills is a graduate of the University of Toronto.

IRON MINING IN ONTARIO IN 1913.

It has been shown by Mr. Thomas W. Gibson, Deputy Minister of Mines for the Ontario Government, that the production of pig iron in 1913 was about the same as in 1912—e.g., about 600,000 tons, which is valued at about $8,000,000. Five companies operate to produce this tonnage. They are located at Sault Ste. Marie, Midland, Deseronto, Hamilton and Port Colborne. A sixth furnace is being constructed at Parry Sound.

Five mines were worked during the year; the Helen and the Magpie located in the Michipicoten district, and owned by the Lake Superior Corporation; the Moose Mountain, the Bessemer, and the Belmont, the two latter being situated in Eastern Ontario. The ore of the Helen mine is hematite; of the Magpie, siderite, which is roasted to expel the carbonic acid and sulphur; and of the three others, the ore is magnetite, which undergoes concentration and sintering previous to shipment. The ore of the Bessemer is concentrated at Trenton, while the ore of the Belmont is shipped to the new blast furnace recently erected by the Buffalo Union Furnace Co. at Port Colborne. The total output of ore from these mines in 1913 was about 200,000 tons.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, lacks the following issues: Aug. 13th, 1909; Sept. 17th, 1909; Dec. 10th, 1909; Jan. 25th, 1912, 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 in order that they are put into the hands of the party interested?

COMING MEETINGS.

CANADIAN MINING INSTITUTE.—Sixteenth Annual Meeting to be held at Windsor Hotel, Montreal, March 4th, 5th and 6th, 1914. Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

Mr. W. A. McLean of the Highways Department of the Ontario Government has shown in a recent report that, in the organized counties of Ontario, there are 50,000 miles of road. A classification would be approximately as follows:—

Trunks roads connecting the large towns and cities	2,500 miles
County or leading market roads	6,000 miles
(a) Main township roads	25,000 miles
(b) Secondary township roads	16,500 miles

The roads described as trunk roads are, with the exception of a few connecting links, among the most important of the county roads. Main township roads comprise principally the concession roads on which numerous farms front and which converge into and create the traffic of trunk or county roads. Secondary township roads include the little travelled connecting roads.

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.

21283—January 28—Authorizing C.P.R. to construct, by means of a bridge, two tracks of the Cambellford, Lake Ont. and Western Ry. across Sidney Street, town of Trenton, at mileage 87.14 from Glen Tay.

21284—January 29—Relieving, for the present, the C.P.R. from provinding further protection at the crossing known as Keewatin Street, Winnipeg, Man., 400 feet west of mileage 3 on the Brandon Subdivision of said railway.

21285—January 29—Refusing application of G.T.R. for an order amending Order No. 14731, authorizing the G.T.R. to reconstruct Bridge No. 272, mileage 55.75, carrying the 13th Dist., Northern Div. of its railway across a farm road and stream on the west half of Lot No. 20, Con. 3, Tp. Albion, Ont.

21286—Approving revised location of Mount Royal Tunnel and Terminal Co.'s tunnel line from St. Antoine Street to the junction with its main line at Montreal, Que.; and rescinding Order No. 20899, November 27th, 1913.

21287—January 29—Amending Order No. 15449, September 15th, 1911, to provide that the Winnipeg Electric Ry. Co. be authorized to construct its tracks across the C.P.R. spur to the Winnipeg Industrial Exhibition alongside the Winnipeg Beach Branch of the C.P.R. on Selkirk Avenue, Winnipeg.

21288—January 31—Ordering protection by gates at the crossing of Prince Edward Street, by the G.T.R. and C.L.O. and W. Ry. at Brighton, Ont

21289—January 30—Ordering that no car or engine of the G.T.R. be left standing within 50 feet of the east side of the crossing of William Street, London, Ont., by G.T.R.

21290—January 29—Providing protection at the crossing of the first highway east of the station at Hastings by the G.T.R. in the Prov. of Ont.; watchman to be on duty from 7.30 a.m. to 7.30 p.m. daily, to be appointed by G.T.R.

21291—January 29—Authorizing the Municipal Council of the Corporation of Brampton, Ont., to open up Helstine Avenue across the track of the C.P.R. in the town of Brampton, Ont.

21292—January 29—Authorizing the C.P.R. to change the present grade crossing in the Don Road, Lot 2, Con. 3, east of Yonge Street, Tp. York, Ont. and to construct an additional track by means of a grade crossing, across said Don Road, at mileage 93.65, Toronto Subdivision.

21293—January 29—Approving plans No. 55070, December 15th, 1913, and No. 55365, showing overhead highway crossing at mileage 91.7 on the C.L.O. and W. Ry., Tp. Murray, Ont.

21294—January 30—Ordering the C.L.O. and W. Ry. to construct a farm crossing over its railway on the property of Smith A. Hendricks, in Lot 13, Con. 1, Tp. Murray, Ont.

21295—January 31—Extending the time for the completion of the farm crossing on R. V. Ditmars' property by the D.A. Railway, until May 1st, 1914, in the Co. Annapolis and Prov. of N.S.

21296—January 2—Approving location of the Kettle Valley Ry. Co.'s line from Coquihalla Summit to Hope, B.C., mileage 0 to mileage 39.42, subject to the condition that the 14 degree curve at mileage 3.2 be changed to a 12-degree curve.

21297—January 29—Authorizing the C.P.R. to take from the G.T.R. the lands required for right-of-way in the S. ½ of Lot 12, Con. 1, Tp. Hope, Co. Durham, Ont., at mileage 127.74 on the C.P.R.

21298—January 31—Authorizing the C.P.R. to construct a foot bridge over the repair tracks at North Transcona, Man. Division.

General Order No. 120—February 3—Amending special tariffs of charges for detention of refrigerator cars when used for shipments of perishable freight, by eliminating the clauses therein relating to detention at the points of loading said cars.

21299—February 3—Authorizing the C.P.R. to re-construct Bridge 91.5, Toronto Subdivision, Ont. Div., Province of Ontario.

21300—February 2—Approving revised location of a portion of C.P.R. main line, Lake Superior Div., White River Subdivision, "as constructed," from mileage 29.00 to mileage 32.69 (Old Line), mileage 29.00 to mileage 32.49 (New Line), through Tps. 37 and 39, Province of Ont.

21301—January 27—Rescinding Order No. 20893, November 25, 1913, and rescinding Order 17358, August 27th, 1912, in so far as it relieves the C.P.R. from erecting and maintaining fences along portions of its right-of-way between Savona and Pennys.

21302—January 30—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway or siding for the Northern Brick Co., from a point on the southwesterly limit of the C.P.R. at mileage 7.42, thence across public highway to and into the premises of the Northern Brick Company, situate in Lot 4, Con. 5, Tp. Waters, Ontario.

21303—January 30—Authorizing the Canada Southern Ry. to connect its lines or tracks with the lines or tracks of the Niagara, St. Catharines and Toronto Ry. at the intersection or crossing of said railways near and west of Canada Southern Ry. Co.'s station at Welland, Ont.

21304—January 31—Extending the time within which the siding for the International Harvester Co. be completed, until the 31st May, 1913 by the G.T.R.

21305—January 31—Amending Order No. 20697, dated October 30th, 1913, by adding the following paragraph:—"4.—That the Grand Trunk Railway be, and it is hereby, authorized to construct the tracks of its branch line of railway crossing Gilkinson Street to and into the premises of the International Harvester Company of Canada, Limited (the said branch line having been authorized to be constructed under the said Order No. 19127, dated April 25th, 1913) across the tracks of the Hamilton Street Railway Company at the said point. the crossing to be protected by an interlocking plant, the details of which to be settled by an Engineer of the Board; and the cost of installing and maintaining said interlocking plant to be borne and paid by the G.T.R. Co."

21306, 21307 and 21308—February 2—Authorizing the Hydro-Electric Power Commission to erect transmission line across wires of the C.P.R. Telegraph on West Street, Goderich, Ont.; at Lots 17 and 18, Cons. 4 and 5, Tp. Winchester, Ont.; and on West Street, Goderich, Ont., respectively.

21309—February 2—Rescinding Orders of the Board Nos. 4406 and 5804, dated respectively 27th February, 1908 and 10th December, 1908, and granting G.T.R. leave to terminate lease described therein; and the G.T.R., its servants, agents, and workmen to re-enter and thereafter to have, possess and enjoy the said lands and premises freed and discharged from any further recognition or obeservance of the right, easement and privilege created by the said lease, or by the covenants therein contained.

21310—February 4—Authorizing the C.P.R. to construct, by means of a grade crossing, the tracks of its Ballast Pit Spur at La Fleche, across road allowances between the S.E. ¼ of Sec. 15, and the S.W. ¼ of Sec. 16; the N.E. ¼ 8, and the S.E. ¼ of 15; and the N.W. boundary of Sec. 6, at mileage 137.07 on the C.P.R. Weyburn-Stirling Branch, Sask.

21311—February 2—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway. or spur, for the Dominion Grocers. Limited. Moose Jaw. Sask., from a point on the northwesterly limit of right-of-way of C.P.R. main line, Alta. Div., thence across North Railway Street, and across sub-div., Lots 5 to 12 inclusive, Block 67, city of Medicine Hat, Alta.

21312—February 4—Authorizing the C.P.R. to construct the tracks of its Ballast Pit Spur at Meyronne, by means of a grade crossing, across the road allowance between the S.W. ¼ of Sec. 26, and the N.W. ¼ of Sec. 23, Tp. 8, Rge. 7, W. 3 M., at mileage 153.0, C.P.R., Weyburn-Stirling Branch.

21313—February 5—Ordering the C.P.R. and G.T.R. to construct a subway under their double main line tracks at or near a point immediately west of the west end of passenger platform of the C.P.R. station at Ste. Anne de Bellevue, Que.

21314—February 4—Authorizing the C.N.R. to reduce its daily passenger service each way, excepting Sunday, to a tri-weekly passenger service each way, between Kindersley, in the Province of Saskatchewan and Hanna in the Prov. of Alta., from the present time until the 1st day of June, 1914.

21315—February 4—Declaring that land applied for by C.P.R. on French River Indian Reserve, Dist. Parry Sound, Ont., is required by Co. for railway purposes and is land which were it property of private owner could be taken without consent of owner.

21316—February 5—Extending until June 30th, 1914, the time within which C.P.R. complete branch line for J. D. Abbott, Balsam Lake, Tp. Eldon, Ont.

21317—February 5—Authorizing C.N.R. to divert public road in S.E. ¼ Sec. 29, Tp. 25, Rge. 20, W. 3 M., Sask., Alsask S.E. line. Rescinding Order No. 17042, July 16th, 1912, insofar as it authorizes crossing of highway between N.E. ¼ Sec. 20 and S.E. ¼ Sec. 29, said Tp.

21318—February 5—Approving and authorizing clearances of G.T.R. sidings serving premises of Canada Forge Co., Limited, Welland, Ont., for a period of six months from date of this Order, subject to provisions that Ry. Co. keep employees off top and sides of cars when operated over said sidings,, and that speed of trains be limited to rate not exceeding three miles an hour.

21319—January 28—Authorizing the C.N.O.R., subject to terms of resolution, to divert Jane Street at station 1094.32 in the town of North Bay, Ont.

21320—February 5—Relieving the C.P.R., for the present, from the speed limitation of ten miles an hour over the crossing of King Street, Virden, Man., subject to certain conditions.

21321—February 6—Authorizing the Toronto Eastern Ry. Co. and the Oshawa Electric Railway Co., to operate their trains and cars, for a period of six months from date of this Order, over the crossing to Carriage Factory, Oshawa, Ont.

21322—February 6—Authorizing the Toronto Eastern Ry. and the Oshawa Electric Ry. to operate their cars and trains over the crossing at Simcoe Street, Oshawa, Ont., for a period of six months from date of this Order.

21323—February 2—Authorizing the C.N.O.R. to construct, maintain and operate spur line of railway from its Montreal-Port Arthur line at the west boundary of the Tp. of Stafford, through the Tp of Stafford and the town of Pembroke, with two branches at its northerly end in Pembroke, for the service of the Box Factory, the Steel Equipment Co., the Pembroke Lumber Co. and the local freight of the town and surrounding country; and to cross certain streets in Pembroke with the said spur line of railway.

21324—February 7—Authorizing B. C. Electric Ry. to operate cars and trains over crossing of Esquimalt and Nanaimo Ry. near Russell, B.C., authorized under Order No. 18733, February 18th, 1913.

21325—February 10—Rescinding Order No. 21286, January 29th, 1914. And amending Order No. 20899, November 27th, 1913, by adding clause:—"2. That approval herein granted be subject to condition that Applicant Co. acquire fee in and take all land of Mrs. H. B. Rainville, a property owner affected."

21326—February 10—Suspending, pending investigation by Board, Supplements Nos. 151 and 152 to G.T.R. tariff, C.R.C. No. E. 2552, published to take effect February 15th and 16th, respectively.

21327—February 10th—Suspending, pending investigation by Board, advanced rates published in Supplements Nos. 40 and 42 to C.P.R. tariff C.R.C. No. E. 2559, applying on building brick from Cooksville and Weston, Ont., to Toronto; and on gravel and building sand from Cooksville, Ont., to North Toronto, Parkdale and Toronto.

21328—February 10—Authorizing C.P.R. to construct spur for Winnipeg Paint and Glass Co., Limited, in D.G.S. 14, parish of Kildonan, Manitoba.

21329—February 6—Suspending, pending hearing and determination of matter by Board, increases in switching rates on sand, gravel and brick as from February 15th, 1914, notice of which is given in Supplements Nos. 19 and 20 to G.T.R. tariff C.R.C. No. E. 2677.

21330—February 9—Relieving C.P.R. from speed limitation of 15 miles an hour over portions of Weyburn-Stirling branch between mileages 0 and 52.2 on said branch line.

21331—February 9—Authorizing C.P.R. to construct spur extension for Ontario Stone Corporation, Limited, from end of existing spur for distance of 500 feet from B to C, as shown on plan, in Lot 10, Con. 4, Tp. North Orillia, Co. Simcoe, Ontario, at Uhtoff, mileage 68.4 on Ontario Division.

21332—February 4—Authorizing C.P.R. to take certain lands in Con. 3, Tp. Bathurst, Ont., for purposes of its railway, subject to certain conditions.

21333—February 9—Authorizing C.N.O.R. to construct across C.P.R. (Ottawa-Prescott Branch), near Hurdman's Bridge, Tp. Nepean, Ont., subject to and upon certain conditions.

21334—February 10—Rescinding Order No. 17477, September 12th, 1912, and 2. Directing that C.P.R., at its own expense, close present crossing and restore original crossing of Toronto and Sydenham Road, Tp. Holland, Ont., crossing to be constructed as nearly as practicable at right angles as shown in red on plan dated January 23rd, 1914.

21335—February 10—Authorizing C.P.R. to construct, by means of a bridge, across road allowance between Lots 22 and 23, Con. "A.," Tp. Hamilton, Co. Northumberland, Ont., at mileage 121.29 from Glen Tay.

21336—February 10—Authorizing C.P.R. to change present grade crossing in road allowance between Lots 13 and 14, Con. 3, in Tp. Trafalgar, Co. Halton, Ont., and to construct an additional track, by means of grade crossing, across said road allowance between Lots 13 and 14, mileage 31.77, London Subdivision, Ontario Division.

21337—January 29—Authorizing C.P.R. to construct, at grade, tracks of St. Mary's and Western Ontario Ry., along Thames Avenue, and across Park and Elgin Streets, town of St. Marys.

21338—February 10—Approving location C.P.R. station at Parsons, B.C., in S.E. ¼, Sec. 30-24-19, W. 5 M., mileage 22.80.

21339—December 3—Authorizing C.N.R. to construct spur for Dominion Gypsum Co. in Lot 13, River Lot 42, St. James, and to construct said spur across St. James Street, city of Winnipeg, Man., subject to and upon certain conditions.

21340—February 11—Relieving C.P.R. from speed limitation of 15 miles an hour over portion of Swift Current southeasterly branch line from point on main line near Swift Current, Sask., to Neville, Sask., mileage 27.5.

21341—February 10—Authorizing C.P.R. to construct, at grade, its Weyburn-Stirling Branch Line across twenty-two (22) highways, between mileages 277.78 and 298.07, province of Saskatchewan.

21342—February 11—Authorizing G.T.R. to reconstruct Bridge No. 240, carrying its railway over Bear Creek at Mile Post 212.07, near Powassan, 12th District.

21343—February 9—Authorizing C.N.R. to construct spur for Messrs. Nicholson and Blain, to serve Lot 112, Block 7, Hudson Bay Reserve, Edmonton, Alta., and to cross with such spur Peace Avenue, said city.

21344—February 11—Amending Order No. 20857, November 19th, 1913, to provide that G.T.P. Ry., construct forthwith a station and platform at Telkwa, B.C., not to be below the standard of a No. 1 A, B.R.C. station.

21345—February 11—Authorizing C.P.R. to reconstruct Bridge No. 18.71, Coronation Northwesterly Branch, over Battle River, Alta.

21346—February 11—Authorizing G.T.R. to reconstruct Bridge No. 234 over McCormick's Creek, mileage 43.30 on Fourth District, Montreal Division, Province of Quebec.

21347—February 10—Approving Supplement No. 3 to Express Classification for Canada No. 3, prescribing regulations for shipping of live poultry in coops.

21348—February 12—Authorizing the C.N.R. to open for the carriage of traffic its line of railway from Drumheller, mileage 314.7 to mileage 396.4, Alta.

21349—February 11—Ordering the Wabash Railroad Co. to stop its train No. 5 at Corinth, if flagged, on Tuesday, Thursday and Saturday of each week, for a period of 60 days from date of this Order.

21350—February 11—Ordering protection at the crossing of Bennett Avenue, Maisonneuve, by the C.N.Q. and the Montreal Terminal Rys., by means of a pair of gates, which are to be operated by day and night watchmen.